A PHENOMENOLOGICAL STUDY: THE LIVED EXPERIENCE OF SELF-DESCRIBED
MATH-ANXIOUS STUDENTS ATTENDING COLLEGE ONLINE

by

Toni Nicole Sawhill

Liberty University

A Dissertation Presented in Partial Fulfillment
Of the Requirements for the Degree
Doctor of Philosophy

Liberty University
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ABSTRACT

The purpose of this transcendental phenomenological study is to describe the lived experience of mathematics anxiety for self-described math-anxious students who completed an undergraduate mathematics course online at a university in the Pacific Northwest part of the United States. The theory guiding this study is community of inquiry (COI) introduced by early pragmatist philosophers C. S. Peirce and John Dewey and further developed by D. Randy Garrison, Terry Anderson, and Walter Archer as mathematics anxiety is a learned behavior based on students’ experiences. This research study answers the central research question: What are the lived experiences of mathematics anxiety for self-described math-anxious college students who completed a mathematics course online? Data was collected from a purposeful, criterion sample of 10 self-described math-anxious students who have completed an online mathematics course. Data collection methods included questionnaires, individual interviews, and focus group meetings. Data analysis followed a systematic procedure that included epoche, phenomenological reduction, imaginative variation, and synthesis. Three themes emerged from this research: teaching presence, social presence, and cognitive presence. The findings revealed how self-described math-anxious students who completed an online undergraduate math class experienced math anxiety due to a lack of understanding of the concepts taught through gaps in prior knowledge or the inability to connect new concepts. Further research is needed regarding math anxiety and other factors to include (a) later in life diagnosis or misdiagnosis of conditions that challenge learning, (b) fear of asking for help, (c) social connection with other students, and (d) addressing math anxiety in the online math classroom.

Keywords: cognitive presence, confidence, distance education course (online class), E-Learning, mathematics anxiety, motivation, performance, social presence, teaching presence
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Dedication

This research project is dedicated to my husband, Christopher Sawhill, and my students. To my husband: you have supported me through my endeavors, both through your actions and your words of encouragement. You listened as I vented and stressed about deadlines and encouraged me when I wanted just to be done. You also offered help where you could all while working full-time and going to school to finish your bachelor's degree. Although I will never be your “sugar mama”, I will always strive for more because I know we have got this with you by my side. To my past, present, and future students: I will continue to be your biggest cheerleader in mathematics because many of you are too hard on yourselves. Remember that everyone makes mistakes, and they are simply learning opportunities.
Acknowledgments

There are several people I wish to acknowledge for their contributions to my journey through my dissertation. Dr. Jennie Carr for helping me not only throughout her course but with other courses and for directing me in the right direction for my theoretical framework and other critical factors in my dissertation process. Dr. Matthew Ozolnieks for his great attitude and always being positive. He was a fantastic chair that made me feel like I was doing amazing work while critiquing me – a true gift. Dr. Park for stepping in during Dr. Ozolnieks' brief absence and ensuring that my progress was not interrupted. She provided excellent advice, tips, and guidance. Dr. Megan Cordes for her keen eye and wonderful edits and suggestions. She was a fabulous committee member to have on my side. My sister, Erica West, and my parents, William and Luetta States, for allowing me to vent and cry when I became overwhelmed with coursework, work, and life in general. The study participants for volunteering their time to participate in my research study. Their selfless act allowed for a better understanding of the lived experiences of self-described, math-anxious students who completed a math course online.
# Table of Contents

ABSTRACT ......................................................................................................................... 3

Copyright Page ................................................................................................................... 4

Dedication .......................................................................................................................... 5

Acknowledgments .............................................................................................................. 6

List of Tables ..................................................................................................................... 13

List of Figures .................................................................................................................... 14

List of Abbreviations ....................................................................................................... 15

CHAPTER ONE: INTRODUCTION ...................................................................................... 16

  Overview ......................................................................................................................... 16

  Background ...................................................................................................................... 17

    Historical ....................................................................................................................... 17

    Social .............................................................................................................................. 21

    Theoretical .................................................................................................................... 22

  Situation to Self .............................................................................................................. 24

  Problem Statement ........................................................................................................ 25

  Purpose Statement ........................................................................................................ 26

  Significance to the Study ............................................................................................... 27

    Empirical ....................................................................................................................... 27

    Theoretical .................................................................................................................... 28

    Practical ......................................................................................................................... 29

  Research Questions ....................................................................................................... 30

  Definitions ....................................................................................................................... 32

  Summary ........................................................................................................................ 33
CHAPTER TWO: LITERATURE REVIEW

Overview ................................................................................................................................. 35
Theoretical Framework ........................................................................................................... 35
Related Literature ................................................................................................................ 45
  Motivation .............................................................................................................................. 45
  Confidence ............................................................................................................................ 48
  Performance .......................................................................................................................... 51
  Interventions ......................................................................................................................... 53
  E-Learning .............................................................................................................................. 60
  Retention ............................................................................................................................... 62
Summary .................................................................................................................................... 63

CHAPTER THREE: METHODS ................................................................................................. 66

Overview .................................................................................................................................... 66
Design ......................................................................................................................................... 66
Research Questions .................................................................................................................. 69
Site ............................................................................................................................................... 70
Participants ............................................................................................................................... 71
Procedures ................................................................................................................................. 73
The Researcher’s Role ............................................................................................................... 76
Data Collection ......................................................................................................................... 77
  Questionnaire .......................................................................................................................... 78
  Individual Interviews .............................................................................................................. 83
  Focus Group Meetings .......................................................................................................... 88
<table>
<thead>
<tr>
<th>Section</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>Katie</td>
<td>108</td>
</tr>
<tr>
<td>Walter</td>
<td>109</td>
</tr>
<tr>
<td>Results</td>
<td>110</td>
</tr>
<tr>
<td>Teaching Presence</td>
<td>116</td>
</tr>
<tr>
<td>Motivation</td>
<td>117</td>
</tr>
<tr>
<td>Trust</td>
<td>118</td>
</tr>
<tr>
<td>Social Presence</td>
<td>119</td>
</tr>
<tr>
<td>Encouraging Collaboration</td>
<td>119</td>
</tr>
<tr>
<td>Sense of Belonging</td>
<td>120</td>
</tr>
<tr>
<td>Cognitive Presence</td>
<td>121</td>
</tr>
<tr>
<td>Motivation</td>
<td>121</td>
</tr>
<tr>
<td>Connecting Ideas</td>
<td>122</td>
</tr>
<tr>
<td>Research Question Responses</td>
<td>122</td>
</tr>
<tr>
<td>Central Research Question</td>
<td>122</td>
</tr>
<tr>
<td>Sub Question One</td>
<td>127</td>
</tr>
<tr>
<td>Sub Question Two</td>
<td>128</td>
</tr>
<tr>
<td>Sub Question Three</td>
<td>130</td>
</tr>
<tr>
<td>Summary</td>
<td>135</td>
</tr>
<tr>
<td>CHAPTER FIVE: CONCLUSION</td>
<td>136</td>
</tr>
<tr>
<td>Overview</td>
<td>136</td>
</tr>
<tr>
<td>Discussion</td>
<td>136</td>
</tr>
<tr>
<td>Interpretation of Findings</td>
<td>137</td>
</tr>
<tr>
<td>Summary of Thematic Findings</td>
<td>137</td>
</tr>
</tbody>
</table>
Appendix K: Responsive Records from Site for Potential Participants .........................185
Appendix L: Recruitment Email Sent to Potential Participants ..................................186
Appendix M: Screening Survey ................................................................................188
Appendix N: Welcome Email to Participants ..............................................................190
Appendix O: Consent Form .......................................................................................191
Appendix P: Questionnaires & Scheduling Email .......................................................194
Appendix Q: Demographics Questionnaire ................................................................196
Appendix R: Email Confirmation for Online Individual Interviews ............................198
Appendix S: Email Reminder with Invitation to Online Individual Interviews ............199
Appendix T: Email Confirmation for Online Focus Group Meeting ............................200
Appendix U: Email Reminder with Invitation to Online Focus Group Meeting ..........201
Appendix V: Email of Gratitude for Participation in the Study and Invitation for Member Check ......................................................................................................................202
List of Tables

Table 1: Self-Described Math-Anxious Student Participants .................................................. 101
Table 2: Initial Codes ............................................................................................................ 112
Table 3: Organization of Themes ........................................................................................ 116
List of Figures

Figure 1: Essential Code Categories to Final Code

115
List of Abbreviations

Community of Inquiry (COI)
Mathematics Anxiety (MA)
Underprepared first-time-in-college (FTIC)
CHAPTER ONE: INTRODUCTION

Overview

Mathematics anxiety has been steadily increasing since the 1950s, and with an ever-increasing technological society, it is essential to build retention in STEM college courses and careers (Chang et al., 2016; Gough, 1954; Hembree, 1990; Jen-Mei et al., 2016; John et al., 2020; Jones, 2015; Xue & Larson, 2015). Students today struggle with mathematics anxiety, which directly affects their education and potential employment due to the ever-increasing use of technology in daily and professional life (John et al., 2020). Math-anxious students may no longer pursue higher education or specific career paths because of their fears (John et al., 2020). Mathematics anxiety is a learned behavior (Hembree, 1990; John et al., 2020) and can be caused by several factors, such as a math classroom experience, an experience with a math teacher, generally falling behind in mathematics, or the act of completing math itself (Ashcraft & Kirk, 2001; Foley et al., 2017; Gough, 1954; John et al., 2020). Mathematics anxiety can be damaging to a student’s motivation (Wang et al., 2018), confidence (Boaler, 2016; Cropp, 2017; Everingham et al., 2017; Herts & Beilock, 2017), and performance (Foley et al., 2017) in mathematics. Richardson and Suinn (1972) defined mathematics anxiety as feelings of anxiety that disrupt the ability to manipulate numbers and solve mathematics problems in daily life and academic situations. Students build walls to avoid mathematics due to their anxieties, but there is hope. There are now interventions that may help reduce their anxieties and build their motivation, confidence, and performance in mathematics rather than building walls. Students can take charge of their mathematics anxiety and change their negative views about mathematics using interventions. With the use of interventions in mathematics, students can construct new thoughts and ideas about mathematics. The community of inquiry model helps explain how
educational experience is built through the intersection of social presence, cognitive presence, and teaching presence (Garrison et al., 2000; Richardson et al., 2012). This means that students are no longer merely learning about mathematics but constructing ways of how they create how they experience learning math. The first chapter of this study provides a background to the problem, situation to self, the problem statement, the purpose statement, the significance of the study, and the four research questions addressed in the study. Key terms were defined, and a summary was provided for the chapter.

**Background**

The background of mathematics anxiety must be understood to better understand it and how it affects students attending college online. The background information found below includes a historical summary of mathematics anxiety, the social background of mathematics anxiety, and the theoretical background for this study pertaining to mathematics anxiety. The historical context of mathematics anxiety is essential as it helps draw a picture of how it began and has grown. It started in the 1950s, first labeled by Gough (1954) as “mathemaphobia” (p. 290). The social context of mathematics anxiety is essential as it helps explain the implications that mathematics anxiety has on society and why it is vital to better understand this phenomenon. The theoretical context is important because it helps tie all the pieces together to form the whole picture of mathematics anxiety from its beginnings to social considerations and how it affects students and their learning.

**Historical**

The academic study of math anxiety began in the 1950s when Sister Mary Fides Gough (1954) introduced the term mathemaphobia, which describes students' phobia-like feelings towards math. Gough (1954) likened mathemaphobia to the common cold and wanted to know
why more effort was not being put into a cure as one does with other physical ailments. Gough (1954) suggested that a foundation such as the heart or cancer foundation should be created for mathemaphobia. Gough (1954) pointed out that the mathemaphobia “germ” (p. 290) may be present for years and not rear its damage until later in a student’s academic career. Suggestions for the causes of mathemaphobia included a negative experience with a math teacher in the past, falling behind in mathematics, students being moved forward in mathematics before being adequately prepared, and parents’ fears of mathematics transferring onto their children (Gough, 1954).

Gough (1954) explained how, unlike other subjects, mathematics builds upon itself, and students must successfully learn the previous topic to successfully complete the next topic and so on. This can be exacerbated by the fact that students will inevitably miss school due to illnesses, accidents, vacations, or for any other variety of reasons, so, at some point in a student’s career, they will fall behind in math (Gough, 1954). Another reason Gough (1954) gave for mathemaphobia was the lack of conceptual knowledge of a topic. Gough (1954) gave the example of the addition axiom being introduced in a geometry class, and by making the concept more concrete, students are better able to understand it. “Money talks” (Gough, 1954, p. 293) was explained as an excellent tool for making concepts more concrete because students, both young and old, know the value of a dollar and how it works. This idea ties into using reasoning to complete word problems and how students need to develop this tool, and those with mathemaphobia may need more time ascertaining this practice due to their fear of math (Gough, 1954). Then there is always the age-old excuse that my parents are not good at math, so I must not be either. Gough (1954) addresses this idea of “hereditary mathemaphobia” (p. 294) by poking good-natured fun at the student and idea to help break barriers and show how ridiculous
that idea is. Gough (1954) explained what mathemaphobia was, how it affected students, its causes, and that it had a cure. Gough (1954) continued with why it may not be noted in higher education yet (the 1950s) as it seemed only to rear its ugly head in required courses, and at the college level, students may elect to avoid these courses.

Although Gough (1954) was the first to describe math anxiety using the term mathemaphobia, Richardson and Suinn (1972) developed the first math anxiety measurement scale in 1972. They used the term mathematics anxiety in their work. They defined it as “Mathematics anxiety involves feelings of tension and anxiety that interfere with the manipulation of numbers and the solving of mathematical problems in a wide variety of ordinary life and academic situations” (p. 551). Their scale was called the Mathematics Anxiety Rating Scale (MARS). It was used to measure mathematics anxiety for the use of treatment and research by reporting normative, reliable, and valid data (Richardson & Suinn, 1972). Richardson and Suinn (1972) believed that the reliable measurement of math anxiety would be helpful as a diagnostic tool, in research to help with the effectiveness of various interventions, as an aid in developing anxiety hierarchy in interventions, and used within control group experiments. MARS was developed as math anxiety was becoming more of a common problem at the college level (Richardson & Suinn, 1972).

As time passed, more research was conducted regarding math anxiety. In 1990, Hembree conducted a meta-analysis. He found that anxiety is an unpleasant emotion that students direct towards future endeavors with mathematics and is unproportionate to the threat of mathematics. The study of math anxiety has encouraged the idea that students’ achievement and participation in math will decline, thus intimidating otherwise capable students (Hembree, 1990). Hembree’s (1990) meta-analysis consisted of 151 studies, 49 journal articles, 23 ERIC documents, 75
doctoral dissertations, and four reports in other sources. The data obtained were assessed, and five tasks were identified. The first task was to identify variables that correlate to the construct. This included performance, attitude, avoidance behaviors, and correlations among anxieties. The second task compared anxiety degrees within variables such as gender, race, grade level, etc. The third task determined the relationships between math anxiety and performance. The fourth task displayed the effects of treating math anxiety. Finally, the fifth task addressed specific theoretical questions using tasks one through four results. The results were fascinating as Hembree (1990) discovered that math anxiety levels increased through junior high, peaked near ninth/tenth grade, and leveled in upper high school and college. It was also found that math anxiety levels were higher in remedial courses and waned with more advanced courses (Hembree, 1990). Hembree (1990) also found that low-anxious students scored better than high-anxious students. Further results showed the interventions did help with math anxiety, but the success level depended on the intervention used. Hembree (1990) also discovered that a substantial reduction in anxiety accompanied a significant increase in math test scores, meaning that mathematics anxiety seemed to be more behavioral in nature and a learned condition similar to test anxiety rather than being cognitive in nature.

Mathematics anxiety has continued to grow and currently affects today’s math students through avoidance of classes, retention in STEM fields both in education and employment (Jen-Mei et al., 2016; Snyder & Cudney, 2017; Xue & Larson, 2015), and graduation rates (Jones. 2015). John et al. (2020) explained that current research supports the idea that students with negative perceptions of math continue to have poor outcomes in math and that retraining students’ perceptions or experiences with math to more positive ones may help in STEM participation. Jen-Mei et al. (2016) presented ways to retain college students in STEM
disciplines through scholarships and supportive academic community through interactions with teachers and other students. Snyder and Cudney (2017) suggested that community college would be a great tool in retaining college students in STEM courses and careers. Weng (2015) suggested that the flipped classroom would be the best method of learning mathematics as it allowed students to learn more naturally at a self-pace.

Historical research presented mathematics anxiety as a learned behavior related to previous math experiences (Gough, 1954; Hembree, 1990; John et al., 2020). If math anxiety is a learned trait, then there must be a way to unlearn it – a cure – implementing interventions (Gough, 1954; Hembree, 1990; Richardson & Suinn, 1972). Thus, alleviating the anxiety and allowing the students afflicted with mathematics anxiety to become more successful in math and less likely to avoid it (Gough, 1954; Hembree, 1990; Richardson & Suinn, 1972). Helping to alleviate mathematics anxiety continues to be at the forefront of education as it has moved into the realm of higher education and stunts students’ progression in the STEM pipeline (Jen-Mei et al., 2016; John et al., 2020; Snyder & Cudney, 2017; Weng, 2015).

Social

College developmental math courses are found at most colleges and universities throughout the United States and are in place to help develop college students’ math abilities and prepare them for college-level math courses (Bailey et al., 2010; Bailey et al., 2016; Cafarella, 2016; Cox & Dougherty, 2019; Park et al., 2018; Valentine et al., 2017; Weng, 2015). One of the primary needs for college developmental math courses is to help with retention in STEM courses and careers by finding interventions to target ways to improve STEM outcomes and feelings towards math (Bailey et al., 2016; Cafarella, 2016; Cox & Dougherty, 2019; John et al., 2020; Park et al., 2018; Valentine et al., 2017; Weng, 2015). Modern society is ever advancing its
reaches in technology, and the success in that is due in large to mathematics and the problem-solving skills that accompany mathematics (Shapka et al., 2006). Furthermore, college students lacking math skills are not afforded the same career opportunities (Shapka et al., 2006).

Underprepared first-time-in-college (FTIC) students are the group that is most likely to enroll in college developmental math courses, and they benefit from these courses (Park et al., 2018). Although there is a need for college developmental math courses, it does not mean that those classes are always successful (Valentine et al., 2017). Some students see college developmental math courses as a waste of time and money as students are essentially retaking a course from high school (Bailey & Jaggars, 2016; Valentine et al., 2017). Still, more students are over- or under-placed in developmental math courses (Bailey & Jaggars, 2016). Many will either not complete the sequence they begin or will forego developmental courses all together (Bailey et al., 2010; Bailey & Jaggars, 2016). Educators must find a way to bridge the gap in math education from high school to college so students can continue their progress forward and are not deterred by extra costs and time due to mathematics anxiety.

**Theoretical**

As of Fall 2018, over six million students participated in some form of online education, with the majority of those being undergraduate students (National Center for Education Statistics, 2018). Reasons students took online classrooms in 2018 included existing commitments that would not allow students to attend on-site courses (47%), online learning was the only way to pursue the interest held (21%), employer incentive or partnership (21%), school reputation (8%), and other reasons (4%) (educationdata.org, n.d.). Today, more college students are completing college online, and the current COVID-19 pandemic has exacerbated this as colleges have closed their on-site settings and transferred classes to an all-online format. In
addition, in March 2020, the Centers for Disease Control and Prevention (CDC) issued guidelines for higher learning institutions regarding alternative teaching methods – primarily online and distance learning (educationdata.org, n.d.). As of April 2, 2020, estimates showed that 22.3 million students were impacted as 98% of institutions had moved from on-site, in-person classes to online classes (educationdata.org, n.d.). The University of Washington was the first major university to close on March 7, 2020 (educationdata.org, n.d.). With the sudden change to online learning, immediate concerns of college and university presidents as of April 2, 2020, included students’ mental health, employees’ mental health, short-term financial costs (unbudgeted), accelerated rates of student attrition, accessibility to online learning platforms/tools, faculty readiness for online learning, and technological readiness for online learning (educationdata.org, n.d.).

With more college students than ever taking online math courses, it is more important than ever to research mathematics anxiety as it relates to online mathematics courses to better understand how it affects students in this setting to promote an effective learning environment. This research benefits students, educators, and curriculum developers as it provides an overall view of mathematics anxiety in an online environment. Curriculum developers will be able to restructure how desired outcomes are presented and met. Educators will be able to modify their lessons and materials, and students will be able to enjoy a more productive learning environment. In completing this research, it was important to examine the variables of motivation, confidence, performance, interventions, E-Learning, and retention. The first three variables were important as they are directly affected by mathematics anxiety. The fourth variable was important as it is what has been executed to help alleviate mathematics anxiety. The fifth and sixth variables are
important as they pertain to how the study of mathematics anxiety will benefit both students and schools.

**Situation to Self**

The paradigm that I brought to this study was the interpretative framework of social constructivism accompanied by ontological beliefs. Social constructivism applies to qualitative research in that the researcher wants to understand the world in which they live and work (Creswell & Poth, 2018). An ontological assumption can be described as the nature of reality that explores multiple forms of truths based on different individuals’ perspectives and experiences and can be seen through multiple views (Creswell & Poth, 2018). I prefer this philosophical assumption because each student experiences math differently and creates their math lens based on those experiences.

Having worked in primary, secondary, and higher education classrooms and as a college math instructor, I have seen first-hand the trepidations students hold towards mathematics. There are several reasons students have such harsh feelings towards mathematics, but the reason that crosses ages, levels of mathematics, and gender is mathematics anxiety. I have seen the stress that mathematics anxiety causes students first-hand, and I have also seen the excitement that comes to students when they break through mathematics anxiety. Mathematics anxiety could come from parents’ projection, a bad experience with a teacher, falling behind in mathematics, and more. Personal experiences with mathematics help build students’ relationships with mathematics in either a positive or negative way. In my experience, the more negative experiences a student faces in mathematics, the more likely they are to develop mathematics anxiety and doubt their mathematics confidence, motivation, and performance. While working with college-level students in a summer math bridge program and as an online college math
instructor, I have discovered that mathematics anxiety is learned and can be unlearned using interventions that help improve students’ mathematics confidence, motivation, and performance. Having experienced this first-hand with students, I believe that mathematics anxiety exists and is created or manifests differently for each student. I also believe that it can be overcome using interventions, employing appropriate teachers, and changing students’ mindsets.

I want to understand the world in which I work, and part of doing so is to understand students’ perspectives and how they construct their relationship with mathematics and why. I want to understand how students feel about completing a math course online and if they believe it was a success or not based on their needs and desires – the constructs they created to measure the course. I hope to better understand how students’ lived realities differ from one another but still contribute to the common phenomenon of mathematics anxiety. My motivation to conduct this study is to better understand the lived experiences of math-anxious college students who have completed an undergraduate math course online to help make math a more enjoyable experience for my future students. In doing so, they can see themselves as successful math students whose fear of mathematics does not hinder their goals and desires. My personal assumptions shaped and influenced my study as I believe in hope and providing hope to others. However, to provide hope, you must understand the need, wants, and desires and what inhibits those.

**Problem Statement**

The problem is as mathematics anxiety has increased so have the advances in technology that rely on mathematics that now drive an ever-increasing technologically savvy society and workforce, but fewer students are remaining in STEM fields (Chang et al., 2016; Everingham et al., 2017; John et al., 2020; Jones, 2015; Wang et al., 2018; Xue & Larson, 2015). This study
was essential as there is a current gap in the literature involving mathematics anxiety and college students taking mathematics courses online. Some effective interventions have been used to alleviate mathematics anxiety, but these interventions have yet to produce any significant effect on a larger scale (Cropp, 2017; Foley et al., 2017; Lazowski & Hulleman, 2016; Manning, 2018). This study sought to help better understand how self-described math-anxious college students completing an online mathematics course experience mathematics anxiety and perceive the phenomenon of mathematics anxiety.

**Purpose Statement**

The purpose of this transcendental phenomenological study was to describe mathematics anxiety for self-described math-anxious students who have completed an undergraduate mathematics course online at a regionally accredited university located in the Pacific Northwest part of the United States. Mathematics anxiety was generally defined as “feelings of tension and anxiety that interfere with the manipulation of numbers and solving mathematical problems in a wide variety of ordinary and academic situations” (Richardson & Suinn, 1972, p. 551). The theory guiding this study is community of inquiry (COI) and was first introduced by early pragmatist philosophers Peirce and Dewey (Garrison et al., 2000; Richardson et al., 2012). COI describes how learning occurs for a group of individual learners through the educational experience at the intersection of the three elements of social presence, cognitive presence, and teaching presence (Garrison et al., 2000; Richardson et al., 2012). Mathematics anxiety is a learned behavior based on students’ experiences (Hembree, 1990; John et al., 2020) created at the intersection of social presence, cognitive presence, and teaching presence.
Significance of the Study

The significance of this study was to further the research on the phenomenon of mathematics anxiety. Researchers of numerous studies have sought to investigate mathematics anxiety in elementary and secondary education. However, fewer researchers have investigated this phenomenon in higher education, and fewer still in online classrooms. A significant gap exists in the research on the experiences of self-described math-anxious college students who have completed mathematics online, particularly examining how and why perceptions develop through a phenomenological lens. This study sought to reveal common themes of how various perceptions develop regarding mathematics anxiety and online math courses so that leaders in higher education could better develop these courses.

Empirical

Mathematics anxiety has been discovered, identified, and studied throughout the world. Most of the research presented here reflects the idea that math anxiety is a learned concept (Gough, 1954; Hembree, 1990; John et al., 2020; Richardson & Suinn, 1972) that can be treated using interventions such as mindset, peer mentoring, engagement strategies, and instruction time (Boaler, 2016; Cropp, 2017; Dweck, 2014, November; Everingham et al., 2017; Foley et al., 2017; Pierson, 2013, May). These interventions differ significantly, but all show positive progress when studied. Studying these interventions was significant to this study as it helped set a baseline that interventions can be successful tools in helping to alleviate mathematics anxiety. Boaler (2016) wanted to intervene using a new mindset, a growth mindset. This idea would change the way students thought about themselves and how they learned. Rather than a student saying that they are not good at math and never will be, students would be challenged to think they are not good at math yet. The power of yet helps students believe in themselves, as Dweck
(2014, November) explained in her TED talk that yet gave students hope. Just because students had not yet mastered a concept did not mean that they could not; it just meant the students required more time and practice (Dweck, 2014, November). Cropp (2017) studied peer mentoring as an intervention to math anxiety and found it successful for most participants. The students were able to build a relationship with their mentor and felt more comfortable talking and asking questions of their peers instead of their teacher. Foley et al. (2017) also applied an idea like peer mentoring and found it successful with one-to-one tutoring intervention. Foley et al. (2017) also discussed interventions at the teacher level with more instruction time and better-quality instruction. This resonates with Gough’s (1954) observation that students’ math anxiety may stem from a bad experience with a teacher and the instruction given or lack thereof. In her TED talk, Pierson (2013, May) echoed this idea of teachers being champions for their students. Pierson (2013, May) expressed how students need someone on their side, motivating them and encouraging them. Everingham et al. (2017) suggested engagement strategies as interventions for math-anxious students. The thought was that if the students were more engaged in the process, they would do better as their math anxiety would decrease as they became more comfortable.

Theoretical

Mathematics anxiety has been studied in depth in primary and secondary schools and in on-site classes, but less is known about mathematics anxiety in higher education and, more specifically, in E-Learning in the form of online classes. The three elements of social presence, cognitive presence, and teaching presence found in the theory of community of inquiry all interrelate with one another to build a community within a classroom (Garrison et al., 2000; Garrison et al., 2001; Garrison & Anderson, 2003; Richardson et al., 2012). The community built from the three elements of COI helps create the students’ learning experience (Garrison et al., 2000;
Pardales & Girod, 2006). COI was initially developed for in-classroom use but has been applied to online learning as it has adapted and evolved as society has done (Garrison & Anderson, 2003). However, not everyone agrees as to the appropriateness of the use of it in online education, specifically the importance placed on each element of COI (Garrison & Akyol, 2015; Bleazby, 2012; Borba et al., 2016; Choo et al., 2020; Huang et al., 2019; Man et al., 2019; Peacock & Cowan, 2018). There has also not been much research regarding COI and mathematics anxiety, specifically related to online learning in higher education. Therefore, the previous community of inquiry studies' findings may not be generalized to self-described math-anxious students in higher education who have completed a mathematics course online. This study employed qualitative research methods to explore further the experiences of self-described math-anxious students who have completed an undergraduate math course online offered by the site to advance the theory of community of inquiry.

**Practical**

The importance of this research taking place at a university in the Pacific Northwest part of the United States is because the university has not yet fully continued normal learning operations. Due to the current COVID-19 pandemic, the site has been offering more online learning opportunities than ever before and plans to continue through Summer 2021. The site is planning to return to normal, pre-pandemic learning opportunities for the Fall 2021 quarter but will offer more online learning opportunities than ever before. This study would help the university administration see how online math courses affect students, if at all. This study's results may help the university promote more online math courses or better able them to provide students with a more accurate depiction of what to expect from these courses regarding students’ experiences. This study could be used on a broader scale to affect change or help a wide group of
people. The results may help support a perceived effective method of promoting growth in self-described math-anxious college students taking a mathematics course online regarding math confidence, motivation, and performance. There may be evidence provided in this study's results to revamp or eliminate college-level developmental mathematic courses saving both students and universities time and money (Valentine et al., 2017).

**Research Questions**

The purpose of this study was to answer one central research question followed by three sub-research questions to provide first-hand descriptions of the phenomenon of mathematics anxiety in an online classroom format in higher education. The four research questions presented intended to better understand the meaning of mathematics anxiety related to the participants and their current situation of having completed an undergraduate mathematics course online. Research needs to explore the learning experience created by developing the three interdependent elements – cognitive presence, social presence, and teaching presence of community of inquiry in the online classroom to better understand the participants’ perspective on mathematics anxiety in the online classroom.

**Central Research Question**

What are the lived experiences of mathematics anxiety for self-described math-anxious college students who completed a mathematics course online?

The central research question that guided this study was concerned with the lived experiences of the participants regarding mathematics anxiety while they completed a mathematics course online to fulfill the mathematics requirement for their degree completion. Higher-level degrees require that undergraduates complete a plethora of classes in different subject areas to satisfy general education requirements, including mathematics (Jack, 2018).
Today many students complete their degrees or at least some of their courses online. There were 6,932,074 students enrolled in any distance education courses at degree-granting postsecondary institutions in the fall of 2018, with 5,724,709 of those students being undergraduate students (National Center for Education Statistics, 2018). With such a volume of students completing their education online, it is imperative to understand the phenomenon of mathematics anxiety better as it pertains to online education.

**Sub-Research Question 1**

What variables or experiences contributed to the cultivation of mathematics anxiety in the participants?

The study's first sub-research question was concerned with what the participants attribute to their mathematics anxiety – how and when it developed. Mathematics anxiety is a learned behavior (Hembree, 1990; John et al., 2020) and can be caused by several factors, such as a math classroom experience, an experience with a math teacher, or generally falling behind in mathematics (Gough, 1954). Understanding what explicitly attributes to the participants’ mathematics anxiety is essential to understand this phenomenon and its development.

**Sub-Research Question 2**

How did the participants address their mathematics anxiety while completing an online mathematics course?

This study's second sub-research question pertained to the participants' experience while taking the mathematics course online. It is understood that mathematics anxiety was first described by Gough (1954) as mathemaphobia and continued to grow with Richardson and Suinn (1972) creating the first math anxiety scale, Mathematics Anxiety Rating Scale (MARS),
to help better understand mathematics anxiety. And Hembree’s (1990) meta-analysis helped confirm the phenomenon of mathematics anxiety, but more information is needed to better understand how students experience mathematics anxiety in an online format. In doing so, it was essential to discover how students addressed their mathematics anxiety.

**Sub-Research Question 3**

How did the three elements of community of inquiry (cognitive presence, social presence, and teaching presence) attribute to the participants’ completion of the course?

The third sub-research question of this study focused on the experience of self-described, math-anxious college students in an online classroom regarding the community of the learning environment that is created through cognitive presence, social presence, and teaching presence as described in the community of inquiry (Garrison et al., 2000; Garrison et al., 2001; Garrison & Anderson, 2003). It was vital to understand if the learning community created by participants attributed to their completion of the course and in what ways.

**Definitions**

1. *Cognitive presence* - how students of any community of inquiry can construct meaning through communication (Garrison et al., 2000).

2. *Confidence* – “is a person’s belief that a chosen course of action is the right choice and that they can properly perform that action. As a personality trait, confidence is sometimes referred to as self-confidence. This term describes the attitudes and beliefs people hold regarding their abilities and strengths” (Good Therapy, n.d., para. 1).

3. *Instructional intervention* – is a program or set of steps to help kids improve at things they struggle with. It focuses on subjects like reading or math. They are designed so that you and the school can track your child’s progress (Lee, n.d.).
4. **Mathematics anxiety** - “Mathematics anxiety involves feelings of tension and anxiety that interfere with the manipulation of numbers and the solving of mathematical problems in a wide variety of ordinary life and academic situations” (Richardson & Suinn, 1972, p. 551).

5. **Motivation** - “want[ing] a change in behavior, thoughts, feelings, self-concept, environment, and relationships” (Souders, 2019, para. 1).

6. **Social presence** – students' ability to show themselves within the community through their personality (Garrison et al., 2000).

7. **Teaching presence** - is made up of two parts – structure and process. The structure is the design of the educational experience where the process is the facilitation, including teachers and students, especially in higher education (Garrison et al., 2000).

8. **Distance education course (online class)** – a class that contains all the instructional content online and in which the delivery is also online (Allen & Seaman, 2017).

**Summary**

Many factors attribute to mathematics anxiety (Gough, 1954). For students to become proficient in mathematics, it is crucial to understand the root causes for the individual student, which involves understanding how it developed, how they experience it, and what can help alleviate it to ensure effective learning occurs. The research presented here substantiates that when math-anxious students are presented with math in the classroom or everyday life, they may avoid it, including furthering their education or selecting career paths (John et al., 2020; Richardson & Suinn, 1972). This is dangerous as the world is an ever-advancing technologically savvy workforce. A vexation, such as mathematics anxiety, should not be allowed to be a divergence from attaining students’ dreams. The use of various interventions has been
implemented to help students cope with their mathematics anxiety and has shown to be effective. However, much of the research regarding mathematics anxiety has been completed at the elementary and secondary education levels, leaving a gap in the research at the higher education level and, more specifically, the online learning environment. This study hoped to better understand mathematics anxiety and how self-described math-anxious college students experience the phenomenon while completing an online mathematics course. In turn, this may provide insight to educators and how they can better help students begin to build a strong foundation that will help develop their math motivation, confidence, and performance, which may lead to more retention in STEM courses, college, and career fields.
CHAPTER TWO: LITERATURE REVIEW

Overview

Chapter two provides a context for the current research study that is grounded in the literature to demonstrate the importance of studying mathematics anxiety of self-described math-anxious students who have completed an undergraduate math course online. First, the theoretical framework that guided the study is discussed to investigate how students create their educational experience. The theoretical framework for this study is community of inquiry (COI). Then, a synthesis of the related literature is provided regarding mathematics anxiety pertaining to motivation, confidence, performance, and interventions. E-Learning and retention are also addressed in the literature review. These criteria were selected as motivation, confidence, and performance are directly affected by mathematics anxiety. They are the three main variables needed to succeed in mathematics, and interventions directly affect mathematics anxiety. E-Learning is relevant to this study as E-Learning is the platform in which the learning has occurred. Retention is relevant to this study because it is imperative to understand how self-described math-anxious students' lived experiences may affect retention in mathematics, STEM courses, and college. Other criteria were not selected for this study, not because they are not important; instead, they did not align with this study's focus. Most importantly, gaps in the literature were identified and addressed – mainly that there is not much research on mathematics anxiety in the E-Learning environment.

Theoretical Framework

The theoretical framework of community of inquiry (COI) is essentially the method in which a classroom is turned into a community for students (Garrison et al., 2000; Pardales & Girod, 2006). Participation in COI stems from the three main elements of cognitive presence,
social presence, and teaching presence, which all converge to create students’ educational experiences (Garrison et al., 2000, Garrison et al., 2001; Garrison & Anderson, 2003; Pardales & Girod, 2006; Richardson et al., 2012). This theoretical framework is appropriate for this study because it sets the parameters for how students create their educational experience, and mathematics anxiety is a learned behavior based on experiences per the research gathered.

The COI model was examined and serves as the theoretical framework for this study. Early pragmatist philosophers Peirce and Dewey (Coghlan & Brydon-Miller, 2014; Garrison et al., 2000; Pardales & Girod, 2006) first introduced this idea. Pierce believed this type of reasoning to be inductive as it moved from general information to specific information in the way it moves from past beliefs to experiences and finally to new beliefs (Pardales & Girod, 2006). Peirce’s idea was that people would come together in education and agree on the community's knowledge rather than an individual’s ideas (Pardales & Girod, 2006). Dewey’s philosophy of education is known as the theory of inquiry (experimentalism) and originated during the progressive era and stimulated a practical approach or view on politics, law, art, and education (Gutek, 2011; Internet Encyclopedia of Philosophy, n.d.). Dewey believed that the goal of education was to enable growth through experiences constructed through inquiry (Dewey, 1916). This experimental model questioned institutions and how well they met the ever-advancing society's needs (Gutek, 2011). His focus was on children's needs and the use of the scientific method as a method of teaching and learning rather than facts being regurgitated (Gutek, 2011). The scientific method was generally used to bridge the gap between practical problem solving and meaningful learning (Gutek, 2011). For Dewey, the educational experience fused the interests of the individual and society as an individual’s
development was dependent on the community (Gutek, 2011). Dewey’s emphasis on social intelligence and community is echoed in the twenty-first-century education as his explanation of students creating meaning through their experiences in education continues to grow and reshape itself and today is known as the community of inquiry (COI) (Garrison et al., 2000; Gutek, 2011).

COI is essentially the method in which a classroom is turned into a community for students (Garrison et al., 2000; Garrison et al., 2001; Garrison & Anderson, 2003; Pardales & Girod, 2006). Participation in COI stems from the three main elements of cognitive presence, social presence, and teaching presence, which all converge to create students' educational experience (Garrison et al., 2000; Garrison et al., 2001; Garrison & Anderson, 2003). However, Matthew Lipman was the first to use the term community of inquiry in the 1980s (Coghlan & Brydon-Miller, 2014). Garrison et al. (2000) acknowledged that for education to be a meaningful experience, it must include the key stakeholders of education – students and teachers – and be rooted within a community of inquiry. The COI model assumes that learning occurs through the interactions of the three elements of cognitive presence, social presence, and teaching presence (Garrison et al., 2000). The three elements work together and overlap to create an educational experience for students (Garrison et al., 2000). Social presence and cognitive presence converge to create supporting discourse, cognitive presence and teaching presence (structure/process) converge to create selecting content, teaching presence and social presence converge to create setting climate, and all three – social presence, cognitive presence, and teaching presence converge to create the educational experience (Garrison et al., 2000; Richardson et al., 2012). Garrison et al. (2000) further explained how the quintessential element in higher education, a cognitive presence, is how
students of any community of inquiry can construct meaning through communication. The second element, social presence, is described as students' ability to show themselves within the community through their personality (Garrison et al., 2000). This helps to represent them as a “real person” to other students (Garrison et al., 2000). The third element of the teaching presence is comprised of two parts – structure and process (Garrison et al., 2000). The structure is the design of the educational experience where the process is the facilitation, including teachers and students, especially in higher education (Garrison et al., 2000).

The element of cognitive presence will be discussed first and is based on Dewey's (1910) ideas and his concept of practical inquiry. Dewey’s (1910) practical inquiry model included three types of reflection – pre-reflection, reflection, and post-reflection. Garrison et al.’s (2000) model is similar to Dewey’s practical inquiry model but based upon experiences. A triggering event occurs in the practical inquiry model, which leaves students feeling uneasy. Next is the exploration category, in which students begin exploration for information and knowledge to help make sense of the situation. Students then enter the third category of integration, in which they combine the information and knowledge into a coherent concept. Here students are trying to gain an understanding of the required information. The resolution of the issue is the final category in the practical inquiry process. During this category, students apply an idea, and the success of this application determines if the process of inquiry continues to the social presence category of COI (Garrison et al., 2000).

Next, the element of social presence will be discussed. Garrison et al. (2000) described the three indicators of social presence as emotional expression, open communication, and group cohesion. Emotional expression is the confidence to express feelings related to the educational experience. The expression of humor and self-disclosure
are two examples from Garrison et al. (2000) that help bring a community together. Humor helps spark a conversation among students as it is perceived as a way to shorten the social gap between students (Garrison et al., 2000). Self-disclosure is the sharing of feelings, attitudes, experiences, and interests, and the more personal information a student provides, the more likely others will follow. This process allows trust and support to develop (Garrison et al., 2000). Open communication is the second category of social presence. This builds group cohesiveness when done respectably. According to Garrison et al. (2000), self-esteem and mutual awareness stem from cohesiveness. Mutual understanding allows students to support one another as well as recognize each other during discussions. Recognition will enable students to express in words, actions - such as eye contact, smiling - and other non-verbal communications (Garrison et al., 2000). Group cohesion is a third category to social presence and is accomplished through activities that build community. It is a sense of belonging.

Finally, the element of teaching presence will be discussed. Garrison et al. (2000) described teaching presence as the category that balances cognitive presence and social presence. This is accomplished through the three categories of instructional management, building understanding, and direct instruction (Garrison et al., 2000). Instructional management is concerned with setting the curriculum, designing methods and assessments, setting time limits, and utilizing the medium. This category is concerned with elements of the classroom both before and during the class (Garrison et al., 2000). The second category of building understanding is concerned with academic integrity in a collaborative classroom. This is a category in which the instructor helps develop the community. The final category is direct instruction from the instructor. This entails lectures, outside sources, personal
knowledge and experiences, and providing feedback to students, among other things (Garrison et al., 2000). It is important to note here that a professor of higher education is the lynchpin to students’ success or failure (Csikszentmihalyi, 2014). For higher education to be successful, it needs to inspire students to pursue knowledge for knowledge itself rather than education for the sake of earning a degree (Csikszentmihalyi, 2014). A large proponent of that success is having a professor who strives to learn as he or she will be best at educating others (Csikszentmihalyi, 2014).

Community of inquiry developed from Dewey’s theory of inquiry (Coghlan & Brydon-Miller, 2014; Garrison et al., 2000; Pardales & Girod, 2006) has continued to evolve with education as society continues to evolve (Garrison & Anderson, 2003). Community of inquiry has adapted to be purposeful and appropriate for online learning in both personal reflection and collaboration (Garrison & Anderson, 2003). Collaboration is key to higher education, yet online higher education participants have not yet begun to appreciate or utilize the E-Learning tools found in the online classroom that help make it a truly collaborative experience (Garrison & Anderson, 2003). Two such E-Learning tools are computer conferencing and text-based communication (Garrison & Anderson, 2003). Computer conferencing takes the place of the lecture, and it opens the spread of information to more students asynchronously (Garrison & Anderson, 2003). In contrast, text-based communication takes the place of face-to-face discussions and opens opportunities for more critical thinking as students have more time for reflection (Garrison & Anderson, 2003). As online learning continues to grow, it is expected that traditional educational ideas will come to the forefront again as students begin to adopt those values to help them control their learning experience (Garrison & Anderson, 2003). Therefore, the shift from verbal
communication to written communication should be considered when proposing COI for higher education, specifically online education (Garrison et al., 2000).

The three overlapping elements of COI, cognitive presence, social presence, and teaching presence, are still present in E-Learning, but each of these elements differs slightly. In E-Learning, cognitive presence is how students create meaning and attribute their understanding of a topic (Garrison & Anderson, 2003). Cognitive presence in the realm of COI is partly dependent on the restriction or encouragement of communication within the classroom (Garrison & Anderson, 2003). In E-Learning, Garrison et al. (2000) explained social presence as how students develop their sense of socialization within the learning community through activities, content, and the amount of time spent within the learning environment. The use of an online classroom stunts the element of social presence as it may be more difficult for a student to present their actual self in such an environment (Garrison et al., 2000) because of the lack of spoken communications (Garrison & Anderson, 2003). Due to this difficulty, it is essential that written communication is done often and that redundancy is used to ensure that miscommunications do not occur (Garrison & Anderson, 2003). In E-Learning, teaching presence is defined the same as on-site environments but may be more challenging to accomplish online due to the asynchronous nature of online learning (Garrison & Anderson, 2003). According to Garrison et al. (2000), online education most often fails due to the lack of teaching presence, a unique challenge in online education. However, this can be overcome through discussions, other interactions with the teacher, and a face-to-face introduction to the teacher to help build trust and comfortability for the students (Garrison et al., 2000). The teacher must engage students and let their presence be known through learning activities, discussions, feedback, and announcements (Garrison & Anderson, 2003).
Garrison et al. (2000) specified how cognitive presence is more easily accomplished when social presence has been well-established and that teaching presence binds the three elements together for COI.

Although different from on-site learning, the categories and indicators of cognitive presence, social presence, and teaching presence are still similar in nature. Garrison and Anderson (2003) used the community of inquiry categories and indicators as a template that guided their assessment of the nature and quality of an E-Learning experience. The elements of cognitive presence, social presence, and teaching presence were each assigned categories and indicators. The categories are generalized occurrences, and the indicators are keywords or phrases that insinuate the presence of the category; thus, the element they correspond to in COI (Garrison & Anderson, 2003). The categories for the element of cognitive presence include a triggering event, exploration, integration, and resolution with sample indicators being puzzlement, information exchange, connecting ideas, and applying new ideas (Garrison & Anderson, 2003). The categories for the element of social presence include open communication and group cohesion, with sample indicators being the expression of emotions, risk-free expression, and the encouragement of collaboration (Garrison & Anderson, 2003). The categories for teaching presence include design and organization, facilitation, and direct instruction, with sample indicators being setting the curriculum and methods, sharing personal meaning, and focusing discussions (Garrison & Anderson, 2003).

One way my study added to the theory of COI was that my study gained a better understanding of how self-described math-anxious college students who completed an undergraduate math course online fit into the community. This was accomplished by understanding how they create their online learning experience in mathematics. It was
essential to know how these students utilize the three elements of cognitive presence, teaching presence, and social presence and if the inclusion or lack of any of the three elements affects their mathematics anxiety or learning experience. If so, it was important to understand where the emphasis needs to be placed throughout the three elements of COI for these students to better shape learning experiences for math-anxious college students completing online learning. In doing so, it was essential to discover which tools are being used within the online classroom to aid in collaboration. This may shed light on how online students understand their role of the student in the online classroom or what they believe their role is. Online students take on extra attributes than on-site learners to include knowledge and ability with technology, new modes of communications, increased levels of self-direction, and the new classroom environment (taking place at any place at any time) (Cleveland-Innes et al., 2007).

Another way my study added to the theory of COI was by further discovering if it is an acceptable online approach as the internet can be problematic to the social and educational aims that COI harbors (Bleazby, 2012). Choo et al. (2020) discovered that COI was successful in online learning and that cognitive and teaching presence were more effective than social presence. Yet, Huang et al. (2019) explained how students’ beliefs should be considered when applying COI to online learning, especially when teaching presence is low. Peacock and Cowan (2018) suggested that COI should move to a student-directed community of inquiries from learning-centered ones because it would create an environment in which the students make meaningful choices and decisions such as they would make in the real-world. Man et al. (2019) described how engagement was key to E-Learning regarding COI and mapped an E-Learning design element and behavior learning path. The purpose of the E-
Learning map was to illustrate how students can participate in deep and meaningful learning through engagement activities in the E-Learning environment (Man et al., 2019). The design elements of cognitive presence include challenge or question exploration of problems, proposing solutions, and resolution (Man et al., 2019). Students experience a sense of puzzlement during this element, sharing information, connecting ideas, and applying new ideas (Man et al., 2019). In E-Learning, the elements of cognitive presence include courses, assignments, content, quizzes, and feedback with the E-Learning experience entailing students to view courses, submit assignments, view content, download content, and interact with feedback (Man et al., 2019). The design elements of social presence include communication, group cohesion, and collaboration (Man et al., 2019). During this element, students experience the value of learning, the opportunity to express views, and encouraging collaboration (Man et al., 2019). In E-Learning, social presence elements include forum discussions, workshops, databases, and chats with the E-Learning experience entailing students to reply to the forum, involve themselves in discussions, and submit group assignments (Man et al., 2019). The design elements of teaching presence include instructor guidance, building understanding, and motivating (Man et al., 2019). During this element, students experience the instructor defining and initiating discussion topics, sharing personal meaning, and focusing on discussions (Man et al., 2019). In E-Learning, the elements of teaching presence include assignment feedback and question and answer forums. The E-Learning experience entails creating assignments and quizzes, grading those items, and uploading notes and contents (Man et al., 2019).

Understanding COI in E-Learning was important as more college students than ever before are completing their higher education online due to the current pandemic that has
forced colleges and universities to deliver classes in a strictly online platform. In 2015, 29.7% of all higher education enrollments were students taking at least one online class, and that number steadily increased from 2012 even though overall enrollments had decreased during that same time (Allen & Seaman, 2017). This could be because online learning has made higher education more accessible to people than on-site higher education in both aspects of location and costs (Baloyi, 2014). Educational theories need to grow as education does, and this was an opportune time to discover what can be done better.

**Related Literature**

The related literature to be discussed for this study has been divided into six crucial categories: (a) motivation, (b) confidence, (c) performance, (d) interventions, (e) E-Learning, and (f) retention. It was essential to research these six categories as they paint a more authentic picture of mathematics anxiety. The first three categories are the main variables needed to be successful in mathematics. The fourth category reflects what is being done to alleviate mathematics anxiety. The fifth category is the platform where the learning occurs, and the sixth category concerns the importance of researching mathematics anxiety.

**Motivation**

Mathematics anxiety is a learned behavior related to previous math experiences (Hembree, 1990; John et al., 2020; Wang et al., 2018). The study of math anxiety has encouraged the idea that students’ achievement and participation in math will decline, thus intimidating otherwise capable students (Henrich et al., 2016). These previous math experiences directly relate to the current math effect, math motivation, and pursuit of math in the future (John et al., 2020). Finding the right type or combination of interventions may be
key to unlearning math anxiety and help motivate students (Hembree, 1990; John et al., 2020; Wang et al., 2018).

John et al. (2020) acquired direct feedback from college students in their own words in the form of narratives about a turning point in their math experience for better or worse. It was direct insight into students’ minds and what changed the math for them. Whereas Wang et al. (2018) looked at the direct correlation between math anxiety and math motivation and if one led to the other's demise. Wang et al. (2018) looked at students with varying levels of math anxiety and math motivation to see if either one alone or combined would directly cause math avoidance. Students whose narratives were negative experiences had the worst math outcomes and planned to avoid math in the future (John et al., 2020). John et al. (2020) stated that their findings could help policymakers and educators help target ways to improve STEM outcomes and feelings towards math. However, Wang et al. (2018) discovered that more anxious students were generally more engaged. It is believed this is due to putting in more effort due to worries about math results. Wang et al.’s (2018) work also revealed that within all levels of math motivation, students with a higher math anxiety level worked longer at math but still performed the worse. This may be because students’ working memory was affected by math anxiety. The effects of working memory being affected by mathematics anxiety were also echoed by Gabriel et al. (2020) and Boaler (2016). John et al. (2020) concluded that many students struggle with math, do not understand its importance, and feel uneasy about it. They found that previous math experiences directly relate to the current math effect, math motivation, and pursuit of math in the future. This gave educators an understanding of what math is like from the students’ perspectives and what motivates them
Wang et al. (2018) echoed this conclusion as they found that math anxiety and math motivation relate to math avoidance.

Another important aspect to consider with motivation is the idea of “flow” (Csikszentmihalyi, 1997, p. 46), coined by Mihaly Csikszentmihalyi. Flow refers to the feelings that occur within people when they immerse themselves in a popular activity (Rodriguez-Ardura & Meseguer-Artola, 2016). When engaged in flow, individuals genuinely enjoy their work and focus only on the task-at-hand (Csikszentmihalyi & Rathunde, 2014). Rodriguez-Ardura and Meseguer-Artola (2016) further clarified that the loss of self-consciousness when emerged in an activity indicated flow being achieved. Csikszentmihalyi and Rathunde (2014) explained flow is a balancing act between challenges and skills, and over-or under-of either challenges or skills will result in a loss of flow, such as anxiety or boredom. Rodriguez-Ardura and Meseguer-Artola (2016) explained flow using the conceptual model in which there are two main portions – flow antecedents and flow consequences. Flow antecedents include the challenge, focused attention, control, and presence which occur during the E-Learning activity and converge to create flow (Rodriguez-Ardura & Meseguer-Artola, 2016). Then the flow consequences include positive effect, academic performance, and continuance in which academic performance occurs at the end of the E-Learning activity, and continuance moves into the next academic topic/course (Rodriguez-Ardura & Meseguer-Artola, 2016). The idea of flow is essentially a motivational tool as it helps develop students’ skills into something more than where they are now. Flow is not a means to an end. Instead, it is a balancing act between knowledge and activity that keeps students motivated as they continue to grow their skills (Csikszentmihalyi & Rathunde,
In addition, flow is a way to extend students learning to future courses and careers (Rodriguez-Ardura & Meseguer-Artola, 2016).

In summary, all the authors believed mathematics anxiety to be a learned behavior related to previous math experiences. Hembree (1990) found correlations between math-anxious students and scores and that interventions may help. Finding the right type or combination of interventions may be key to unlearning math-anxiety. This may help motivate students. John et al. (2020) acquired direct feedback from college students in their own words in the form of narratives about a turning point in their math experience for better or worse. It was direct insight into students’ minds and what changed the math for them. Wang et al. (2018) looked at the direct correlation between math anxiety and math motivation and if one led to the other's demise. It looked at students with varying levels of math anxiety and math motivation to see if either one alone or combined would directly cause math avoidance.

Flow is a motivator because it is the process of students being fully engaged in an activity (Rodriguez-Ardura & Meseguer-Artola, 2016) as skills and challenges are balanced. This balance means frustrations such as boredom or anxiety are less likely to occur (Csikszentmihalyi & Rathunde, 2014). Fewer frustrations mean fewer breaks in flow, allowing students to continually feel good about themselves and their work as they continue to grow in their education (Rodriguez-Ardura & Meseguer-Artola, 2016).

**Confidence**

Boaler (2016) stated that math facts appear to be where students begin developing math anxiety because they are taught that mastering math facts and quick recall of them are the keys to mathematics. Boaler (2016) identified that those two ideas were wrong, and in fact, they contributed to the creation of math anxiety. Boaler (2016) further explained how
number sense is more important than math facts because it incorporates them and a deeper understanding of how numbers relate. She explained how timed math facts rely on working memory and how the stress of being under pressure to perform well under a time limit blocks working memory, so students do not have access to those facts (Beilock, 2008). This is where math anxiety begins to manifest, and confidence erodes. Putting students through math fact exercises is the catalyst for losing them from mathematics, and it is the beginning of math aversion (Boaler, 2016).

Everingham et al. (2017) conducted their study due to the ever-increasing demand for technologically savvy employees needed in a technology-driven world. Mathematics is required for students to progress in all education and employment that include science, engineering, and technology (Everingham et al., 2017). Yet, it is seen as a hurdle for various reasons to students. According to Everingham et al. (2017), the intervention of engagement worked to overcome math anxieties and low math confidence in interdisciplinary subjects. The results showed a continual increase in math confidence and a dramatic decrease in math anxiety. Student feedback also supported the correlation between engagement and math anxiety and confidence.

Herts and Beilock (2017) explained Janet Taylor Spence's work as a pioneer of math anxiety research and how she focused on manifest anxiety and trait anxiety. Mathematics anxiety was identified as a trait anxiety that is both distinctive and widespread (Herts & Beilock, 2017). Hembree (1990) acknowledged that math-anxious students in the United States take fewer elective math courses in high school and college than low math-anxious students. Herts and Beilock (2017) described the relation between anxiety and performance and its relation to working memory, which was later paralleled in other works such as
Ashcraft and Kirk (2001), who suggested that tasks that require more working memory are more affected by anxiety. This includes math anxiety. Several studies have collaborated on this idea to include fMRI imaging (Young et al., 2012). It is important to note that some strategies seem to help with math anxiety. One such strategy is having students write about their anxiety before working on a high-stakes math test, as Ramirez and Beilock (2011) explained. This would suggest that anxiety plays an important role in math performance and that these students are not less capable because interventions helped (Herts & Beilock, 2017).

The findings of Young et al. (2012) supported the idea of math anxiety being specific to both situations and activities and that this knowledge can help create intervention strategies like those used for phobias.

In summary, all the authors agreed that there was a correlation between mathematics anxiety and confidence. They saw that math confidence lowered as mathematics anxiety rose. They believed the employment of interventions could help math-anxious students because it could build their confidence in mathematics. Boaler (2016) explained how and why math-anxious students are created and that math anxiety is destroying confidence in math students and averting them from mathematics. Her growth-mindset teaching method is an intervention to mathematics by teaching it from a different perspective and having students think about it from a different perspective. Cropp (2017) and Everingham et al. (2017) directly linked the use of interventions with math-anxious students that raised students’ confidence levels in mathematics. Herts and Beilock (2017) discussed how mathematics anxiety affected confidence and gave examples of interventions that can be implemented to help alleviate and even motivate math-anxious students. Young et al. (2012) exposed the groundwork for
intervention ideas and opportunities. They set up the basis behind intervention theories and their application with math-anxious students.

**Performance**

Dowker et al. (2016) thoroughly explained the different aspects that may affect students and their beliefs and feelings towards mathematics. These negative emotions regarding math have been linked to poor math performance (Hart & Ganley, 2019; Herts & Beilock, 2017). In addition, Bailey and Jaggars (2016) found that most college students are either over- or under-placed in college math classes based on tests that are not conducive to placing students, which can dramatically affect students’ performances.

Foley et al. (2017) explained the direct correlation between math anxiety and math performance in students worldwide and how it is vital to understand this because STEM careers are becoming more mainstream as technology advances. Part of understanding this is to better understand that instruction time and the quality of instruction help develop much of students’ learning in mathematics (Foley et al., 2017). Dowker et al. (2016) agreed that there is a negative correlation between math anxiety and math performance, but that could be due to overworking the memory resources or lack of practice, as students with math anxiety tend to avoid it. Schillinger et al. (2018) used information from previous studies and The Abbreviated Math Anxiety Scale (AMAS) to create their own study that confirmed the findings of earlier studies - that there is a correlation between math anxiety and numerical intelligence; however, not due to verbal intelligence. This suggested that math-anxious students struggle with numerical processing. Dowker et al. (2016) explained how math anxiety is not purely emotional as other anxieties but relates to self-rating/self-efficacy. Math
Anxiety is different from other anxieties, such as general or text anxiety, and math anxiety is more prevalent than other subjects (Dowker et al., 2016).

Dowker et al. (2016) described different physiological ways to measure math anxiety giving examples of measuring cortisol and recording brain functions using various methods, including MRI. Students with math anxiety show greater activity in the parts of their brains related to pain when anticipating doing math as compared to those who do not have anxiety (Dowker et al., 2016). Foley et al. (2017) detailed findings from the Program for International Student Assessment (PISA) and how math and achievement relate to students worldwide. Dowker et al. (2016) echoed this finding and stated that factors that impacted math anxiety include genetics, gender, age, culture, and nationality. Dowker et al. (2016) explained how these factors could greatly influence students’ beliefs and attitudes towards mathematics. This included other peoples’ negative thoughts on math and changes to math content itself. Foley et al. (2017) stated that math anxiety could be passed onto students by parents and teachers who negatively relate to mathematics. Treatment options ranged from modeling more positive attitudes towards mathematics to non-invasive brain stimulation (Dowker et al., 2016). Again, writing out the negative thoughts and one-on-one tutoring has been given an example of treatment (Dowker et al., 2016). Efforts to curb math anxiety were also described by Foley et al. (2017) by using psychological techniques and one-on-one tutoring. Schillinger et al.’s (2018) findings showed a correlation between math-anxious students and both numerical intelligence and math deficits. They suggested using their findings to help create future interventions to improve mathematics for students with math anxiety (Schillinger et al., 2018).
In summary, all the authors believed that mathematics anxiety correlated to either deficits or difficulties in mathematics and that applied interventions could help restore math-anxious students’ beliefs in their own abilities. Dowker et al. (2016) were inclusive of what has been learned about math anxiety in the past 60 years and illuminated some concepts that may relate more to math anxiety than an emotion. They suggest understanding how the different aspects discussed relate to one another to help understand math anxiety further. Foley et al. (2017) found that mathematics anxiety could be attributed to difficulties with mathematics. Meaning students could be predisposed to math anxiety if they had difficulties with math. Foley et al. (2017) suggested what contributes to mathematics anxiety and how it could help students believe in their abilities. They also provided ideas on how to correct math anxiety with interventions. Schillinger et al. (2018) also postulated intervention ideas to help students feel better about their abilities.

Interventions

Much of the research presented here reflects the idea that math anxiety is a learned concept that interventions can treat. These interventions include supportive services (Coleman et al., 2017; Cox & Dougherty, 2019), mindset (Boaler, 2016; Paunesku et al., 2015; Shen et al., 2016), peer mentoring (Cropp 2017), engagement strategies (Everingham et al., 2017), instruction time (Weng, 2015), motivation interventions (Lazowski & Hulleman, 2016), and over-hauling developmental math courses and programs (Cafarella, 2016; Manning, 2018). These interventions differ significantly, but all show positive progress in college developmental math classes.

Supportive Services
Supportive services are services provided by the college or university to help students prior to registering in a developmental math course and while in a developmental math course. These supportive services include orientations, better screening methods (Coleman et al., 2017; Cox & Dougherty, 2019), tailored advising, faculty development, structured design, and frequent communications (Coleman et al., 2017). Students can learn more about the college developmental math course process during orientations and gather a better understanding of how it affects them both timeline and monetary wise (Cox & Dougherty, 2019). Screening could also be completed during orientation if needed or screening appointments scheduled to allow students more time to prepare for the placement and understand its importance (Cox & Dougherty, 2019). Tailored advising and faculty development would also assist students in college developmental math courses (Coleman et al., 2017; Cox & Dougherty, 2019). More structured designs in class and more frequent communications from advisers and instructors may help students through the developmental courses in a more advantageous way (Coleman et al., 2017; Cox & Dougherty, 2019). Professor goals play an important part in students successfully completing assignments and passing the course, as students’ goals tend to mimic professors’ goals (Cox & Doughtery, 2019).

**Mindset**

Academic mindset affects students’ motivation, strategies, and perseverance (Paunesku et al., 2015). The intervention of a growth mindset would change the way students think about themselves and how they learn as a growth mindset is one in which a person’s belief in his or her intelligence is not fixed but can grow and develop in time (Boaler, 2016; Claro et al., 2016; Paunesku et al., 2015). With a growth mindset, students participate in
interpreting the world around them and the beliefs of those in that world (Dweck & Molden, 2017). Rather than a student saying that they are not good at math and never will be, students would be challenged to think they are not good at math yet (Dweck, 2014, November). The power of yet helps students believe in themselves, as Dweck (2014, November) explained in her TED talk. Yet gave students hope. With a growth mindset, students are asked to re-wire the way they think about their relationship with math, and rather than give up when facing a complex problem, they are asked to take more time and understand that they can be successful in math, but it may take time (Bailey & Jaggars, 2016; Boaler, 2016; El-Alayli & Baumgardner, 2003; Shen et al., 2016). Shen et al. (2016) provided the following example of how a growth mindset can help students in mathematics using persistence - participants who tried different approaches to a difficult problem allowed some students to feel that progress was being made as they were able to cross off attempts. It is believed that students’ mindsets can be affected by their parents’ views on failures (Dowker et al., 2016; Haimovitz & Dweck, 2016). Students who had parents who believed that failure was an opportunity for growth tended to be more likely to have a growth mindset when compared to students whose parents did not reflect that idea (Haimovitz & Dweck, 2016). Academic mindset interventions reach the core of students’ beliefs about learning and impact important questions such as “Can I learn and grow my intelligence?” and “Why should I learn?” (Paunesku et al., 2015, p. 785). The idea of the struggle being part of the learning process rather than a sign of incompetence (Boaler, 2016; Dweck, 2014, November; Paunesku et al., 2015) is one of the most important aspects of a growth mindset. Such interventions have proven to be successful with students, especially those who face greater hardships (Claro et al., 2016).

Peer Mentoring and Engagement Strategies
Peer mentoring and engagement strategies as interventions to math anxiety were found to be successful for math students (Cropp, 2017). With peer mentoring, the students were able to build a relationship with their mentor and felt more comfortable talking and asking questions of their peers as opposed to their teacher (Cropp, 2017). One-to-one tutoring was also found to have similar success as peer mentoring (Foley et al., 2017). Group work was found to be successful with high math-anxious students and a teaching method that high math-anxious students preferred as it was perceived as more helpful to those students (Bjälkerbring, 2019). Engagement strategies stem from the thought that if math students were more engaged in the process, they would do better as their math anxiety would decrease as they became more comfortable (Everingham et al., 2017). This would include Gough’s (1954) idea of making the concept being taught more concrete and one that students understand. In doing so, students gain a better conceptual understanding of the materials being taught, which would lead to better math success.

Instruction Time

It is thought that interventions at the teacher level with more instruction time and better-quality instruction benefits math students (Foley et al., 2017). This idea resonates with Gough’s (1954) observation that students’ math anxiety may stem from a bad experience with a teacher and the instruction given or lack thereof. This brings up the idea of a flipped classroom in which students complete lectures/lessons on their own outside of the classroom and complete their work in the classroom. This allows students to preview the work ahead of them and give them access to the instructor while completing their work. The use of a flipped classroom allows for self-paced learning and seems to be more natural for mathematics' teaching/learning process (Weng, 2015). The flipped classroom allows
students to preview the lecture from anywhere at any time in any place as students complete the lecture/exercise component of the course on their own using web-based technology (Weng, 2015). Then students bring in their questions, concerns, or needs to the instructor in a face-to-face setting for a better explanation (Weng, 2015). This setup allows instructors to make the most out of their time with students by focusing on what the students bring to them as being the most important or most challenging (Weng, 2015).

Motivation

Motivation as an intervention in college developmental math courses is one of simplicity but possibly has the most impact (Lazowski & Hulleman, 2016). Intervention programs in developmental math courses should be tailored around motivating students to succeed as motivation is a significant aspect of learning, yet instructors are not using it to its fullest potential to help students learn (Lazowski & Hulleman, 2016). It sometimes appears that educators take the stance that if students do not want to learn, then there is nothing to be done about it, but that is simply not the case. The key here is to find what motivates the students to learn. Motivation can come in a multitude of different avenues, such as good grades, passing a class, praises from parents, instructors, and classmates, personal growth, need, and more (Lazowski & Hulleman, 2016). This includes the use of Gardner’s Multiple Intelligences (Gardner, 2008; Parkay et al., 2019). Gardner’s (2008) theory of multiple intelligences brings to light that intellect is measured by standardized tests such as the IQ test, SAT, and other tests created to measure a person’s knowledge based on memory (Gardner, 2008). However, Gardner (2008) protests that these tests are not capable or even include the necessary questions to measure all intelligence that a person contains. He explicitly mentions brilliant chess players, world-class violinists, and champion sports
players as examples of intelligence types that are not included in the typical IQ tests (Gardner, 2008). In the 1980s, Gardner described this theory in terms of abilities, talents, or mental skills (Gardner, 2008). Intelligence is not just one’s ability to memorize and repeat facts, processes, or knowledge but includes a whole array of aspects, and it is important not to confuse intelligences with learning styles. The original intelligences included musical intelligence, bodily-kinesthetic intelligence, logical-mathematical intelligence, linguistic intelligence, spatial intelligence, interpersonal intelligence, and intrapersonal intelligence (Gardner, 2008). These intelligences have grown and been reshaped over the last several decades as Gardner has continued researching and exploring his theory (Gardner, 2008; Parkay et al., 2019). With that background in the theory of multiple intelligences, Gardner discussed the importance of being cautious in characterizing students' intellectual profiles because each unique situation needs to be accessed (Parkay et al., 2019). It is not that a student fits or does not fit into one of the intelligences; instead, several factors must be examined to include the specific problem being solved, the kind of information being memorized, and claims of transfer (Parkay et al., 2019). Gardner explained that the reason for this caution and examination of details is because intelligences can be transferred and used for different types of situations (Parkay et al., 2019). One can assume which intelligences are being used but cannot be sure of this; thus, it remains a theory (Gardner, 2008; Parkay et al., 2019).

**Overhaul of Developmental Math Programs**

College developmental math courses are found at most colleges and universities throughout the United States. They are in place to help develop college students’ math abilities and prepare them for college-level math courses (Cafarella, 2016; Manning, 2018;
Park et al., 2018; Valentine et al., 2017). One big component of the need for college
developmental math courses is math anxiety. The term developmental education can be
defined as “a set of policies and practices designed for students who are underprepared to
do college-level work in a given area” (Valentine et al., 2017, p.806). The purpose of these
courses is to provide students with the skills, habits, and knowledge that will help them
succeed in college-level versions of the course (Bailey et al., 2016). However, placement
into developmental courses has negatively impacted those students at universities as
opposed to community colleges (Valentine et al., 2017), which may contribute to poor
completion outcomes. Poor completion outcomes have generated interest in changing
developmental education policies and practices to increase students’ chances of success
(Cox & Doughtery, 2019). Such changes include revisions testing and placement policies,
amendments to the intended curriculum, and restructuring of the format and sequencing of
courses (Cox & Doughtery, 2019). Another factor in overhauling developmental math
programs is the cost and time that these courses require, as some students feel as though
they are paying twice for the same class – taken in high school and now in college (Park et
al., 2019; Valentine et al., 2017). The idea of overhauling developmental math programs
would essentially decrease developmental math courses and increase college-level math
courses by allowing students to bypass developmental classes altogether or speed up the
process for those students who still need them (Cafarella, 2016; Manning, 2018). This
intervention increased enrollments, retention, and earned credits for students (Manning,
2018). However, it is important to note that accelerated programs did not work for all
students, and some still benefitted from the traditional lecture-based developmental courses
(Cafarella, 2016). Park et al. (2018) echoed the findings of Cafarella (2016) as
underprepared FTIC students appeared to benefit from taking developmental courses paired with an Intermediate Algebra course rather than bypassing the developmental course altogether.

**E-Learning**

E-Learning refers to using information and communication technologies via electronic sources from a distance using an online platform to access learning/teaching materials with a disregard to time and space (Aparicio et al., 2016; Arkorful & Abaidoo, 2015). Today’s E-Learning includes technology, learning strategies and methods, and the distribution of content and connection (Aparicio et al., 2016). It has rapidly expanded and consists of various technologies and devices (computers, smartphones, and tablets) to access the learning resources that impact both learning and teaching methods (Al-Fraihat et al., 2020). E-Learning unites learning and technology (Al-Fraihat et al., 2020; Aparicio et al., 2016). Technology is used as a student would use any other education tool such as a pencil or paper (Aparicio et al., 2016). Arkorful and Abaidoo (2015) described three different E-Learning models: adjunct, blended, and wholly online. The adjunct model is when online learning is an assistant to the traditional classroom (Arkorful & Abaidoo, 2015), such as using a flipped classroom. The blended model is when education takes place between a traditional classroom and an online learning environment (Arkorful & Abaidoo, 2015). The wholly online model is when education takes place entirely online, and the traditional classroom is void (Arkorful & Abaidoo, 2015). Aparicio et al. (2016) constructed a holistic E-Learning systems theoretical framework that better explained the stakeholders, technologies, and activities of E-Learning. The three components of the E-Learning systems include people, technologies, and services. People interact with the E-Learning systems; E-
Learning technologies allow for interaction between users through content, communication, and collaboration; and E-Learning services involve E-Learning activities merging the pedagogical models with instructional strategies (Aparicio et al., 2016). Aparicio et al. (2016) explained the stakeholders as customers (students and employees), suppliers (teacher, content providers, accreditation bodies, educational institutions, and technology providers), professional associations, student commissions, and board and shareholders (education ministry and industry). The E-Learning technologies were described by Aparicio et al. (2016) as content (documents, digital audio and video, tools, search engines, learner journals, assessment, glossary, and more), communication (discussion forums, chat areas, social networks, synchronous communication, and e-mail), and collaboration (sharing tool, ask an expert discussion forum, one-to-one mentoring, and problem/solution area). E-Learning activities were described as either pedagogical models (open, learning, distributed learning, learning communities, knowledge-building communities, and more) or instructional strategies (contextualizing instruction, presenting content, activating learning processes, assessing learner outcomes, creating processes into instructional lessons, promoting/supporting learning activities, promoting collaboration, supporting role-playing and multiple perspectives, and more) (Aparicio et al., 2016).

E-Learning is seen as a way to fight global education challenges as it widens access to higher education (Stone et al., 2016). E-Learning in higher education provides an opportunity that many students would not have otherwise due to work, family, and other obligations (Stone et al., 2016). Essentially, E-Learning opens higher education to those students who never thought they had a chance at it (Stone et al., 2016). The flexibility of it is a particular advantage as students are still able to commit to work and family while attending school
Positive and negative experiences are associated with E-Learning in higher education (Arkorful & Abaidoo, 2015; Stone et al., 2016; Irfan et al., 2020). The positive experiences include the flexibility of time as school can take place anywhere at any time and save travel costs (Irfan, 2020; Stone et al., 2016). The negative experiences include technical problems, lack of interaction between other students and the instructor, problems with instructional materials, students’ time management difficulties (Stone et al., 2016), the potential of plagiarism, internet availability or strength, and supportive devices (Arkorful & Abaidoo, 2015; Irfan, 2020). Social presence is a significant factor for online students' success from non-traditional backgrounds as these students create a better learning environment for themselves when they feel connected (Stone et al., 2016). Stone et al. (2016) discovered that most students were motivated to attend school to better their and their children’s lives as they were seeking a better future for themselves either through employment, increased income, or personal goals.

**Retention**

Providing straightforward structure and predictability will help with retention in college in general, as the longer a student is in college, the less likely it is that they will graduate (Snyder & Cudney, 2017). For public college and university students who began college going full-time, only 13% of students graduate with a two-year associate given three years to complete it, followed by 43% of students graduating with a four-year non-flagship bachelor’s program in six years, and only 68% of students graduate with a four-year flag-ship bachelor’s program given six years (Jones, 2015). Remedial students graduate around half the rate of their peers (Jones, 2015). At 2-year colleges, in which students seek an associated degree, 20% of college-ready students complete their associate's degree within three years
compared to only 9% of remedial students (Jones, 2015). Twenty-six percent of college-ready students will complete their associate's degree within four years compared to 14% of remedial students (Jones, 2015). Reasons for low college retention include unsuccessful remedial courses, the priority of enrollments rather than graduates, a system removed from students’ needs, and unclear choices students must make for themselves (Jones, 2015). This does not account for the undue stress of mathematics anxiety plaguing students. The United States faces a gap in skills as only about half of college students graduate (Jones, 2015). However, more is being done now to increase STEM retention, such as investments into programs by universities and colleges to support STEM students (Snyder & Cudney, 2017). Xue and Larson (2015) explained how the STEM workforce is heterogeneous, meaning that there are both shortages and surpluses of STEM employees. This is largely affected by the particular segment of the specific job market – either government, academic, private sector, etc. (Xue & Larson, 2015). One way to encourage students to continue through the STEM pipeline is to create programs that encourage them to do so through restructuring and scholarships (Chang et al., 2016; Jen-Mei et al., 2016; Snyder & Cudney, 2017). Another way is using math bridge programs that students take before they enter the school to help with students’ self-efficacy (Johnson & O’Keefe, 2016). Still another way is through developmental math courses that are in place to help develop college students’ math abilities and prepare them for college-level math courses (Park et al., 2018). Underprepared first-time-in-college (FTIC) students are the group that is most likely to enroll in college developmental math courses, and they benefit from these courses (Park et al., 2018).
Summary

Chapter two focused on the literature by examining the theoretical framework of community of inquiry, which grew from Dewey’s theory of inquiry and has now found its way into online learning (Coghlan & Brydon-Miller, 2014; Garrison et al., 2000; Garrison & Anderson, 2003; Pardales & Girod, 2006). In mathematics, mathematics anxiety directly correlates to students’ attitudes (Dowker et al., 2016; Lisciandro et al., 2018; Lyons & Beilock, 2012) and self-efficacy (Bandura, 1986; Dowker et al., 2016; Johnson & O’Keeffe, 2016). After examining the theoretical framework, a symposium regarding how mathematics anxiety affects students’ math motivation, confidence, and performance was presented, and an explanation of what interventions had been used to curtail mathematics anxiety was given. Furthermore, E-Learning was discussed as well as the importance of retention being further examined. Mathematics anxiety is a learned behavior (Hembree, 1990; John et al., 2020) and can be caused by several factors (Gough, 1954) and can be damaging to a student’s motivation (Wang et al., 2018), confidence (Beilock, 2008; Boaler, 2016; Cropp, 2017; Everingham et al., 2017), and performance (Foley et al., 2017) in mathematics. Interventions to curtail mathematics anxiety have been implemented throughout grade levels and the world, but despite such interventions being studied, mathematics anxiety continues to affect students (Cropp, 2017; Foley et al., 2017; Hembree, 1990; Lazowski & Hulleman, 2016; Manning, 2018). Mathematics anxiety directly affects retention in STEM fields and careers (Chang et al., 2016; Jen-Mei et al., 2016; John et al., 2020; Jones, 2015; Snyder & Cudney, 2017; Xue & Larson, 2015). Due to the world pandemic of COVID-19 and its effects on E-Learning, it was more imperative now than ever to better understand mathematics anxiety in online learning. For some students, there is no choice in their learning environment. The
review of the literature presented an apparent gap concerning mathematics anxiety and college students completing mathematics courses online. It was important to better understand the phenomenon of mathematics anxiety regarding self-described math-anxious college students completing math courses online and the application of community of inquiry within their online classrooms because it may help shape the future of how these courses are developed.
 CHAPTER THREE: METHODS

Overview

The purpose of this transcendental phenomenological study was to describe mathematics anxiety for self-described math-anxious students who had completed an undergraduate mathematics course online at a regionally accredited university located in the Pacific Northwest part of the United States. The primary focus in chapter three is to clearly describe the methods and structure executed during the study. This chapter begins with a discussion of the study’s design model and its relevance to the type of study being pursued, followed by the research questions. The setting, participants, procedures, and the role of the researcher are then described. This is followed by a description of the techniques used for data collection to include interviews, questionnaires, and focus group meetings to understand the phenomenon under study. The remainder of this chapter contains the data analysis process, the study's trustworthiness, the study's ethical considerations, and the chapter summary. In this study, all identifiable information associated with the setting, participants, and any other identifying information has been changed to pseudonyms to protect the participants' confidentiality.

Design

The research design approach of phenomenology can be defined as a shared experience of a concept or phenomenon of several individuals that can occur across geography, age, and other factors (Creswell & Poth, 2018; Milacci & Zambloski, 2020a; Moustakas, 1994). A phenomenological research design approach focuses on describing the commonalities shared by individuals with a phenomenon (Creswell & Poth, 2018; Moustakas, 1994). In a phenomenological research design, the philosophical element is strong, and it draws from Edmund Husserl’s writings (Creswell & Poth, 2018). It is a popular research design in social and
health sciences and involves the study of lived experiences that are conscious ones that are described rather than analyzed (Creswell & Poth, 2018). Stewart and Mickunas (1990) explained the four philosophical perspectives of a phenomenological approach as being (a) returning to traditional philosophy, (b) no presumptions, (c) consciousness being intentional, and (d) not using subject-object dichotomy, rather understanding that objects are perceived with the experience to the individual (Creswell & Poth, 2018). The two approaches to phenomenological research design are hermeneutic and transcendental (Creswell & Poth, 2018; Moustakas, 1994). Hermeneutic phenomenology is best associated with van Manen (1990, 2014) and involves lived experiences and interpreting the “texts” (Creswell & Poth, 2018, p. 77) of life (Creswell & Poth, 2018; Moustakas, 1994). Transcendental phenomenology is best associated with Moustakas (1994). It focuses more on the description of the participants’ experiences. The researcher’s personal experiences are set aside in a process called bracketing (Creswell & Poth, 2018), known as epoche (Moustakas, 1994), and is an effort to put aside personal judgments and look at the phenomenon without bias (Creswell & Poth, 2018; Moustakas, 1994; van Manen, 1990). The researcher is trying to acknowledge and limit possible bias during the analysis process by presenting any personal background.

A transcendental phenomenological research design involves several steps, with the first step addressing if the research problem is best researched using a phenomenology approach (Creswell & Poth, 2018; Moustakas, 1994). Then the researcher must identify the phenomenon of interest and describe it (Creswell & Poth, 2018; Moustakas, 1994). Next, the broad philosophical assumptions must be indicated and separated (Creswell & Poth, 2018; Moustakas, 1994). Following that, the process of data collection may take place and includes collected data from five to 25 participants using in-depth interviews and other resources (Creswell & Poth,
Themes are then generated based on significant statements, and those themes are then used to describe what was experienced and develop structured descriptions (Creswell & Poth, 2018; Moustakas, 1994). Then the “essence” (Moustakas, 1994, p. 9) of the phenomenon – the shared experience - can be discussed, and finally, findings were presented in written form (Creswell & Poth, 2018; Moustakas, 1994). There are some challenges to a phenomenology design approach. First, philosophical assumptions may be more abstract (Creswell & Poth, 2018). Second, finding individuals who share the same common phenomenon may be difficult, meaning that participant selection must be made carefully (Creswell & Poth, 2018). Third, bracketing may be complicated; thus, the researcher should introduce their experiences (Creswell & Poth, 2018). These are not the only challenges but some of the biggest.

My study's topic was math-anxious students attending college online, and the phenomenon of mathematics anxiety was explored. This topic aligns with a transcendental phenomenological design approach as it is the process of understanding a phenomenon (mathematics anxiety) using an inquiry approach that explores a human problem (Creswell & Poth, 2018; Gall et al., 2007). The intention was to better understand how college students experience mathematics anxiety in an online mathematics course. The purpose of a phenomenological study is to take all the individual experiences with the phenomenon and draw the essence of the phenomenon from that (Creswell & Poth, 2018, Gall et al., 2007; Moustakas, 1994). A phenomenological study was appropriate for this research as the goal was to describe a common phenomenon experienced by multiple individuals as they lived it (Creswell & Poth, 2018). A transcendental phenomenological design was a valid design for this study as the goal of the study was to understand the essence of the experience that self-described math-anxious students have with the phenomenon of mathematics anxiety while completing a mathematics
course online. This is a shared experience among several individuals that occurs across geography, age, gender, etc. (Creswell & Poth, 2018, Milacci & Zambloski, 2020a; Moustakas, 1994).

**Research Questions**

The following questions guided this transcendental phenomenological study to better understand the essence of the phenomenon of mathematics anxiety as experienced and described by self-described math-anxious college students who have completed an undergraduate mathematics course online. There was one central research question (CQ) that sought to better understand the lived experience of mathematics anxiety for self-described math-anxious college students taking an online math class. The three sub-questions (SQ) sought to better understand how past experiences contributed to the cultivation of mathematics anxiety, how the participants addressed mathematics anxiety during the course, and how cognitive presence, social presence, and teaching presence of the community of inquiry affected online learning for self-described math-anxious college students who have completed an undergraduate mathematics course online.

**Central Research Question**

What are the lived experiences of mathematics anxiety for self-described math-anxious college students who completed a mathematics course online?

**Sub-Research Question 1**

What variables or experiences contributed to the cultivation of mathematics anxiety in the participants?

**Sub-Research Question 2**
How did the participants address their mathematics anxiety while completing an online mathematics course?

**Sub-Research Question 3**

How did the three elements of community of inquiry (teaching presence, cognitive presence, and social presence) attribute to the participants’ completion of the course?

**Site**

Located in the Pacific Northwest of the United States is a regionally accredited university that is ranked as one of the top 50 universities in the West by U.S. News and World Report. With over 135 accredited majors offered and an average class size of 20, the site’s mission is “is to prepare students for enlightened, responsible, and productive lives; to produce research, scholarship, and creative expression in the public interest; and to serve as a resource to the region and the state through effective stewardship of university resources” (site’s mission page).

The site had 14,918 full and part-time undergraduates in 2019-2020, with about 2,000 graduates. The ratio of male to female students is 45.53%:53.57%, with 35% of students being of color (site’s quick facts). The majority of students are from the state in which it is located; however, the site does offer twelve online bachelor’s degree programs and is ranked as one of the top 10 Best Value Colleges in the state by Smart Asset (site’s online page).

The site is committed “to hands-on learning and discovery, and individual attention takes students beyond the limits of the classroom and books. Students get to do what they’re studying in real-world, professional settings, which makes learning exciting and relevant” (site’s about page). Points of pride for the site include diversity, enrollment growth, online college affordability, and best value university, among other points. The site values student success, access, engagement, inclusiveness, shared governance, facilities, and safety. The values are
maintained through the cooperation of several administrations, including the board of trustees, the president, the provost/academic affairs, business and financial affairs, student affairs, operations, faculty senate, faculty relations, foundation, public affairs, and enrollment management. This all culminates into the five common themes of the site: teaching and learning, inclusiveness and diversity, scholarship and creative expression, public service and community engagement, and resource development and stewardship (site’s accreditation page).

This site was selected because it is a public university with a far reach through the online education opportunity provided to students. This allows students to continue their education regardless of their location. Because of its online reach, there should be a diverse population of students to select from as a sample. The online population also allows for the opportunity to better understand mathematics anxiety online as compared to studies that have focused on students’ experiences with mathematics anxiety in on-site courses. This site was also selected for its commitment to its online students, with online classes being taught by faculty and small class sizes, usually only 25 students per online class. This allows students the opportunity to better know their instructor and classmates (site’s online page). It is also important to note here that the selected site is still currently offering most classes online and requiring staff and faculty to work from home whenever possible to continue offering an educational experience through the current COVID-19 pandemic. The site plans to offer normal, pre-pandemic courses (remote, hybrid, on-site) in Fall 2021, with more online learning opportunities being available (site’s COVID-19 page).

**Participants**

Since this study sought to better understand the essence of the phenomenon of mathematics anxiety as described by self-described math-anxious college students who have
completed an undergraduate mathematics course online, all participants met the criteria of being a self-described math-anxious student who had completed an undergraduate mathematics course online. Creswell and Poth (2018) referred to this as purposeful, criterion sampling as all participants must have had experience with the phenomenon being studied. This is useful in quality assurance. In addition, participants must have been 18 years of age or older and be self-described as being afflicted with mathematics anxiety and have completed an undergraduate mathematics course online offered by the site. Participants were elicited and selected for this study from students who attended a university in the Pacific Northwest of the United States during the Spring 2021 quarter. Participants were offered a small incentive in the form of a $30 electronic Amazon gift card for their participation in the study to be disseminated to those who completed the study. Participants were selected based on the criteria needed from those students who responded. Once the criteria were ascertained, the researcher disseminated the approved consent form to the participants.

The sample size required for a phenomenological study can vary from five to 25 participants using in-depth interviews and other resources (Creswell & Poth, 2018). For qualitative research, the sample's actual size will depend on when saturation is reached while analyzing data (Creswell & Poth, 2018; Moustakas, 1994, Saunders et al., 2018, van Manen, 2014). Saturation in qualitative research indicates that no new data information is being collected due to redundancy and that data collection may cease as gathering more information or completing more analysis would not be necessary (Creswell & Poth, 2018; Moustakas, 1994; Saunders et al., 2018; van Manen, 2014).

However, van Manen et al. (2016) explained how saturation in a phenomenological study was not appropriate as there is no true saturation point in a phenomenological study. Vagle
(2018) explained that there is not a specific number to be used when it comes to sample sizes for phenomenological research studies; instead, the sample size used should match the needs of the phenomenon. Hennink et al. (2017) agreed that qualitative research should not focus on the number of participants but rather the quality of the data. That could mean spending quality time with a few participants or relatively little time with more participants (Vagle, 2018). For this study, spending time with 10 participants allowed the researcher to gather multiple lived experiences regarding the phenomenon of mathematics anxiety and online learning and was only a few participants short of a full class size. Therefore, a purposeful, criterion sample size of 10 participants was selected for this study as it was believed that this number of participants provided enough insights into the bottomless phenomenology (van Manen et al., 2016) of mathematics anxiety. A pilot of the data collection methods was conducted using students enrolled in an undergraduate mathematics course online to ensure each question and prompt’s clarity and wording. This was to ensure that the study was successful (Wray et al., 2017).

**Procedures**

This study took place virtually via Microsoft Forms and Zoom, with participants being students from a university in the Pacific Northwest part of the United States. To conduct this study, an appropriate institution and program that would grant permission for the study were identified. Liberty University required Institutional Review Board (IRB) approval and a signed letter granting permission for the study to occur (see Appendix A). Additionally, a site permission request (see Appendix B) was required and sent. Once IRB approval was secured from Liberty University (see Appendix A) and the site permission was received (see Appendix C), data collection began.

The data collection process included a questionnaire (see Appendix D), individual
interviews (see Appendix E), and two focus group meetings (see Appendix F). Experts in the field were asked to review data collection methods to check for clarity and conciseness (see Appendix G). A pilot study of the questionnaire, interview, and focus group prompts was conducted and included students enrolled in an undergraduate mathematics course online (see Appendix H). The pilot study ensured that the questions and prompts for the questionnaires, interviews, and focus group meetings were efficient. Qualifying participants for the study included students who were 18 years old or older, who had completed an undergraduate math class online, and who were self-described as being math-anxious. A request for public records form from the site (see Appendix I) and a commercial purposes declaration (see Appendix J) provided by the site were completed to request a list of potential participants. Once approval was given and the list was received (Appendix K), a recruitment email was sent to all potential participants (see Appendix L) to include a screening survey link (see Appendix M). Promptly after receiving interest from participants and their screening surveys, a welcome email inviting qualified participants to take part in the study (see Appendix N) was sent along with the consent form (see Appendix O). Following the receipt of the consent form, an email (see Appendix P) requesting participants to complete a demographics questionnaire (see Appendix Q), the questionnaire (see Appendix D), and schedule the individual interview was sent. These were all completed using Microsoft Forms. Once the scheduling of the individual interviews was set, confirmation emails were sent to participants (see Appendix R). As the scheduled times approached for the online individual interviews, individual reminders and invitation emails were sent to participants (see Appendix S). Following the completion of the individual interviews, the focus group meetings were scheduled using Microsoft Forms. Once the scheduling of the focus groups meetings was set, confirmation emails were sent to participants (see Appendix T). As the
scheduled times approached for the focus group meetings, individual reminders and invitation emails were sent to participants (see Appendix U). A weekly journal of the study's process was kept, and transcription of individual interviews and focus group meetings were actively completed throughout the study using Grain.

Once data collection was completed using questionnaires, individual interviews, and focus group meetings, data analysis began. Data analysis consisted of the four techniques provided by Moustakas (1994) (a) epoche, (b) phenomenological reduction, (c) imaginative variation, and (d) synthesis. Coding, which is the process that allows the researcher to make sense of all the data gathered more logically, was used during data analysis as it is the process of categorizing data into themes (Creswell & Poth, 2018). This process was completed by taking the large amount of data collected and reducing that volume into raw information. From there, patterns were discovered from the data, and meaning was drawn from the data to build a logical chain of evidence (Creswell & Poth, 2018; Moustakas, 1994; Tobin & Begley, 2004). The individual interview sessions and the two focus group meetings were transcribed using Grain. Participants were each assigned pseudonyms that helped code each participant’s responses to an element found in community of inquiry. After the individual interview sessions and focus group meetings were thoroughly coded by themes, individual responses were sorted and organized against others' common responses (Moustakas, 1994). This allowed for the identification of common themes among participants’ individual perceptions about mathematics anxiety (Moustakas, 1994). At the end of the preliminary data analysis process, emails were sent to participants to thank them for their participation and ask them to participate in member checks (see Appendix V).
The Researcher's Role

Qualitative research is unique as the researcher serves as a human instrument (Creswell & Poth, 2018). Therefore, it was imperative that I set aside my assumptions about the phenomenon being studied before conducting this study by conducting epoche (Moustakas, 1994). Moustakas (1994) referred to epoche as – “a Greek word meaning to refrain from judgment, to abstain from or stay away from the everyday, ordinary way of perceiving things” (p. 33). In this process of a phenomenological study, the researcher removes themselves as much as possible from the phenomenon being studied (Creswell & Poth, 2018; van Manen, 2014). This ensures that the researcher is looking at the study without preconceived ideas; instead, they are looking at the study with open minds about what the participants experience and describe.

I am currently an adjunct instructor of mathematics, teaching an undergraduate math course online. I have had experience working with students from kindergarten through higher education (undergraduate level) in an array of subjects. My higher education experience has been specific towards mathematics, either as an adjunct instructor or a mathematics consultant for a college math bridge program. My work in higher education mathematics has provided opportunities for me to interact and work with self-described math-anxious students for the purposes of completing a college course and options for math placement as incoming students to college. I have personally seen how mathematics anxiety can affect students’ motivation, confidence, and performance. Although I have seen statistics that show the success of undergraduate mathematics courses online, I want to better understand how the participants experienced the class. I want to know more than what a letter grade represents. I can also personally identify with self-described math-anxious students as I also have experienced mathematics anxiety personally throughout different times in my academic career. My
mathematics anxieties stemmed from experiences with teachers, the work itself, my own need to be perfect, and not wanting to appear dumb to others.

For this study, my relationship with the phenomenon of mathematics anxiety was one of professional standards only. Although I was a lead math consultant for the site’s summer Math Bridge Program in the past, I am not currently working for the site in any capacity. I was vigilant not to let my perceptions of mathematics anxiety become apparent to participants. I allowed participants to describe their experiences. My personal experiences and beliefs did not influence their responses because I did not know any participants. I did not believe my past connection to the site affected the research study.

Data Collection

Data collection is a quintessential step in qualitative research. It is more than merely interviewing individuals but more of a robust process – a “circle” (Creswell & Poth, 2018, p. 147) of interrelated activities as described by Creswell and Poth (2018). The interrelated activities involved in data collection included locating a site, gaining access to the site, sampling purposefully, collecting data, recording information, exploring field issues, and storing data (Creswell & Poth, 2018). The interview is the method of data collection most associated with a phenomenological research design (Moustakas, 1994). Interviews are the backbone of qualitative research studies as they provide an opportunity for participants to describe their experiences with the phenomenon being researched (Creswell & Poth, 2018; Vagle, 2018; van Manen, 2014). Creswell and Poth (2018) explained the interview as an attempt for the researcher to understand the world from the participants’ points of view. Moustakas (1994) continued that the interview should be informal and include open-ended questions that allow participants to be interactive in the process.
Other data collection methods appropriate for a phenomenological research design include questionnaires and focus group meetings (Creswell & Poth, 2018). Questionnaires provide the qualitative researcher a method to extract experiences from participants in a more relaxed format because the researcher is not in front of the participants asking the questions (Creswell & Poth, 2018). This environment may allow students to provide more detailed information that they may have felt uncomfortable sharing via interview or may enable them to fill in any gaps in information. Focus group meetings provide the qualitative researcher an opportunity to listen to participants collaborate on their experiences (Krueger & Casey, 2015). Focus group meetings provide means by which a researcher can gather information by listening to participants’ feelings about a particular topic (Krueger & Casey, 2015). The purpose of a focus group meeting is to encourage participants to share personal experiences with one another (Krueger & Casey, 2015). The goal is for participants to feel comfortable with one another and theoretically share additional details that they may recall as they collaborate with one another and hear other participants’ experiences that were not shared during questionnaires or individual interviews with the researcher (Krueger & Casey, 2015). Listening to the other participants’ perceptions encourages rich discussion and contributes to the data (Krueger & Casey, 2015). In addition, focus groups provide additional information to help discover patterns and themes in the participants’ perceptions and experiences (Krueger & Casey, 2015). It is recommended that focus group meetings include five to 25 participants (Creswell, 2014). A focus group meeting focuses on asking general, broad-scoped questions that bring focus to the interview (Creswell, 2014; Moustakas, 1994).

**Questionnaire**
For this study, a questionnaire was sent electronically to the participants using Microsoft Forms, and it was estimated that the questionnaire should take no more than an hour to complete. A pilot for the questionnaire was conducted via Zoom meetings and telephone meetings with volunteer students currently enrolled in an undergraduate mathematics course online with me as their instructor. The pilot was conducted to ensure clarity and understandability of the questions, and corrections and modifications were made based on the volunteer students’ feedback. The most notable feedback was that if the student could not immediately answer the question, it needed to be rewritten. I rewrote any problematic questionnaire questions and then presented the volunteer students with the new questions to ensure they were better developed. I developed the questionnaire (see Appendix D) with influence from Shea and Bidjerano (2009) with the purpose to discover the perceptions and experiences that self-described math-anxious college students have regarding online learning and how that pertained to the three elements of community of inquiry: cognitive presence, social presence, and teaching presence. It was important to have a complete understanding of the community created in the classroom through cognitive presence, teaching presence, and social presence as they all converge to create the entire educational experience, especially in E-Learning (Dunlap et al., 2016). When completing the questionnaire, participants were instructed to refer to the specific undergraduate online math course they identified in their demographics questionnaire.

1. How did the instructor clearly communicate important topics and goals in the online math classroom?

2. How did the instructor provide clear instructions on how to participate in the learning activities in the online math classroom?
3. How did the instructor clearly communicate important due dates or time frames for assignments in the online math classroom?

4. How was the instructor helpful in teaching the topics in the online math classroom in a way that helped you?

5. How did the instructor help keep you engaged and participating in class discussions in the online math classroom?

6. How did the instructor help to focus discussion on relevant issues in a way that helped you to learn in the online math classroom?

7. How was feedback provided to you from the instructor in the online math classroom?

8. In what ways did the instructor provide feedback that helped you understand your strengths and weaknesses in the online math classroom?

9. How did the instructor’s actions reinforce the development of a sense of community among the students in the online math classroom?

10. How did you use online or web-based communication to communicate with classmates or the instructor in the online math classroom?

11. How did you feel communicating with your classmates in the online math classroom?

12. How were you able to form distinct impressions of some of your classmates in the online math classroom?

13. How did getting to know other students in your online math class give you a sense of belonging in the class?

14. What was your comfort level in participating in the discussions in the online math classroom?

15. How did you get your point of view across in the online math classroom?
16. How did the online discussions help you to develop a sense of collaboration within the online math classroom?

17. In what ways did the online math class activities pique your interest?

18. How were you motivated to explore the content in the online math classroom?

19. In what ways were discussions in the online math classroom valuable in helping you appreciate different perspectives?

20. In what ways did the learning activities in the online math classroom help you construct explanations or solutions?

21. What resources did you use to help you resolve content-related questions in the online math classroom?

22. How can you apply the knowledge from your online math class to your work or other non-class-related activities?

23. How has a reflection of the content, assignments, or discussions of the online math classroom helped you to understand the fundamentals of the course?

The responses to questions one through nine allowed participants to discuss teacher instruction available to them in the online math class and how it helped shape their education experience and, in doing so, affect their mathematics anxiety. This is significant as teaching presence is one of the three elements found in community of inquiry. Therefore, it is imperative to understand teacher instruction to better understand the classroom's learning community and how that affected the educational experience. Often, teachers take on-site materials and place them on an online platform and maybe use some technologies associated with that, but less often do they truly create a true learning experience through teaching presence (Lee et al., 2020). It is of importance to note that the three elements of cognitive presence, social presence, and teaching
presence are interrelated and work together to create the classroom community and learning experience (Garrison et al., 2000). Teaching presence has become more a part of social presence in the online learning environment (Armellini & De Stefani, 2016). Not to mention that teachers’ math anxieties or students’ perceptions of a teacher’s mindset can transfer to their students in subtle ways that may cause long-term effects for students (Frenzel et al., 2018; Ganley et al., 2019; Gutshall, 2016; Jackson & Leffingwell, 1999; Ramirez et al., 2018a). Elementary school teachers tend to possess more mathematics anxiety than middle or high school teachers, and it is believed it is due to it not being their prime focus of education; however, teachers at all levels may experience mathematics anxiety (Ganley et al., 2019). However, teachers can have the opposite effect on their students as their joy of mathematics can rub off on their students (Fuller, 2016). Either way, there is a link between how teachers feel about math and their students' math learning outcomes (Martinez, 1987).

Questions 10 through 16 offered an insight into how participants felt about the communication in the online classroom and how that experience helped to shape their educational experience through social presence (Ashcraft, 2002; Gangley et al., 2019; Mammarella et al., 2015; Passolunghi et al., 2019; Ramirez et al., 2017). And in doing so, how that affected their mathematics anxiety—remembering that problem-solving is affected by cognitive aspects and emotional and motivational aspects and that working memory is affected by mathematics anxiety (Ashcraft, 2002; Gangley et al., 2019; Mammarella et al., 2015; Passolunghi et al., 2019; Ramirez et al., 2017). Students must communicate with one another as learning is a collaboration (Garrison & Akyol, 2015). All too often, communication between the teacher and student is emphasized, but more emphasis should be placed on communication between the students themselves (Borba et al., 2016). Armellini and De Stefani (2016) explained
how conversation that enhances cognition is not necessarily manifested through the promotion of social presence, but it is a significant component of online learning (Armellini & De Stefani, 2015). This is the one element that students control. The asynchronous discussion board is a large part of the social aspect in an online classroom and allows students the opportunity to critically engage with their classmates (Borba et al., 2016; Junus et al., 2019). This interaction provides an opportunity for students to engage with one another and with the teacher (Junus et al., 2019).

Responses to questions 17 through 23 allowed participants to discuss aspects of cognitive presence available to them in the online math class. This is significant as cognitive presence is created through communication and is one of the three elements found in community of inquiry. Therefore, it is imperative to understand what communication methods were available to better understand the learning community of the classroom and how that affected the educational experience. This is accomplished through the asynchronous discussion board as they require more critical thinking than a discussion in an on-site class (Breivik, 2016; Junus et al., 2019) and other aspects of the online classroom. However, students are not taking advantage of all the online classroom offers (Koh & Kan, 2020). Students have a well-developed understanding of the administrative aspects of the online classroom, but it seems as though they do not take full advantage of the learning applications to include online discussions (Koh & Kan, 2020). The use of all the components of the online classroom is crucial to students’ success as it is the communication that helps build the cognitive element of the community of inquiry (Garrison et al., 2000).

Individual Interviews
The interviews for this study took place virtually via Zoom meetings due to the site's global reach and the current pandemic and were expected to take no more than an hour. All individual interviews were recorded via Zoom for audio and video purposes, and a backup recording was completed using the app VoiceMemos via an iPad. A pilot for the individual interview questions was conducted via Zoom meetings and telephone meetings with volunteer students who were currently enrolled in an undergraduate mathematics course online with me as their instructor. The pilot was conducted to ensure clarity and understandability of the questions, and corrections and modifications were made based on the volunteer students’ feedback. The most notable feedback was that if the student could not immediately answer the question, it needed to be rewritten. I rewrote any problematic individual interview questions and then presented the volunteer students with the new questions to ensure they were better developed. I developed the interview questions (see Appendix E) with the purpose of discovering the perceptions and experiences that self-described math-anxious college students have regarding completing an undergraduate mathematics course online and mathematics anxiety. It was important to understand how the completion of this course online and mathematics anxiety affected one another, if at all.

1. Please tell me a little bit about yourself.
2. How would you describe your relationship with math?
3. Please describe what math anxiety is to you.
4. How did your math anxiety develop?
5. How is your math anxiety triggered?
6. What is your favorite part about math?
7. What is your least favorite part about math?
8. What subjects other than math cause you anxiety?

9. How have you coped with anxiety in those subjects?

10. How can you apply your coping methods in other subjects to math?

11. Why did you decide to pursue an online math course?

12. Why did you decide to take the math class that you identified in your demographics questionnaire?

13. How did you feel upon enrolling in that math course online?

14. How would you describe your math anxiety level while completing that math course online?

15. How did you address your math anxiety while completing that math course online?

16. Please describe your math anxiety during the first week of that math course online.

17. Please describe your math anxiety throughout that math course.

18. How comfortable are you with math now after completing that math course?

19. Do you have any further information you would like to add that I have not asked that you feel would help me better understand math anxiety and your relationship with it?

Question one served the purpose of an icebreaker as the participants and I did not know one another (Moustakas, 1994). This question may also provide some insights into the phenomenon that had not been anticipated.

Responses to questions two through three provided an opportunity for a better understanding of how participants feel about mathematics while providing their thoughts about what mathematics anxiety is to them and their experiences. Dowker et al. (2016) explained how mathematics anxiety and math ability typically have a negative correlation, but that does not mean that someone with high mathematics anxiety cannot be great at math or that someone
without mathematics anxiety is bad at math. That is why it was important to hear directly from the participants as they can provide real insight into their circumstances. Knowing that mathematics anxiety can cause a disconnect with students (Ramirez et al., 2018b) and be the cause of low math achievement (Betz, 1978), it is crucial to have them reflect on what mathematics anxiety is and how it began. The best way to identify students with mathematics anxiety is through self-reporting questionnaires (Ramirez et al., 2018b).

Questions four and five offered an insight into how participants’ mathematics anxiety began and what triggers it, the experiences associated with that, and how it affects them. This question also helped provide more in-depth knowledge of how mathematics anxiety ebbs and flows. Dowker et al. (2016) explained the short- and long-term effects of mathematics anxiety, with the short-term impact being shortfalls in mathematics skills and the long-term effects being increasing gaps in knowledge that are difficult to overcome as anxiety tends to be persistent. The anxiety and negative emotional experiences surrounding mathematics have been found to change students’ cognitive processes, and those students with high anxiety will utilize less effective math strategies than their counterparts (Ashcraft, 2002). Mathematics anxiety can begin as early as kindergarten, but most studies suggest that it appears more in first through third grade and becomes even more prominent beyond the elementary level (Lu et al., 2019; Sorvo et al., 2017). Elementary school students tend to have mathematics anxiety regarding two factors: arithmetic fluency (math-related situations) and failure (Sorvo et al., 2017).

The responses to questions six and seven offered time for participants to reflect more on their relationship with mathematics – both the bad and good. These questions may allow for an opportunity for participants to describe their past or present experiences with mathematics or mathematics anxiety. Responses here may drudge up unexpected information. The root cause of
mathematics anxiety is unknown as it is a complex concept, but some theories place the
development of mathematics anxiety into three categories: poor math skills, genetic dispositions,
or socio-environmental factors (Ramirez et al., 2018b). However, history has shown that
mathematics anxiety is more problematic to place than this as the manifestation of it is different
for each student (Gough, 1954). How a student feels about themselves and the beliefs of their
capabilities directly affects their self-efficacy (Bandura, 1986).

Questions eight through 10 were intended to allow participants an opportunity to reflect
on other subjects and if anxiety is associated with any of them or if mathematics anxiety is
unique to them. Mathematics anxiety is caused when an individual is confronted with math
stimuli. This brief exposure to math stimuli is similar to a fear-conditioned stimulus in that
students are biased and will avoid the stimuli (Pizzie & Kraemer, 2017). It was important to
know if this occurs in other subjects and how students cope with that, as Gallagher and Stocker
(2018) provided methods to incorporate social-emotional learning and how anxiety can be
alleviated to some degree with this.

The responses to questions 11 through 18 provided insight into why a math-anxious
student would take a mathematics course online and how an online course affected their
mathematics anxiety. Online education or E-Learning has opened education to more students and
might explain why students with mathematics anxiety are taking an online mathematics course –
it is convenient (Man et al., 2019). Lisciandro et al. (2018) and Lyons and Beilock (2012)
supported the importance of students’ attitudes and how that may influence their attitude towards
mathematics and can create mathematics anxiety. Parnis and Petocz (2016) explained attitude as
a favorable or unfavorable response to a situation or stimulus. The idea of taking an already
stressful subject in an online format is of interest here, as Beilock (2008) explained how math performance might waiver in stressful situations.

Question 19 allowed an opportunity for participants to express additional information that was not included in the questions presented. This is important as this study was about their experiences. They should be allowed to express any experiences that may have been overlooked as information here may be an unexpected plethora of valuable information. Again, participants were able to describe their experiences as they were lived and felt, possibly focusing on specific events or happenings (van Manen, 2014).

**Focus Group Meetings**

The two focus groups meetings for this study took place virtually via Zoom due to the site's global reach and the current pandemic and are expected to take no more than an hour. The focus group meetings were recorded via Zoom for audio and video purposes, and a backup recording was completed using the app VoiceMemos via an iPad. The focus group meetings’ purpose was to gather a better understanding of the participants’ experience with mathematics anxiety and how taking an online mathematics course played into that experience. A pilot for the focus group meeting prompts was conducted via Zoom meetings and telephone meetings with volunteer students who were currently enrolled in an undergraduate mathematics course online with me as their instructor. The pilot was conducted to ensure clarity and understandability of the prompts, and corrections and modifications were made based on the volunteer students’ feedback. I rewrote any problematic focus group meeting prompts and then presented the volunteer students with the new prompts to ensure they were better developed. I developed the focus group meeting prompts (see Appendix F) with the purpose of discovering the perceptions and experiences that self-described math-anxious college students have by returning to the
concepts explored in the questionnaire and individual interviews. That includes online learning and the community created through the three elements of COI (cognitive presence, social presence, and teaching presence) and completing an undergraduate mathematics course online and mathematics anxiety. It was important to return to these concepts from the questionnaire and individual interview during focus group meetings, so participants have an opportunity to collaborate with one another while they share their personal experiences. The idea was that by revisiting these ideas in this manner, additional details not mentioned in the two previous data collection methods were shared (Krueger & Casey, 2015).

1. Describe your prior experience with online education.
2. How do you feel about math?
3. How is math anxiety created?
4. How did the online learning environment affect your feelings towards math?
5. How important is trust in your instructor as it relates to math anxiety?
6. How were you able to build trust in your online math instructor?
7. How important is a social connection with other students as it relates to math anxiety?
8. How were you able to create a social connection with other students in the online math classroom?
9. Do you have any further information you would like to add that was not presented here that you feel would help me better understand math anxiety and your relationship with it?

The first prompt served the purpose of understanding the prior experience with online classrooms that each participant has. This helped to better understand if the participant is well-versed in online education or if it is new to them. This was important to know for this study as
anxieties may come from the learning environment rather than the subject. Gerdes and Mallinckrodt (1994) explained how students require adjustment time to college. Today many students may be refugees not only in higher education but also in online education (Stone et al., 2016). Young et al.’s (2012) findings supported the idea of math anxiety being specific to activities and situations. It is also important to note that E-Learning unites two main areas of learning and technology (Aparicio et al., 2016). In this way, technology is used as another tool, just as a book, pencil, or paper would be used (Aparicio et al., 2016). Other than technology, the concept of E-Learning also includes learning strategies, learning methods, and content dispersal and connection (Aparicio et al., 2016). An online classroom is no longer just a room where learning takes place, but it is an intricate part of that learning and the experience created and must include a learner-focused design (Tallent-Runnels et al., 2006) to help both low and high achievers (Sotiriou et al., 2020). It was important to understand if participants are anxious in all online courses or if an online mathematics course is unique to this. Stocker and Gallagher (2019) described how specific academic courses had been proven to have caused anxiety in students, more specific courses in the STEM field.

The second prompt provided participants the opportunity to discuss their feelings about mathematics in general without any pointed directions as to how they should feel or what makes them feel this way. It is important to remember that mathematics anxiety is created through experiences (Gough, 1954; Hembree, 1990; John et al., 2020) with math that can vary from an experience with a teacher to falling behind in math (Gough, 1954).

The third prompt offered insight into how participants believe math anxiety is created. Hembree (1990) and John et al. (2020) described how mathematics anxiety was a learned
behavior based on the participants’ experiences, so it is essential to identify how students believe it is created. This allowed for a comparison of what research states and what students state.

Prompts four through six provided an opportunity for students to specifically discuss how the online learning environment affected their feelings towards mathematics. This is accomplished through a direct question regarding the online learning environment and follow-up questions regarding the specific elements of a learning environment. The community of inquiry explains how the learning environment is crucial to education and that it is created through cognitive presence, social presence, and teaching presence (Garrison et al., 2000; Richardson et al., 2012).

The seventh prompt allowed an opportunity for participants to express additional information that was not included in the questionnaire. This was important as this study was about their experiences. They should be allowed to express any experiences that may have been overlooked as information here may be an unexpected plethora of valuable information. Participants were able to describe their experiences as they were lived and felt, possibly focusing on specific events or happenings (van Manen, 2014).

Data Analysis

Data analysis is the process of understanding what the data collected from the study was conveying (Creswell & Poth, 2018). Data was analyzed following Moustakas’s (1994) techniques (a) epoch, (b) phenomenological reduction, (c) imaginative variation, and (d) synthesis. By performing a thorough analysis of the data gathered, the “essence” (Moustakas, 1994, p. 8) of the experience was uncovered (Moustakas, 1994; van Manen, 2014). Each of the techniques to be utilized contributed to the reliability and validity of the research study. The trustworthiness of the study was ensured through the integration of triangulation, reflexivity,
member check (see Appendix V), rich and thick detail, and an audit trail (Creswell & Poth, 2018; Moustakas, 1994; van Manen, 2014).

**Epoc**

The first technique used in data analysis was the process of epoc. A researcher must first complete a personal epoc (Moustakas, 1994) to remove personal bias or assumptions (Creswell & Poth, 2018; Moustakas, 1994). The purpose of epoc was to set aside my personal experiences, biases, and assumptions as much as possible so that the experiences of the participants of the study can be examined (Moustakas, 1994). An important component of the research as the human instrument is to be able to epoc my “preconceived bias and judgments, setting aside voices, sounds and silences that so readily tell us what something is” (Moustakas, 1994, p. 60). Attempting to epoc all pre-determined beliefs and assumptions allowed me to examine the phenomenon without any pre-conceived ideas or notions as though it was my first time seeing it.

**Phenomenological Reduction**

The second technique that was used in data analysis was phenomenological reduction. Phenomenological reduction is the process of describing just what is seen both internally and externally – the relationship between the phenomenon and the self (Moustakas, 1994). This process requires the researcher to repeatedly look and describe the phenomenon for itself (Moustakas, 1994). Several steps are involved in phenomenological reduction: bracketing, horizontalizing, clustering the horizons into themes, and organizing the horizons and themes into a textural description of the phenomenon (Moustakas, 1994).

During the first step of phenomenological reduction, known as bracketing, the focus of the research (topic or question) was placed in brackets, and everything else was set aside. This
ensured the entire research process was fixed only on the topic or question (Moustakas, 1994). The second step of horizonalizing is the process of giving all the statements equal value (Moustakas, 1994). During this step of phenomenological reduction, horizons that stood out as irrelevant to the experience or repetitive, overlapping horizons were deleted (Moustakas, 1994). The process of delimited horizons left only the horizons of the experience. This third step of phenomenological reduction, known as horizons, is nonrepetitive, nonoverlapping statements that were the textural meanings and consistent qualities of the phenomenon from which themes are created based on each research participant (Moustakas, 1994). The fourth step of phenomenological reduction was the process of clustering the horizons into themes (Moustakas, 1994). Phenomenological reduction was completed when the horizons and themes of all the individual textural descriptions were organized into composite textural descriptions of the phenomenon (Moustakas, 1994). Structural themes were created after the list of structural qualities was clustered into themes (Moustakas, 1994).

**Imaginative Variation**

Imaginative variation was the next technique in the data analysis process as it allowed the researcher to develop structural themes from the textural descriptions found during phenomenological reduction (Moustakas, 1994). During this step of the research process, imagination was used to further explore the data gathered through the idea of varying possible meanings, varying perspectives, and fantasy variations to understand how the experience of the phenomenon occurred (Moustakas, 1994). The goal of imaginative variation was to create a list of structural qualities of the experience using intuition that developed into universal structures as themes that developed into a composite structural description (Moustakas, 1994).

**Synthesis**
Synthesis was the final technique in the phenomenological data analysis process in which the composite textural and structural descriptions from imaginative variation were reflected upon to develop a synthesis of the meanings and essences of the phenomenon or experience (Moustakas, 1994). Noting that the essence of an experience was just that – the essence of that experience at that time in that circumstance in which the researcher studied it (Moustakas, 1994).

**Application to the Current Study**

For this study, elements of the community of inquiry were employed to assist in phenomenological reduction. Throughout the study, individual interview sessions and focus group meetings were audio and video recorded. Transcription of all individual interview sessions and focus group meetings began in which I emerged myself into all the data collected (Bird, 2005; Henderson, 2018; Milacci & Zambloski, 2020b). To code a phenomenological study, the researcher must follow Moustakas's (1994) phenomenological techniques as described above. The researcher transcribed the interviews and began the process known as horizontalizing, in which significant statements from participants were highlighted, and each statement was relevant and of equal value (Creswell & Poth, 2018; Moustakas, 1994).

First, the questionnaire was analyzed by reading and coding the data collected from each participant. The commonalities and differences that emerged from each participant were identified. Then individual interview sessions were analyzed, and it was determined if any of the data corresponded with any of the codes that emerged from the questionnaires. Last, the focus group meetings were analyzed, and identifications were made about how the data collected matched with previously established codes identified in the questionnaires and individual interview sessions. New codes were established for any data that did not match prior codes (Friese, 2014; Saldaña, 2013). Meanings were then clustered into common themes and
overlapping and repetitive statements were removed (Creswell & Poth, 2018; Moustakas, 1994). Using the data collected through the questionnaires, individual interview sessions, and focus group meetings, a list was created of significant statements that occurred continuously throughout the data and those that do not repeat. Textural descriptions are narratives used to explain the participants’ perceptions of the phenomenon using verbatim excerpts from the individual interview sessions and focus group meetings (Creswell & Poth, 2018; Moustakas, 1994). Common themes from the questionnaires, individual interview questions, and focus group meetings were investigated and organized into a composite textural description to discover the essence of the experience as the participants experienced it.

**Trustworthiness**

Trustworthiness was established in this study by addressing the credibility, dependability and confirmability, and transferability of the study (Lincoln & Guba, 1985). Several methods were completed to ensure each of these concepts was upheld and that the study was one that could be trusted. Creswell and Poth (2018) described validity by explaining Polkinghorne’s (1989) notion of validity in which an idea is both well-grounded and supported. Credibility was established through the triangulation of data collection methods, dependability and credibility were established through reflexivity and member checks, and transferability was established through rich and thick descriptions and audit trails (Creswell & Poth, 2018; Lincoln & Guba, 1985). Using different strategies for validation helped collaborate the trustworthiness of the qualitative research (Creswell & Poth, 2018).

**Credibility**

Credibility in qualitative research explains the extent of how accurately the findings describe reality (Creswell & Poth, 2018). Credibility is established when the participants’
responses and the researcher’s representation of those responses correlate (Tobin & Begley, 2004). Triangulation of data was utilized to ensure that my study was completed in a credible, reliable, and valid manner (Creswell & Poth, 2018). Triangulation is the process of using multiple methods to test the validity of qualitative research through the merging of information from different sources (Creswell & Poth, 2018; Lincoln & Guba, 1985). Data was collected using three collection methods: a questionnaire, individual interviews, and focus group meetings. The common themes that emerged from the shared experiences of each of the participants using the three different data collection methods were recognized. Credibility through validity is created when common themes emerge through various data collection methods through the triangulation of information (Creswell & Poth, 2018).

**Dependability and Confirmability**

Dependability in qualitative research refers to how truly the data represents the interviews and questionnaires of participants. To achieve dependability, researchers can ensure the research process is logical, traceable, and clearly documented (Tobin & Begley, 2004). The researcher's meticulous notetaking can enhance dependability to include methods used to record audio and video and the methods employed for transcribing those recorded files (Creswell & Poth, 2018). Confirmability focuses on the degree to which a study's results could be confirmed or corroborated by others to ensure that the interpretations of the findings are clearly developed from the data collected (Tobin & Begley, 2004). The use of reflexivity and member checks ensured the dependability and confirmability of the research.

Reflexivity refers to the researcher keeping detailed notes about the research, methodological decisions, rationales, and keeping account of the researcher’s personal reflections (Creswell & Poth, 2018). Reflexivity is the process of the researcher keeping a
journal throughout the study that includes internal and external dialogue and the daily ongoings of the study (Creswell & Poth, 2018). This process was vital because it helped the researcher avoid bias in their research as personal beliefs, values, and biases were reported at the onset of the study (Creswell & Poth, 2018). This allows the reader to understand better what might have shaped the study (Creswell & Poth, 2018).

Member check refers to having the participants review and respond to the findings and interpretations of the preliminary data analysis. (Creswell & Poth, 2018; Lincoln & Guba, 1985). The critical technique of member check is vital when establishing credibility (Lincoln and Guba, 1985). It is important to note that the participants did not receive the transcripts or raw data; rather, participants were asked to check the accuracy of the preliminary data analysis as well as note if anything was missing from it (Creswell & Poth, 2018; Lincoln & Guba, 1985). This process increased the dependability of the study because the participants reviewed the researcher’s interpretation of the data and filled in any gaps or made clarifications (Creswell & Poth, 2018).

Transferability

Transferability focuses on the external validity of the data. Creswell and Poth (2018) describe transferability as to how the findings in the study could be transferred to other settings. The use of a descriptive richness of the site and participants will allow the reader to determine if the information from the study can be transferred to other situations (Creswell & Poth, 2018). Transferability was evident in my study through the rich detail that was used to describe my participants and their experiences (Creswell & Poth, 2018, Moustakas, 1994). The use of an audit trail (Nowell et al., 2017) was employed by keeping all audio and visual recordings of each interview session and focus group meeting as well as keeping all the questionnaires. To ensure
that no details were overlooked, each questionnaire and interview was carefully reexamined and reviewed several times. A complete context of the study was provided so that other researchers could potentially replicate it.

**Ethical Considerations**

Several ethical considerations were addressed in this study. First, Institutional Review Board (IRB) approval from Liberty University and site permission were sought and obtained before any data collection was attempted for this study. Next, issues of confidentiality were addressed by assigning pseudonyms to people, places, and other potential identifiers of this study. Participants were aware of the purpose and nature of the study so that they knew what to expect as a participant of the study. The voluntary nature of this study was also made evident, and each participant was asked to sign and return an informed consent form (see Appendix O). Included in the consent form was the information that notified participants about their right to withdraw from the study via email stating the desire to withdraw and informed them that their data apart from the focus group meeting data would be destroyed immediately and not used in the study. Focus group meeting data would not be destroyed, but their contributions would not be used in the study. A fingerprint-protected computer was used to store all electronic file data. The computer that the files were on will remain in my domicile for three years from the end of the study, at which time the files will be deleted. Finally, all reports based on the data collected were completed honestly concerning the participants’ experiences, and any contrary findings were reported.

**Summary**

The primary focus of chapter three is to clearly define the methods used throughout this transcendental phenomenological study by addressing the experiences of self-described math-
anxious college students completing an undergraduate mathematics course online. The purpose of this study was to examine experiences of self-described math-anxious college students who completed a math course online in response to the need for STEM retention due to an ever-increasing tech-savvy society (Chang et al., 2016; Jen-Mei et al., 2016; John et al., 2020; Jones, 2015; Xue & Larson, 2015). The participants of the study were self-described math-anxious students who had completed an undergraduate math course online provided by the site. In this chapter, a detailed outline of the methods and procedures of the intended transcendental phenomenological study was provided by giving a detailed description of the research design, questions, the site, participants involved, and the data collection methods. Following the collection of data, data analysis took place using epoche, phenomenological reduction, imaginative variation, and synthesis. The validity and trustworthiness of the study were ensured using triangulation, reflexivity, member check, rich and thick detail, and an audit trail. The chapter concluded with a thoughtful description of how ethical considerations were ensured throughout the study.
CHAPTER FOUR: FINDINGS

Overview

The purpose of this transcendental phenomenological study was to describe mathematics anxiety for self-described math-anxious students who have completed an undergraduate mathematics course online at a regionally accredited university located in the Pacific Northwest part of the United States. The purpose of Chapter Four is to present the results of the study. The chapter provides an individual description of the 10 self-described math-anxious students who participated in the study. Then the data from the questionnaire, individual interviews, and focus group meetings is presented by themes in the forms of narratives, tables, and figures. These themes were established from data analysis based on transcendental phenomenological reduction, as discussed in Chapter Three. The chapter concludes with responses to the research questions that guide this study.

Participants

Ten self-described math-anxious students who had taken an undergraduate college math course online participated in this study. They were selected using purposeful, criterion sampling for quality assurance as all participants had to meet the criteria for the study. Participants were selected from a comprehensive list of students who attended a university in the Pacific Northwest during the Spring 2021 quarter. The list of potential participants was received from the records office at the site and included 10,101 student names. Recruitment emails requesting research participants were sent to the first 6,599 students listed, and of those, 71 students responded to the screening survey. Of those 71 potential participants identified, 24 students did not qualify due to lack of math anxiety or lack of completing an undergraduate online math course. Of the 47 that qualified to be participants of the study, only 13 volunteered to participate in the study, with
three of those opting to drop out of the study due to their schedules after sending in their consent forms. The 10 participants in the study all attended the same university. However, the participants had completed different online math classes and had varying experiences with online college courses. All participants were in North America, and six were male, and four were female. They ranged in age from 20 to 24 years. Seven participants identified as Caucasian, and three identified as being two or more ethnicities. Six of the participants were 3rd year-juniors, and four were 4th-year seniors. All participants were full-time students, with eight working while two were traditional students. “The traditional student has parents who are able to pay for college; can (afford to) live on campus; is unencumbered by children, and thus does not require employment to afford tuition” (Bahrainwala, 2020, p.251). Two commonalities among all 10 of the participants were (a) that they all took the online math class they referred to in this study due to the COVID-19 global pandemic, and (b) they do not hate math but hate the way math makes them feel.

Table 1

Self-described Math-anxious Student Participants

<table>
<thead>
<tr>
<th>Student Participant Name</th>
<th>College Grade Level</th>
<th>Student Status</th>
<th>Undergraduate Math Course Taken Online</th>
<th>Number of Online College Courses Completed</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sam</td>
<td>4th year - senior</td>
<td>Full-time, working</td>
<td>Linear Algebra</td>
<td>10</td>
</tr>
<tr>
<td>Rico</td>
<td>4th year - senior</td>
<td>Full-time, working</td>
<td>Micro-Economics</td>
<td>10</td>
</tr>
<tr>
<td>John</td>
<td>4th year - senior</td>
<td>Full-time, working</td>
<td>Math101</td>
<td>14</td>
</tr>
</tbody>
</table>
Adam  4th year - senior  Full-time, working  Medical Math & Terminology  15-20
Sarah  3rd year - junior  Full-time, working  Pre-Calculus  4
Matthew  3rd year - junior  Full-time, working  Calculus 1  13
Mary  3rd year - junior  Full-time, traditional  Math in Society  6
Julie  3rd year - junior  Full-time, working  Personal Finance  20
Katie  3rd year - junior  Full-time, traditional  Introductory Statistics (Psychology)  13
Walter  3rd year - junior  Full-time, working  Calculus 1  17

Sam

Sam was a 4th-year physics student interested in engineering and matters that go along with that, such as electronics and coding. He selected physics as his major as it was the most diverse major. As a physics major, he had to take every math class, which gave him a minor in math. Sam completed Linear Algebra online due to the global pandemic of COVID-19 and had completed 10 college courses online. Sam described his relationship with math as very tumultuous. The issue was that he did not like math but had always been good at it. For him, math anxiety was getting anxious when approaching a problem, especially if it could be solved from different directions. Sam said he was “more interested in the bigger picture, but can get lost in certain parts of problems rather than what he was supposed to solve for.” He also got worried about taking too long to solve math problems. Sam had always felt math anxiety. He always had some reason why he did not want to do a math problem. He specifically referred to when middle and high school math problems became more complex. Time constraints triggered his math
anxiety. He explained this as being “when a problem is taking longer to complete than I want it to take.” Sam did not doubt himself when approaching problems, but his math anxiety would “flare-up” when he had difficulties with problems.

**Rico**

Rico was a 4th-year senior studying history and anthropology with a double minor in Latin American and Native American studies. Rico completed Micro-Economics online due to the global pandemic of COVID-19 and had completed 10 college courses online. Rico said, “it [relationship with math] is a loveless marriage. I respect it. I know that it is needed, but I don’t want it near me.” Rico continued, “math anxiety to me is honestly the social structure that tells you, ‘Hey, you’re in college, you should be really advanced in math.’” However, Rico said he was not advanced in math, and college math had been difficult. He worried about memorizing formulas and what to substitute into them because he overthinks. Rico said his math anxiety developed around middle school. He would focus really hard but barely retain any information to pass the tests or exams. He was constantly worried about how close he was to failing, but that feeling would pass when he found out he passed the test. However, he was failing more in college, so the more math he was presented with, the more anxious he got about it. He equivalated it to the “catch-up game” of not knowing what they did last week and being presented with something new this week. That triggered Rico’s math anxiety as he felt he was falling behind and failing and then needing to catch up.

**John**

John was a 4th-year senior who completed Math101 online due to the global pandemic of COVID-19 and had completed 14 college courses online. He described his relationship with math as something that he always had to put more effort into because it never really clicked.
John had to take extra math classes in middle and high school to support him as he was not at the grade level he should be in math. He did not meet the standards for college math courses, so he took extra math classes in college again because he did not understand math well. To John, math anxiety was worrying about memorization, including memorizing the formulas and what to substitute into them. He used the specific example of formulas for loans and not remembering what term would be substituted in for the variable $n$. John said, “I feel like I understand like what to do, but my anxieties, especially with any type of test, I just overthink a lot.” John’s math anxiety developed in elementary school and has followed him and continued to develop his whole education career. He said he was below average compared to the other kids in his grade, so he kept taking more math classes. He stated, “I was taking more of those math classes; I was kind of losing confidence in myself.” He started questioning if he was smart enough and thinking he was just too dumb to solve math problems. John’s confidence continued to fall because he had overachieving friends who thought math was easy, so why was it not easy for him. “You kind of get into the mentality of, am I just, uh, am I dumb or am I stupid,” he said. John’s math anxiety was triggered when “I feel like there’s something at stake.” He explained this by referring to a basic math test he had to pass for the education program at his university, and everyone was saying how it was a breeze, but it brought on feelings of self-doubt and worry for him.

Adam

Adam was a 4th-year senior majoring in public health, specializing in pre-nursing and minoring in entrepreneurship. Adam completed Medical Math and Terminology online due to the global pandemic of COVID-19 and had completed 15 to 20 college courses online. He described his relationship with math as “never really being a big fan of math. I thought it would be easier going into it, but I’ve always struggled with it.” When he was younger, he thought he
wanted to be a mechanical engineer, and then he realized how much math was involved with that career and decided he did not want to go that route. Adam described math anxiety as a struggle to get through, all the while worrying if he is doing it right and then getting frustrated when he did all that work and got a wrong answer. He really worked at math to get a good grade in the class, but math was on the bottom of his to-do list. Adam’s math anxiety developed in elementary school. He described how he was pretty good in most subjects, but math was harder. He said,

as it [math] progressed and math got harder, uh my, you know, level of confidence with it just kind of like dropped in proportion. Um, like just, it seems like math is getting more difficult, and I’m understanding less of it.

Adam explained how those “very lengthy math questions don’t help” when it came to what triggered his math anxiety. He further described that situation in terms of how a single math problem can require many steps, and if he did not completely understand one of the steps, then the whole question was wrong. He said,

you know, for a lot of subjects, you can kind of fake it ‘til you make it. If you don’t understand one thing, like, okay, you might miss a question. But, if you don’t understand one thing with math, you might miss like a whole chunk of a quiz.

Sarah

Sarah was a 3rd-year junior studying to become a physician’s assistant. Sarah completed Pre-Calculus online due to the global pandemic of COVID-19 and had completed four college courses online. She shared a saying that her cousin had shared with her a long time ago. “Just because you’re not good at math or science doesn’t mean you shouldn’t pursue a career that you want.” She explained how she had never been good at math, but her passion was to go into the
medical field. Sarah used to be good at math a long time ago, and she loved solving equations. She was even on a math team in high school, but she soon realized that she did well on homework but did not do well on tests. She did very well in English because she felt that part of her brain communicated with her, whereas the math part of her brain did not. She described math anxiety as

when you are presented with problems, and they’re math-related, but you’re not able to, you might not have the knowledge to get those completed. And so, you almost feel overwhelmed and frustrated that you can’t get those taken care of and done.

Sarah’s math anxiety developed throughout high school. She was good at most subjects, with math being harder for her, but then she realized that she could not complete the assignments because she did not understand what her teachers were teaching her. Her math anxiety was triggered during class when she felt that her classmates understood the material and she did not understand it as fast as they did. It gave her the feeling that she needed to pick up the pace or fail.

Matthew

Matthew was a 3rd-year junior studying mechanical engineering but changed his major to safety and health. Matthew completed Calculus I online due to the global pandemic of COVID-19 and had completed 13 college courses online. His relationship with math was intriguing, as up until ninth grade, he said he was terrible at math. He explained how he would earn Bs in class, but that was with a lot of help, and even then, he did not fully understand the math all that well. Then in ninth grade, something changed, and he understood math. He consistently received As, and it had been good since then, apart from calculus which gave him some trouble because he completed it online. To Matthew, math anxiety was that feeling you got before a math test when you were unsure of all the topics presented. However, he did not feel the same math anxiety with
homework or quizzes. His math anxiety developed before ninth grade when he was having a much more difficult time. He never felt ready for math tests, but his math anxiety with tests had lessened since he now understood math more. Matthew’s math anxiety was not triggered in class or by homework but focused on tests. His math anxiety built up each day as the test day got closer. It was less if he understood the material but was always there. He used to have nightmares due to his lack of understanding, but luckily that did not happen anymore.

Mary

Mary was a 3rd-year junior. She was a “military brat,” which brought her to the Pacific Northwest. She went to community college, where she earned her associate degree. She then transferred to the university where she was continuing her education. Mary completed Math in Society online due to the global pandemic of COVID-19 and had completed six college courses online. Mary said she was good at math, but she did not like doing it because she hated the process. She said, “it is a love, hate relationship.” To her, “math anxiety is the feeling you get when you see your homework or your test, and you’re like, oh crap, this is going to take me five hours to get through.” She explained how her math anxiety developed as a young child because she was expected to make As, but then math got harder. Mary began to worry when she knew she would not make an A because the math had gotten harder, and she no longer understood it. She was now expected to understand the previous topics and more. Mary’s math anxiety was triggered by not understanding one element, and then it snowballed and rolled downhill, getting more extensive as it accumulated more because math builds on itself.

Julie

Julie was a 3rd-year junior majoring in hospitality. Julie completed Personal Finance online due to the global pandemic of COVID-19 and had completed 20 college courses online.
Her relationship with math was one of dread. It was not her favorite subject, and she did not enjoy it. To Julie, math anxiety is being uncomfortable and not feeling confident. Julie explained, “I think I could work on it to be better at math, but I think I just don’t have the motivation or like the wants to be good at it.” Her math anxiety developed throughout high school because she compared where she was in math to other students. Julie was in a math bridge class in high school her senior year rather than being in pre-calculus or statistics like other students. Julie’s math anxiety was triggered by being called on by the instructor to answer a question. However, if she volunteered to answer a question, she was okay because she felt confident.

Katie

Katie was a 3rd-year junior studying political science and law and justice. Katie completed Introductory Statistics (Psychology) online due to the global pandemic of COVID-19 and had completed 13 college courses online. Her relationship with math was rocky. She said she had always struggled with math since childhood. She had a tutor in elementary school that put her on track for middle school and high school math. However, in her senior year of high school, she again began falling behind in math because she had difficulties identifying what topic was being built off. By the time Katie was in college, her math world had imploded. She said, Um, so it felt like at one point in my life I, I understood math. And then, as I’ve gotten older and my attention has drifted away from math, I don’t understand it as much anymore. So, I don’t think anything really stuck.

Katie found math anxiety hard to define but became aware of it due to the amount of stress during her calculus one class. She said she could do the work, but the class was extremely hard, and she was constantly stressed about that class because she “felt I wasn’t learning the way I should be or at the rate I should be.” Katie explained how she felt the professor was not doing a
good job teaching the materials. The amount of pressure to do well was more than in any other class she had taken. Katie’s math anxiety developed at a very young age when her mother got her a math tutor. Having a math tutor made Katie feel like she was not smart enough to do the math. She compared herself to other students and felt different from other students because she needed one-on-one help in math. She recovered from this feeling until high school, when she began falling behind again. Katie described math as a subject that you must be on board with, or you will be left behind because it builds on itself so fast. Katie detailed that her math anxiety was triggered when learning a new topic in math when she did not fully understand the current topic. Katie shared her feelings of “I’m such an idiot,” as she felt embarrassed at falling behind because she did not understand. Katie was frustrated with her math anxiety as she said she was a good student with a 3.9 GPA.

**Walter**

Walter was a 3rd-year junior studying mechanical engineering technology. Walter completed Calculus I online due to the global pandemic of COVID-19 and had completed 17 college courses online. Walter did not have any issues with math up until college. He knew the materials would be more difficult, but Walter attributed his math anxiety to the online classroom as everyone was new to online classes, including the instructors. Walter explained that he did not have the proper study habits for an online course and that the instructors did not deliver the class materials well. Walter described how his relationship with math was more dependent on the professor. He said a professor who makes students care about learning the material by making it more enjoyable is vital. This was not the case for Walter in his online math class, and he became overwhelmed quickly. Walter found math anxiety hard to define as he was not even aware of it being a thing until his online Calculus I class. After that, he felt like he was more stressed out,
not because he had problems keeping up but because it was hard. He reiterated that he could complete the work but was constantly stressed. Walter explained, “I wasn’t learning the way I should be or the rate I should be.” He felt immense pressure to do well on exams because he felt as though the professor had not taught well. Walter’s math anxiety developed at the first quiz in the class. Walter expressed how his math anxiety began quickly in the quarter, and he knew it was going to be a hard quarter as there were many quizzes. Walter’s math anxiety was triggered by quizzes and exams – anytime that he had to recall all the material he had just learned. Because he was not confident in himself as he did not feel he was taught well by the instructor.

Results

The results of this study were found by analyzing the data gathered from a questionnaire, individual interviews, and focus group meetings using the elements of the community of inquiry to assist in phenomenological reduction. Data saturation was achieved when the participants began repeating many of the same experiences, and no new data information was being collected due to redundancy (Creswell & Poth, 2018; Moustakas, 1994; Saunders et al., 2018; van Manen, 2014). The focus group meetings supported the themes that emerged from the interviews, as did the questionnaire after an exhaustive examination. To uncover the essence of the experience (Moustakas, 1994; van Manen, 2014), I had to thoroughly analyze the data gathered. This began with me first completing a personal epoche (Moustakas, 1994) to remove personal bias or assumptions (Creswell & Poth, 2018; Moustakas, 1994). Next, I emerged myself in the data collected (Bird, 2005; Henderson, 2018; Milacci & Zambloski, 2020b) to begin phenomenological reduction. When emerging myself into the data, I had to bracket the research questions and set everything else aside as the research questions were my focus (Moustakas, 1994). First, the questionnaires were analyzed by reading through them at least five times and
uploading the questions and all participants’ responses into an Excel document. Second, all transcripts from individual interviews and focus groups were transcribed using Grain. The transcriptions from the individual interviews and focus group meetings were then uploaded into Excel documents, respectively. I listened to each individual interview and focus group meeting at least five times and read through the transcripts each time and several times thereafter. Then I began the process of horizontalizing data collected from each data collection method individually, in which significant statements from participants were highlighted, and each statement was relevant and of equal value (Creswell & Poth, 2018; Moustakas, 1994). Repetitive and overlapping horizons were removed to leave only the horizons of the experience. Following this, I clustered the horizons into themes and organized those themes into a textural description of the phenomenon (Moustakas, 1994). I completed that process beginning with the questionnaires, followed by the individual interviews, and finished with the focus group meetings. Each time I analyzed a data collection method, identifications were made about how the data matched previously established codes. New codes were established for any data that did not match prior codes (Friese, 2014; Saldaña, 2013). Using the data collected through the questionnaires, individual interview sessions, and focus group meetings, a list was created of significant statements that occurred continuously throughout the data and those that did not repeat. Structural themes were subsequently formed from the textual descriptions that developed into a composite description during imaginative variation. Afterward, I reflected upon those structural and composite descriptions to develop the essence of the phenomenon or experience (Moustakas, 1994). Through the data analysis process, three themes emerged from this study: teaching presence, social presence, and cognitive presence.
In the questionnaire and transcripts of the individual interviews and focus group meetings, I found significant statements about how the self-described math-anxious students experienced math anxiety while they completed an online undergraduate math course. Each of these statements was treated equally and became my initial codes, shown in Table 2. Then I removed all repetitive codes, created a list of essential codes, and organized them into final code categories based on Garrison et al.’s (2000) community of inquiry coding template to create a list of codes for describing the lived experience of self-described math-anxious students attending college online, as seen in Figure 1. Finally, I organized the final code categories into themes, as seen in Table 3.

**Table 2**

*Initial Codes*

<table>
<thead>
<tr>
<th>Not understanding</th>
<th>Feeling stupid</th>
<th>Making comparisons</th>
</tr>
</thead>
<tbody>
<tr>
<td>Getting angry</td>
<td>Confidence</td>
<td>Complicated math</td>
</tr>
<tr>
<td>No opportunity to show work</td>
<td>Uncomfortable</td>
<td>Comfortable</td>
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<tr>
<td>Giving up</td>
<td>Chemistry</td>
<td>Trust</td>
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<tr>
<td>Focusing on understood parts</td>
<td>Getting some credit</td>
<td>Prior knowledge</td>
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<tr>
<td>Building of math</td>
<td>Relationship with teachers</td>
<td>Peer relationships</td>
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<tr>
<td>Behind screen</td>
<td>Resources</td>
<td>Support</td>
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<td>Vulnerability</td>
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<td>Stakes</td>
<td>Fear of failing</td>
<td>Success</td>
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<tr>
<td>Problem-solving</td>
<td>Teacher-student relationship</td>
<td>Schedule conflicts</td>
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<td>Peers</td>
<td>Screen fatigue</td>
<td>Tutors</td>
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<tr>
<td>Scared</td>
<td>Available resources</td>
<td>Assignments</td>
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<tr>
<td>Lack of understanding</td>
<td>Family support</td>
<td>Good at math</td>
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<td>Hate the process</td>
<td>Worry</td>
<td>Pressure</td>
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<td>Math got hard</td>
<td>Building on itself</td>
<td>Not getting everything</td>
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<td>Staying up all night</td>
<td>Taking a lot of time</td>
<td>Sciences</td>
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<td>Practice</td>
<td>Advocating for self</td>
<td>Feeling rejected</td>
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<td>Light bulb</td>
<td>No interaction</td>
<td>Pre-recorded</td>
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<tr>
<td>Not confident</td>
<td>Comparing self to others</td>
<td>Learning from others</td>
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<tr>
<td>Less anxious online</td>
<td>Dread</td>
<td>No motivation</td>
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<td>Formulas in science</td>
<td>Group work</td>
<td>Embarrassment</td>
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<td>Defeated</td>
<td>Not smart enough</td>
<td>Feeling of defeat</td>
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<td>Enjoyed online</td>
<td>High stakes</td>
<td>Anger with self</td>
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<td>Low self-esteem</td>
<td>Messes with confidence</td>
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<td>Own pace</td>
<td>Practicality</td>
<td>Should understand</td>
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<td>Easy communications</td>
<td>Outside sources</td>
<td>Study groups</td>
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<td>Effective teaching</td>
<td>Pressure to do well</td>
<td>Not knowing</td>
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<td>Fear of not knowing</td>
<td>Comparisons</td>
<td>Method of teaching</td>
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<td>Less interaction online</td>
<td>Values group work</td>
<td>Social connections not forged</td>
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<td>Prefer in-person</td>
<td>Professor makes a difference</td>
<td>Prefer Zoom</td>
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<td>Like pre-recorded</td>
<td>Not knowing what to do</td>
<td>Not learning as well</td>
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<td>Fear of not knowing</td>
<td>Comparing self to others</td>
<td>Teaching method</td>
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<td>Trust in instructor</td>
<td>Teachers’ abilities</td>
<td>Connection to instructor</td>
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<td>Fear of being thought stupid</td>
<td>Liked math less due to online</td>
<td>Only looking at a screen</td>
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<td>Availability of professor</td>
<td>Going to others for help</td>
<td>Social connection important</td>
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<td>Topic</td>
<td>Description</td>
<td>Concerns</td>
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<td>Interacting with classmates</td>
<td>Encouragement to interact</td>
<td>Stressing out</td>
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<tr>
<td>Social connection is not important</td>
<td>Difficult to create social connections online</td>
<td>Fear of professor thinking dumb</td>
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<td>Professor relationship important</td>
<td>Online can be just as good as on-site</td>
<td>Pre-recorded as if in lecture preferred</td>
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<td>Non-math subjects involving math</td>
<td>Disproportionate experience</td>
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<td>with online and onsite professors</td>
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</table>
Figure 1

Essential Code Categories to Final Code

Essential Code Categories

- In-person math classes preferred
- Frustrations with online learning
- Value of trust in professor
- Teacher social connection important
- Professor communication
- Teaching recorded
- Resources
- Peer relationships
- Impressions of classmates
- Sense of belonging
- Positive interactions with classmates
- Lack of class interactions
- Social connections
- Fear
- Understanding
- Hard math
- Necessity
- Problem-solving
- Math in other classes
- Explaining/Showing work
- Support

Final Codes

- Teaching-positive
- Teaching-negative
- Online preferred
- Teaching live
- Teaching method
- Teacher relationship
- Screen fatigue
- Comparing
- Negative feelings
- Confidence
- Being Uncomfortable
- Advocating for self
- Peer engagement
- Pressure to do well
- Instructional management
- Building understanding
- Direct instruction
- Motivation
- Emotional Expression
- Open Communication
- Group Cohesion
- Triggering event
- Exploration
- Integration
- Resolution
Table 3

*Organization of Themes*

<table>
<thead>
<tr>
<th>Teaching presence</th>
<th>Social Presence</th>
<th>Cognitive Presence</th>
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<td>Instructional management</td>
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<td>Triggering event</td>
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<tr>
<td>Building understanding</td>
<td>Open communication</td>
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<td>Direct instruction</td>
<td>Group cohesion</td>
<td>Integration</td>
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<td>Motivation</td>
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<td>Resolution</td>
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Both data triangulation and member checking were used during the study to ensure the credibility and dependability of my findings. Data triangulation uses multiple methods to test the validity of qualitative research by merging information from different sources (Creswell & Poth, 2018; Lincoln & Guba, 1985). Data was collected using the three collection methods of a questionnaire, individual interviews, and focus group meetings. Common themes regarding the shared experience of each participant emerged from the three data collection methods. These findings and interpretation were then verified through member checking. Member check refers to having the participants review and respond to the findings and interpretations of the preliminary data analysis. (Creswell & Poth, 2018; Lincoln & Guba, 1985). The participants who participated in member check all agreed that I had captured the deep, rich description of their experience with math anxiety while completing college math classes online and accurately reflected this (Moustakas, 1994).

**Teaching Presence**

Teaching presence consists of structure and process (Garrison et al., 2000). These two parts are essential in ensuring that teachers are not merely present in the classroom but that they
are more than mere facilitators. This is accomplished by developing trust with students, encouraging communication, and clearly communicating and teaching the lessons to students while motivating students to do their best. When asked how did the instructor clearly communicate important topics and goals in the online classroom, Walter stated, “He didn't really, he essentially just explained each topic very briefly, worked through problems incredibly fast, and then expected everyone to understand what was going on.” When asked the same question, Katie said,

This instructor never clearly communicated the goals or the layout of the class. We were given a link to a syllabus, but I never personally met with my professor or was ever given the option to have a zoom meeting with them.

**Motivation**

Motivation is defined as “want[ing] a change in behavior, thoughts, feelings, self-concept, environment, and relationships” (Souders, 2019, para. 1). Instructors should be cheerleaders for their students. They should motivate students to be successful in ways defined by students. This could be making an A, making a C, or getting a better grasp on the subject. Instructors should find unique ways to connect to each student and make math interesting. When asked how has a reflection of the content, assignments, or discussions of the online math classroom helped you to understand the fundamentals of the course, Sarah answered,

I think this course is vigorous, but with the right amount of resources and a professor willing to recognize their students as humans, it truly allowed me to see that math and other subjects are well in reach of my own mindset and that I can accomplish. I feel that access to this class being online gave me not only the knowledge of the subject but also provided me with a confidence and my own time frame for the assignments. The
fundamentals of this course were easy to obtain through the syllabus as well as the work and are assignments I don’t feel I will forget due to the way they were taught.

Trust

Trust is earned by students and is essential when teaching. This trust can mean being easy to talk to, being available to answer questions, being unbiased about students’ level of understanding, and being willing to help. In general, it is approachability. When asked how were you able to build trust in your online math instructor, Matthew explained,

I think it did build a good bit of trust with like my physics professor cause, uh, him, I had physics that one was, that was rough online. Uh, so I was attending these zoom office hours with him every, at least once a week, generally. Uh, if not multiple times, but uh, uh, yeah, he was exceptionally helpful, and it came to that plus, I also saw him in person in the lab, so it kind of helped to further have a, have a connection with him. And, uh, I, I appreciated his assistance in kinda going through that all the different types of problems and clarifying things. And, uh, it was nice being able to speak live with them pretty much too, in order to, rather than like emailing, um, to where I could get stuff answered in a, uh, I mean yeah, stuff answered, and then even he could pull up a, like a white board thing and then draw the problem out over the zoom call with the share screen type of thing and you know, things like that. It's just nice.

However, Adam had a very different experience in which he explained

I don't know. Honestly, it was never really able, somebody was saying earlier, like with online stuff, it just kind of feels like, all right, do you read this section of the textbook, do the, these assignments, and that's kind of all, it really is. Uh, for a lot of my, for some of my, uh, online courses with that, uh, medical, math class I took in particular. Um, it didn't
really feel like there was a professor. It just kinda felt like I had a calendar of things a bit. And, uh, so I, I didn't talk with any, I didn't talk with the professor. And then when you, in the survey you asked, like, I didn't have any communication with any of the other students either. Uh, just kinda the ended up being me being, reading from a textbook and doing assignments on time.

Social Presence

Social presence is how students express their personalities within the classroom (Garrison et al., 2000). This can be accomplished through discussions, interaction with the instructor and classmates, and communications with the instructor and classmates. Social presence helps create a sense of belonging and collaboration as students can express their points of view and see from others’ perspectives. When asked how did you get your point of view across in the online math classroom, 70% of the participants said they did not get their point of view across in the online math classroom. Thirty percent of the participants explained how they used email communications with the teacher and solution statements to get their point of view across. Matthew explained, “I did not really get my point across in the classroom as I did not need to, or the classroom was an online lecture that was pre-recorded.”

Encouraging Collaboration

Encouraging collaboration is something the instructor helps facilitate but can be encouraged by students themselves (Aparicio et al., 2016; Borba et al., 2016; Garrison & Anderson, 2003; Garrison & Akyol, 2015; Junus et al., 2019; Man et al., 2019). This can be done by creating group work or having students go to one another for questions before going to the instructor for help. The point is to get students to talk to one another about solving a math problem and math in general – feelings towards it, plans, or goals. When asked how did the
instructor’s actions reinforce the development of a sense of community among the students in the online math classroom, Mary stated, “The other students in my class didn't ever really interact with each other, at least I didn't nor did anyone ever reach out to me.” Whereas, Sarah explained, “This was definitely seen in our classroom through working with our peers to answer our solutions rather than just doing them on our own.”

**Sense of Belonging**

Sense of belonging in the online math classroom allows students to express their feelings, questions, or concerns without the concern of backlash, ridicule, or any other negative response. Having a safe environment provides an opportunity for students to learn freely, as explained by John

I think, um, I think just like in general for students who, uh, aren't strong in math, uh, we talked about a little bit, but just making sure like the environment is very safe to ask questions. Um, I've never worried with it myself cause I love asking questions, but I've known a lot of my friends or just people who just don't like asking because they're worried about, like, um, looking different or not looking as intelligent as everyone else. So I think as long as the environment is safe, um, and almost like every regard, whereas what's possible, I think there's gonna be a lot of progress happening.

This also makes it possible for students to form impressions of their classmates, see from their perspectives, and feel a sense of belonging. When asked how did getting to know other students in your online math class give you a sense of belonging in the class, Mary said, “It allowed me to recognize that I was not the only one struggling and feel proud that I was able to share that with others for the first time in a while in a math class.” Walter seconded this, “I
suppose it helped to know everyone was going through a similar situation to me in that class, but that's about it.” However, 60% of the participants did not have a sense of belonging.

**Cognitive Presence**

Cognitive presence is how students construct meaning, and most of this takes place through communication (Garrison et al., 2000) but is different than social presence in the fact that students are exchanging information and connecting ideas. However, social presence and teaching presence help form cognitive presence (Garrison et al., 2000). This can be done independently but tends to blossom more through communication. Many times cognitive presence occurs when interests are piqued. When asked in what ways did the online math class activities pique your interest, 10% of participants stated that they did not have class activities, 20% of participants’ interests were not piqued, and 70% said their interests were piqued with real-life application problems. Matthew said, “Some of them used real-life examples that justified the existence of that particular problem, making it something you would actually use in a normal life scenario.”

**Motivation**

Information exchange occurs when instructors and students alike share information with one another. This mostly occurs in math courses through class content, in which discussions follow. When asked how were you motivated to explore the content of the online classroom, John described, “My motivation came from the importance I saw in what my professor was having us do. And its real-life correlation.” Katie had similar reasons for exploring the class content and explained, “I stayed motivated by telling myself that I needed the credits and that statistics can be used in your everyday life, so try to learn the best you can.” The participants' motivation to explore the class content in the online math classroom varied. Twenty percent of
the participants were not motivated, 10% of the participants were motivated by the teacher being a kind and understanding person, 40% of participants were motivated through class assignments or programs, and 30% of participants were motivated by the end outcome of earning a degree, a final grade, or class credit.

**Connecting Ideas**

Connecting ideas occurs when students make the connections between different math topics or how they can be applied outside of the math classroom. Math builds on itself, so it is necessary to connect the different topics to create the whole picture. Being able to construct explanations or solutions is vital in math. When asked in what ways did the learning activities in the online math classroom help you construct explanations or solutions, Mary stated, “I had to use problem-solving and critical thinking, as well as typical math skills to help me get through lessons and chapters.” Walter explained, “Whenever there was any sort of activity, which was maybe once, it helped to understand other students' solutions.” John summed it up by stating, “[It] made me more self-reliant on creating my own comfortable area to learn.”

**Research Question Responses**

There was one central research question and three sub-research questions that guided this transcendental phenomenological study to better understand the essence of the phenomenon of mathematics anxiety as experienced and described by self-described math-anxious college students who have completed an undergraduate mathematics course online.

**Central Research Question**

What are the lived experiences of mathematics anxiety for self-described math-anxious college students who completed a mathematics course online? All participants had unique stories to tell about their experiences with math anxiety while completing an online college math course.
They all experienced math anxiety on varying levels, and each had their own positive and negative aspects and experiences to share. These experiences all matched one of the three elements of community of inquiry – teaching presence, social presence, cognitive presence. First, the experiences that matched teaching presence are discussed. Some of the online math classes were pre-recorded lessons, while others were held live with the instructor. Participants had mixed feelings over which they enjoyed best due to preferred methods of learning and scheduling factors. Matthew said,

I mean, it didn't really affect my feelings towards it too much. I mean, still math, uh, just taught a bit different than anything. It's just the methods of teaching. Like now, maybe I'd rather have, like math, more of an in-class thing for me at least just seek and ask questions and just kind of have the, the drawn-up example problems and such straight ahead of you as opposed to being over a video call or prerecorded.

Whereas Sam explained, “Um, I definitely think I learn better online. I think I'm not much of a people person. So going into class like makes me anxious. I think so. I definitely learn better online in those courses.” However, participants had a consensus that teaching presence was important to the online experience and that math is a class better taken in person because they can ask questions and receive immediate feedback. Adam explained, “Cause I have so much trouble with math, and it's so much harder to reach out and ask questions and get the help you need in an online course than it is to do in person.” The instructor needs to be present and available for communication. Mary explained, “The online textbook and study guides provided instruction on how to complete assignments, assessments, and tests. The instructor didn't really communicate with us except for a weekly message on what needed done and the link to the online textbook.” Most participants communicated with their math instructors through Canvas
(online classroom) and emails. Only one participant had discussions in the online math class, and that was during live instruction. The instructor must also be trustworthy and knowledgeable on the topic they are teaching. Katie stated,

I want to be able to trust that my professor isn't going to judge me for asking certain questions. You know, like my biggest fear is somebody thinking that I am stupid or that I'm not capable of learning something because I think I am capable of learning something in math. I just, it takes me longer. So, if I don't feel like there's that trust there with my teacher or my professor, I'm not going to ask questions, and I'd rather just get left behind, then make myself look like a fool, you know, or have my professors think that I'm, I'm dumb.

Second, the experiences that matched social presence are discussed. The participants agreed that social connection with the instructor and classmates was another vital element of the online math class. Julie asserted that “I am a very shy person, so communicating with my classmates is not one of my strong suits, but my professor did make the learning environment comfortable.” Those participants who did have this opportunity felt a better sense of belonging in the class as they were able to learn from one another and share their feelings about math and realized that they were not alone and that others felt the same way. This helped to build connections. Julie stated. “The classes were open discussions which made it easy for students to feel comfortable asking questions. This open discussion atmosphere made the learning environment feel more like community.” And Mary declared,

Well, I feel like the connection in math is really important because it, I mean, someone has the same question you do all the time, you know, and, and, you know, like kind of just creates mutual feelings and makes you feel better about math. Um, in my online
classroom, we didn't talk at all though. Pretty much everything was strictly through our online textbook, over tests and, and everything was through that. And so, we never interacted at all.

Sarah had a different experience in which her professor did encourage communication amongst the students for at least part of the class. She shared,

Um, for my homework, uh, in the course, I don’t know how he set it up or what format, but, um, basically, you would like submit your answer, and then the next slide over would be like a randomized student and their answer would also be there. And then you would explain like how you got the answer, and then you would read how they got their answer. So that helped me with the homework portion. Um, outside of that, I don't remember who was saying it, but, um, yeah, I think like those social communications, uh, is really important, and I have that now for my physics and chem class. And without that, if I were taking this online, I don't think I would be passing.

Finally, the experiences that matched cognitive presence are discussed. Another point of consensus among the participants was that cognitive presence is important to be successful in the online math classroom. The critical factor here is their understanding of the topic being taught. Julie revealed,

My favorite part [about math], I wouldn't say when I get the answer right. But I think when I like understand how to do a problem, like when I really have nailed it down, like certain, like when I took my finance class, like when I knew like the formula like when I had that down, I think it's one, like what I enjoy about it, I guess probably when I know what I'm doing.
John seconded this idea when he said, “it's that just a satisfaction of when you, um, I'm just like when you put everything together and just comes into a result that you just know is correct, like a puzzle.” When participants had prior knowledge or understood a topic, their math anxiety would be lower when compared to times when they did not understand the topic being taught. It was during these times that their math anxiety would rise. This would continue to be the trend as they attempted to catch up on the material and typically did not secede until they got back to more comfortable topics because they understood them. Rico defined it as “that little breath of fresh air whenever you solve a homework problem or when you thought you failed a problem in an exam, but that is the only one you got right – you won the battle but not the war.” This brought feelings of being perceived as dumb or not smart enough or as smart as others. Katie summarized this by saying,

Um, when I think I started getting a feeling when my mom sat me down, and she was like, okay, you need a tutor because then I felt like I'm not smart enough to do it anymore. You know? Like I need somebody to work. One-on-one with me. I'm different, you know? Cause kids care a lot about that when they're younger, you know, like how do I look compared to so-and-so, you know, so-and-so gets it. Why don't I get it? Why do I have to work with a special person to reteach it to me? You know, in a way that makes sense. So, I would say that had a lot to do with it. And then once I didn't have a tutor anymore, and once I got to like high school, middle school age, and I started falling behind again, that's when it was really like, oh, like I just don't understand math.

It is important to note that not all math caused anxiety amongst the participants. Their math anxiety would rise when they perceived the math as getting harder or more complicated.
However, they all seemed to grasp what they explained as basic math. Mary explained this best when she said,

I feel pretty comfortable with pretty basic math. Okay. Um, like pretty common, basic math. Um, I can sometimes remember the harder stuff. Um, and if I happen to review it, I'm sure I could do like a small, like a few problems on it. But um, I feel pretty good about math now, probably because the hard stuff is over. And you know, I basically just use pretty basic math now to do everyday things.

All ten participants had varying experiences with math anxiety as they completed an online undergraduate math course online. However, the essence of their experiences culminated in the same three themes of teaching presence, social presence, and cognitive presence. The way those three elements of community of inquiry interact with one another created the learning environment and community for students – good or bad.

Sub Question One

What variables or experiences contributed to the cultivation of mathematics anxiety in the participants? The variables or experiences that contributed to the cultivation of mathematics anxiety in the participants spiral around six main ideas: (a) not understanding, (b) being left behind, (c) feeling or being perceived as dumb or not smart enough, (d) comparing themselves to others; (e) feeling embarrassed or defeated, and (f) the learning environment. Each of the six main ideas fits into one of the three themes of teaching presence, social presence, and cognitive presence. The learning environment fits in the element of teaching presence. Being left behind, feeling or being perceived as dumb or not smart enough, feeling embarrassed or defeated, and comparing themselves to others fit in the element of social presence. Not understanding fits in the element of cognitive presence. The participants agreed that they felt math anxiety more when
they did not understand the topic(s) being covered. This could be due to a lack of prior knowledge needed to build on the topic or an inability for the instructor to communicate the topic clearly. Adam explained, “Um, like just, it seems like math is getting more difficult, and I'm understanding less of it.” The lack of understanding then caused the participants to catch up in the class as they felt they were being left behind. Rico described “falling behind and failing and then needing to catch up.” This feeling of being behind can be compounded due to the speed or time constraints of the course. With that comes the feeling that they are dumb or not smart enough to learn math or are being perceived in that way by their instructor or classmates. This feeling is exacerbated by the participants comparing themselves to their other classmates or even family members and believing that everyone else must be so much smarter than them because they “get” it. Julie believed,

Hmm, Hmm. I think throughout like high school, it [math anxiety] like probably started to get worse during high school, just because I think like comparing myself to other students on like where I was at. I think that's what really like made it worse. I would say is like comparing myself like what classes I was in because I was in like a bridge to college math in high school, like my senior year and said being in my pre-calc or statistics. So, I would say, I would say it like developed on like viewing other people.

This all snowballs into feelings of embarrassment and defeat as they felt they were the only ones who felt this way. Katie stated,” Then I feel like, oh my gosh, I'm such an idiot. You know, like, oh, I'm embarrassed.” And without being in a safe learning environment that cultivates building understanding, open communication, and integration, math anxiety continues to build upon itself in much the same way as math itself does.

Sub Question Two
How did the participants address their mathematics anxiety while completing an online mathematics course? Participants addressed their math anxiety using coping methods to help them through their math anxiety while completing the math class online. These coping methods varied drastically from participant to participant. Some of the coping methods included cognitive presence. Many of them studied harder, believing that if they could grasp the parts of problems they deemed most important, they would better set themselves up for success. This was due to the belief that earning partial credit was better than earning no credit. Adam justified, “[his] method of, uh, kind of realizing which like portions of a question are more important? Like uh, which things would be involved more often kind of a thing.” Still, other coping methods included social presence and teaching presence. Some participants sought help from others, including instructors, tutors, classmates, friends, and family members. Working together helped participants better understand the work as they could see the work from others’ perspectives and that they were not alone. Julie explained, “I think I like got help with it, like, from my roommate, which is really what helped me, I think.” John seconded this method when he explained,

I was just really open with the TA. So, there was a TA that was, uh, I think it was every Tuesday. I like for like an hour and a half, so we can talk to, um, and I don't know if this is on purpose, but their, uh, teaching styles were almost completely different. Um, and not in a bad way. I'd say it was really helpful. Cause I would ask a question and see, like did you ever look at it this way, like a different way that professor didn't describe it as, and that really kind of helped. Um, it sets it probably like a more, uh, human aspect since I wasn't listening to a video telling me what to do. It was someone talking to me through the steps.
Instructors and tutors would often state how other students had trouble, and classmates could share their feelings about math when working together. Still, other participants coped with their math anxiety by talking to roommates, significant others, family, and friends. Mary said,

Um, you know, also just asking questions I found is also like a huge like relief on that because you know, like if I had a question and I didn't get it, then my little brother didn't get it. I was like, oh, well, that means I'm not so dumb about it. You know?

Participants did not only cope with their math anxiety through classroom methods. Participants also coped with their frustrations in physical or emotional ways. Some participants would take breaks when they got frustrated. Mary said,

I had to, I had to take a lot of breaks. Like I just go on, I go to the gym to really help relieve stress about it, and stuff worked out some of that negative energy and things, or I would go and visit my grandma for a few hours or go out and ride a horse or, you know, try to like get my mind off of it for a while and come back back to it with fresh eyes.

Other participants would cry. Katie stated,

I cried a little bit, but I did have a friend who was also in the same class as me. So we were able to do virtual study dates kind of situation, which helped a lot. Um, because things that he didn't understand, I understood and things, you know, I understood he didn't, we were able to teach each other because we didn't have a teacher. So that, um, was a good coping mechanism because it reassured what we were learning, you know?

This allowed them to release the negative energy they were carrying and start over. Although participants had different coping methods with their math anxiety, all participants had a method(s) for coping.

**Sub Question Three**
How did the three elements of community of inquiry (teaching presence, cognitive presence, and social presence) attribute to the participants’ completion of the course? Although the elements of community of inquiry (teaching presence, social presence, and cognitive presence) cultivated math anxiety in the participants, they also attributed to the participants’ completion of an online math class, albeit not all participants experienced the three elements the same and many relied on self-teaching to complete the course. Teaching presence attributed to the participants' completion of an online math class through direct instruction (teacher or tutor), building understanding for participants, and instructional management (Garrison et al., 2000). For some participants, teaching presence was strong as their instructors held pre-recorded or live zoom sessions in which they taught the materials directly. Sam explained,

The best classes I have had online were classes where the professor just recorded themselves teaching. Like it was a normal class because it felt like you just went to class, you know? Uh, but of course, you can't like ask questions and stuff, but luckily, I would email the professor, and he would get back to me pretty quickly. And so that helps too, you know, just the availability.

In contrast, other less engaged instructors facilitated using the calendar in the online classroom as the primary tool for communication. Adam said, “Um, it didn't really feel like there was a professor. It just kinda felt like I had a calendar of things.” Katie seconded this,

Yeah. That's exactly how I felt. Um, I didn't even know what my professor looked like. I never met her, never met anybody else in my class. It just felt like I was self-guiding the whole time. You know, like my canvas was full of assignments. I just had to figure out how to do it. And because she didn't respond, I couldn't ask questions. So, I just had to figure it out.
Instructors also built understanding through direct communications, either through email or office hours. These two methods were met with mixed reviews from the participants as either could be intimidating or less effective than in-person conversations. Sam declared, “I was incredibly uncomfortable the few times I joined synchronous office hours, so much so that I would normally wait until after everyone left to ask my question.” Instructional management was mainly experienced through the syllabus and course calendar.

Social presence attributed to participants' completion of an online math class through emotional expression, open communication, and group cohesion (Garrison et al., 2000). Most participants experienced a lack of social presence in their online math courses. Walter said, “There was very little interaction between the students, and we weren't encouraged to talk to each other.” Few instructors encouraged social interaction between participants and their classmates, but some did succeed in this. This was completed through group assignments, table partners, checking and comparing work, and discussions in the online classroom. Note: discussions refer to discussions in a live zoom meeting and not asynchronous discussion boards within an online classroom. Julie exclaimed, “The zoom chats allowed for students to connect and relate with each other, which created a sense of belonging. Creating relationships with classmates seems to create such an impact in the learning experience.” Sarah seconded this idea when she said, “It allowed me to recognize that I was not the only one struggling and feel proud that I was able to share that with others for the first time in a while in a math class.” Most participants did not have discussion boards in their online classrooms and were not often given the opportunity for open communication with their classmates. Participants who lacked this also found less sense of belonging when compared to participants who had open communication with the instructor and classmates. Sam said, “I didn't know anybody, so I didn't have a sense of
belonging.” Lack of communication caused a lack of emotional expression and group cohesion. Participants felt as though they were the only ones who felt the way they did regarding mathematics and felt alone, especially as many were comparing themselves to their classmates, which made them feel less confident in themselves. Participants saw their classmates excel and thought they were not as smart as their classmates without knowing how their classmates felt. John put it best when he explained,

I like not to like, Hate on myself. I'm like, am I smart enough? Am I too dumb to actually like solve this equation, seeing how I always had to keep on taking classes on something that a lot of people say is really basic? And when you have a lot of friends who are like overachievers, where you hear like how easy this math class was, you kind of get into the mentality of, am I just, uh, am I dumb or my stupid.

Cognitive presence attributed to participants' completion of an online math class through exploration, integration, and resolution (Garrison et al., 2000). Participants were expected to learn a new online platform (online class and sometimes another online platform such as MyLab or MyMathLab) on top of learning the materials covered in the course. They were expected to explore the online platform(s) and become acquainted, if not master them, to integrate them while learning math successfully. Julie stated, “I did enjoy doing the math homework through MyLab. I think the way it is set up (providing feedback during problems) allowed for me to be more motivated and encouraged me to get my assignments done.” This exploration continued to further develop by searching for outside online resources to aid them with math, such as Khan Academy. Several participants sought the help of outside online resources to better understand the topics covered in class as they felt their instructor did not do a thorough job of explaining/teaching. Participants would then integrate this information with what the instructor
provided to assist them in completing the math task at hand. Walter said, “I used a lot of non-school references, the biggest being Khan Academy. Literally, without it, I would not have passed that class.” Resolution was made apparent by participants in the fact that they completed the online math class and how they could apply their knowledge from that math class to other classes or their lives. Mary explained, “The class taught me to be persistent with myself and keep determined to complete my goals. It also taught me some important problem-solving skills to help me through life.” Sarah seconded this,

I feel that just as my teacher mentioned, we are still going to be dealing with these types of equations and situations in our daily life, even if we do not always sit down and write out every solution. I think that if I were to not have taken this class, I would not be as knowledgeable in my physics classes now or chemistry classes.

However, several participants voiced that they did not feel they retained much of what was taught or even understood how they passed the course but felt they could apply the maths learned if they had a brief refresher. Katie stated, “Honestly, I don't remember any of the information that I learned in that class, and I continue to struggle with math in my everyday life.” This is incredibly frustrating as participants continually noted how math builds on itself, and it is easy to get behind when you get lost on one concept.

Although participants had different experiences with an online math class, it is evident that the three elements of community of inquiry (teaching presence, social presence, and cognitive presence) play a vital role not only in their experiences had but also in the cultivation of math anxiety and the completion of the online math course itself. The coping methods for math anxiety may vary. Still, all participants had methods that they used in their experience with
math anxiety in math classes and in other courses that they experienced anxiety (sciences and STEM due to math components).

Summary

In this chapter, I presented the data collected from the study using the three data collection methods of a questionnaire, individual interviews, and focus group meetings. The 10 participants reflected on and shared their lived experiences of math anxiety while attending college online. The participants all had unique experiences with math anxiety, but they all shared commonalities. The participants had similar ages, years in college, and were all full-time students. They differed in the math classes they took online and how many total online classes they had completed. I analyzed their responses to establish three themes that emerged from their descriptions of their experiences. The first theme was teaching presence and included the two subthemes of motivation and trust. The second theme was social presence and included the two subthemes of encouraging collaboration and sense of belonging. The third theme that developed was cognitive presence and included two subthemes of motivation and connecting ideas. The data from the questionnaires, individual interviews, and focus group meetings were used to answer the central research question: What are the lived experiences of mathematics anxiety for self-described math-anxious college students who completed a mathematics course online?
CHAPTER FIVE: CONCLUSION

Overview

The purpose of this transcendental phenomenological study is to describe mathematics anxiety for self-described math-anxious students who had completed an undergraduate mathematics course online at a regionally accredited university located in the Pacific Northwest part of the United States. The chapter begins with a discussion of the interpretations of findings to include a summary of thematic findings. Following this, implications for policy and practice will be discussed, and recommendations for stakeholders based on the findings of the study will be made. Next, the theoretical and empirical implications are discussed based on the findings. Finally, the limitations and delimitations are then addressed, and the chapter concludes with recommendations for future research.

Discussion

I conducted a phenomenological study to uncover the essence (Creswell & Poth, 2018, Gall et al., 2007; Moustakas, 1994) of the experiences of 10 college students who had completed an undergraduate college math course online. I selected a transcendental phenomenology research approach because it focused on describing the participants’ experiences. Furthermore, this topic aligns with a transcendental phenomenological design approach because it is the process of understanding a phenomenon (mathematics anxiety) using an inquiry approach that explores a human problem (Creswell & Poth, 2018; Gall et al., 2007). The intention was to better understand how college students experience mathematics anxiety in an online mathematics course. The theoretical framework that guided this study was community of inquiry (COI). It is essentially the method in which a classroom is turned into a community for students (Garrison et al., 2000; Pardales & Girod, 2006). This idea was first introduced by early
pragmatist philosophers Peirce and Dewey (Coghlan & Brydon-Miller, 2014; Garrison et al., 2000; Pardales & Girod, 2006) and developed into the framework it is today by Garrison, Anderson, and Archer (2000).

**Interpretation of Findings**

The purpose of this transcendental phenomenological study is to describe mathematics anxiety for self-described math-anxious students who had completed an undergraduate mathematics course online at a regionally accredited university located in the Pacific Northwest part of the United States. Data collection methods included a questionnaire, individual interviews, and focus group meetings. The data was then analyzed using coding, and three themes emerged: teaching presence, social presence, and cognitive presence. From each theme, subthemes developed. The theme of teaching presence had subthemes of motivation and trust. The theme of social presence had subthemes of encouraging collaboration and risk-free expression. The theme of cognitive presence had subthemes of information exchange and connecting ideas.

**Summary of Thematic Findings**

The first theme to emerge from data analysis was teaching presence, consisting of structure and process (Garrison et al., 2000). Teaching presence is the element that balances cognitive presence and social presence, and that is accomplished through instructional management, building understanding, and direct instruction (Garrison et al., 2000). The instructors may define and initialize discussion topics, share personal experiences, and focus discussion (Garrison et al., 2000). Two subthemes developed from teaching presence: motivation and trust. The shared experiences of the 10 participants confirmed that an instructor should help motivate their students to be successful in their course, and this is more easily accomplished
when students trust the instructor. During the focus group meetings, the seven present participants discussed how trust in an instructor was very important and that building a relationship with the instructor helps with math anxiety. Matthew said that trusting a math instructor is important. He continued that trust includes trusting that the instructor knows how to teach the material and that the instructor teaches the material well. Julie explained that trust was a huge aspect and important because when she felt connected to a professor, it helped alleviate some math anxiety. Katie agreed that trust was important as she wanted to trust that the instructor would not judge her for her questions. The second theme to emerge from data analysis was social presence which consists of the ways students express their personalities in the classroom (Garrison et al., 2000). Students can accomplish this through sharing their emotions and expressing their views (Garrison et al., 2000). Two subthemes developed from social presence: encouraging collaboration and sense of belonging. Garrison et al. (2000) explained how emotional expression of students allowed for trust and support to develop and that open communication built cohesion among students, and group cohesion built the community that created the sense of belonging. The instructor should play a significant role in fostering student collaboration as teaching presence is the element that helps balance social presence with cognitive presence to create the learning environment (Garrison et al., 2000). Still, students may also seek this role out themselves, as many of the participants in this study did so when they felt they needed more help and would seek out their classmates or friends. Collaboration is the key to higher education (Garrison & Anderson, 2000). The participants all felt that student collaboration is more easily accomplished when students feel they can express themselves risk-free and clear of ridicule by their classmates or their instructor, whether instructor or student fostered. John best explained this when he stated, “…just making sure the environment is very safe to ask
questions.” The third theme to emerge from data analysis was cognitive presence, which is how students construct meaning (Garrison et al., 2000). Students can accomplish this through a sense of puzzlement and applying new ideas (Garrison et al., 2000). Cognitive presence occurs in several stages that include a triggering event, exploration, integration (understanding), and resolution and is based on experiences (Garrison et al., 2000). Two subthemes developed from cognitive presence: motivation and connecting ideas. This can be accomplished by instructors and students sharing information and using that to help them connect ideas from past lessons to current ones and on to future ones. Seventy percent of the participants liked it best when the math concepts could be applied to real-world applications as it gave them an applicable reason to learn and use the concepts. The participants were better able to understand how math impacted their lives, which motivated them to learn it better. This included applying their math knowledge to non-class-related activities, applying their math skills to other math-heavy subjects such as chemistry and physics, facilitating their learning, and using problem-solving skills learned in the math class.

**Motivation and Trust.** The participants were motivated to complete a math class online due to the global pandemic of COVID-19. However, their motivation to complete their online math courses included several reasons: stakes, needs, and wants. For example, John was motivated to try and do well and work hard due to the high stakes (passing or failing the course). Whereas Mary was motivated by the math class being the last class she needed to earn her associate degree. And Sarah was motivated because she wanted to work in the medical field and would not let math stop her from achieving her goal. In addition, trust in the instructor helped motivate some participants. They felt they could freely go to the instructor and ask for help as they trusted that the instructor would not make them feel dumb or embarrassed and allowed the
participants to feel okay with getting something wrong and asking for help, making their experience seem better.

**Encouraging Collaboration.** Encouraging collaboration helped set participants up for success when completing online math classes as it allowed them to learn from one another and build relationships. Collaboration amongst students can take several forms: group activities, correcting or sharing work, tutoring, and using one another as their first resource for help. For example, Sarah explained how her instructor had students check their work against other students’ work and explain their process. And Julie stated how her instructor held live Zoom discussions. As a result, both participants described how they felt more of a sense of belonging because they could learn from others and not feel alone.

**Prior Knowledge is Essential.** All the participants agreed that they did not hate math but hated how math made them feel. They conceded that not all math caused them anxiety but only the more complicated math. However, math is a subject that constantly builds on itself and uses prior knowledge to form new connections. This makes understanding the basics of math vital. It is imperative to instill in students that math is not something to be downloaded and dumped but must be retained to bridge concepts both in and outside of the math classroom, specifically STEM courses.

**Lack of Understanding.** All 10 participants conceded that math anxiety appears to be cultivated by a lack of understanding, which manifests into strong feelings of anxiety and embarrassment. Rather than address the issue at hand, math anxiety seems to have been coined to cover up the education system's shortcomings. This was evident by the number of participants who shared that they had taken extra math classes throughout their educational career to help them catch up or stay on track with math. Math anxiety is a failure not only on educators as they
have failed to teach but also on the education system as they have failed to allow adequate time or additional resources. The lack of the education system has cultivated the lack of understanding in math students.

**Implications for Policy or Practice**

The findings of this study exposed how self-described math-anxious college students experienced math anxiety in the online classroom, which variables or experiences contributed to the cultivation of mathematics anxiety, how students addressed their mathematics anxiety, and how the three elements of community of inquiry attributed to students’ completion of an online math class. This study has significant practical, theoretical, and empirical implications for mathematics. Students, instructors, curriculum designers, and university administrators can use the results of this study.

**Implications for Policy**

The global pandemic of COVID-19 caused most higher education institutions in the United States to pivot from on-site classes and rely more heavily on online education, both strictly virtual and a combination of virtual and on-site as in hybrid courses. Estimates showed that the global pandemic impacted 22.3 million students as 98% of institutions had moved from on-site, in-person classes to online classes as of April 2, 2020 (educationdata.org, n.d.). The online class experience must be successful for students regardless of which higher education institution students attend. Higher education institutions in the United States should be required to ensure that the online math classroom represents an environment that encourages growth in students just as in an on-site class. This would include that students attending class online do not exceed the two and a half hours per week required meeting times for a three-hour credit course and that the hours required for study time do not exceed the two hours per contact hour (Texas
A&M International University, n.d.). An online class should not mean that students have more work to complete and less instruction time than an on-site class.

**Implications for Practice**

Instructors of online college math courses should be better trained and better prepared to teach online and should not simply take their on-site materials and transfer those to an online class as the two environments are not the same (Lee et al., 2020). Instead, educators need to modify their lessons and materials to fit the environment, so that teaching presence is truly created in the learning environment (Lee et al., 2020). Several participants voiced that they did not feel like they had an instructor but rather just a list of items to complete as the instructor was missing. Walter explained, “One of the professors I had for calc two was actually my professor for pre-calculus one. So, I had him for both an in-person and an online class. And my experience in his class online was far, far worse than my experience than the in-person.” Garrison and Anderson (2003) explained how online education tends to fail due to a lack of teaching presence. Regardless of location, students should be receiving the same level of education and commitment from their instructors.

Curriculum designers should also be aware of the differences between on-site and online math classes. The same curriculum may be used for both types of classes, but assignments and instructions should be altered to better fit the needs of an online math class. For example, a linear model project may work wonderfully in an on-site class and be applied to an online class with modifications to better suit the environment. Along with that, each online math course curriculum should discuss math anxiety and mindset to help identify those students who struggle with it to be better prepared to help engage them. After all, engagement is the key to E-learning (Man et al., 2019). Katie stated
I do think if we acknowledged math anxiety more within the classroom, or if like a teacher could understand, oh, this person is, you know, they're struggling and they, they clearly are upset when they're in class. Maybe I need to work a harder with them. I feel like that would make a whole world of difference because when I would shut down like that and I just gave up, I stopped asking questions. My teachers just focused on somebody else, you know. And that's what really bugged me about the way math was taught. And I don't know if this is maybe I just had crappy teachers.

School administrators should also be better prepared and knowledgeable about online learning environments. It is wonderful to advertise that an institution promotes inclusive learning for students regardless of their location or schedules using online education (Aparicio et al., 2016; Arkorful & Abaidoo, 2015; Stone et al., 2016). However, the quality of that education should still be of high quality in which a student is taught by an instructor and not expected to teach themselves. A school’s administrators should also help promote students’ understanding of online education and what will be expected of them. Students should understand if the online class is asynchronous or synchronous, the number of hours expected to complete the course, and overall have a better understanding of the online class. Online classes are lumped into one broad experience, but a few different online classes are available. There are asynchronous classes in which students work at their own pace watching videos, reading materials, and meeting deadlines set forth for them (Arkorful and Abaidoo, 2015; Scheiderer, 2021). There are synchronous classes in which students are required to log in and participate in the class at a specific time each week (Arkorful and Abaidoo, 2015; Scheiderer, 2021). And there are hybrid courses that combine asynchronous and synchronous classes in which students work at their own pace online but are required to meet in class at least once a week. School administrators should
make the types of online classes clear to students so the students can then choose an online class that best suits their needs and learning style so they will be able to enjoy a more productive learning environment.

**Theoretical and Empirical Implications**

The shared experiences of the 10 participants confirmed previous research regarding math anxiety. To begin with, all 10 participants described how their math anxiety developed and confirmed that mathematics anxiety is a learned concept, just as most of the research presented in this study suggested (Gough, 1954; Hembree, 1990; John et al., 2020; Richardson & Suinn, 1972). Furthermore, it was confirmed that mathematics anxiety could be treated or minimized with interventions (Boaler, 2106; Cropp, 2017; Dweck, 2014, November; Everingham et al., 2017; Foley et al., 2017; Pierson, 2013, May). Many participants sought help from tutors, instructors, friends, roommates, family, and classmates and felt better after doing so. However, it is imperative to note that this study uncovered that the participants did not necessarily feel better due to the interventions but felt better due to the byproduct of said interventions which was understanding. Participants experienced less math anxiety when they understood the math being presented. Therefore, understanding math affects or diminishes the feelings of math anxiety, not the act of interventions.

In sharing their experiences, the 10 participants shed light on how the community of inquiry fits into online education and, more specifically, online math education. Bleazby (2012) suggested that the community of inquiry was not appropriate for online education as the internet could be problematic to the social and educational aims of COI. However, the findings from this study suggest otherwise. The participants made it abundantly clear that all three elements – teaching presence, social presence, and cognitive presence – were vital to online math education.
This confirmed Choo et al.’s (2020) views that COI is just as applicable in the online classroom as in the on-site classroom. The relationship between the three elements of COI does create the learning environment for students in the online classroom. It was noted by several participants that a safe learning environment was vital to a conducive learning experience. Because the students felt comfortable expressing themselves freely without fear of ridicule or embarrassment, they could better connect with the math concepts. Although this study’s finding suggests that COI is appropriate for online math learning, it is still unclear as to how much importance should be placed on each element (Garrison & Akyol, 2015; Bleazby, 2012; Borba et al., 2016; Choo et al., 2020; Huang et al., 2019; Man, 2019; Peacock & Cowan, 2018).

Nevertheless, it was confirmed through this study’s findings that teaching presence is the main reason for the failure of a learning environment (Garrison et al., 2000). Participants who had engaging instructors had a more pleasant learning environment and built trust with their instructor compared to those who barely had any interactions with the instructor. All the participants agreed that being encouraged to collaborate and collaborating with classmates made their online math experience better. Participants who felt a sense of belonging through class activities and discussions were more engaged in the classroom when compared to the participants who shared that they did not have any class activities to keep them engaged. Which confirmed that social presence has more importance in the online classroom as students must communicate with one another as learning is a collaboration (Garrison & Alkyol, 2015). Borba et al. (2016) seconded this idea that more emphasis should be placed on communication between students. Even though cognitive presence and teaching presence were more successful to produce in an online math classroom (Choo et al., 2020), social presence must not be ignored. Peacock and Cowen (2018) suggested that COI should move to a student-directed community of
inquiry from learning-centered so students would have more real-world decision-making opportunities. However, the findings of this study suggest that COI does not need to move to a student-directed community; instead, the assignments in the online class should reflect more real-world applications. Participants responded well to concepts and topics they deemed essential to the real world or could apply outside of the classroom in everyday life. The findings from this study have confirmed that COI applies to the online math learning environment as it has adapted and evolved as society and education have done (Garrison & Anderson, 2003).

Limitations and Delimitations

Limitations are the boundaries of the study's methodology typically related to data collection and analysis that the researcher has no control over but could be construed as weaknesses (Creswell & Guetterman, 2019; Joyner et al., 2018). For example, although the sample of 10 participants represented both males and females almost equally, there was less diversity in ages, ethnicity, years in school, and geographic location. The participants ranged from 20 years old to 24 years old, with 70% of them identifying as Caucasians and all of them being 3rd- and 4th-year students attending one school in the Pacific Northwest of the United States. Furthermore, of the 10 participants, two did not participate in a focus group meeting, and three did not participate in member check – two of the three were the same two that did not participate in a focus group meeting. Other limitations of the study were related to the design and analysis. For example, it was assumed that participants responded truthfully to the qualitative research questionnaire, interview questions, and focus group prompts. Additionally, despite the researcher’s best efforts, it is likely that perfect epoche was not achieved, but the time, effort, and energy that the researcher continuously put into the process assisted in drastically reducing
personal bias or preconceived notions (Moustakas, 1994). Finally, data collection occurred after the participants had completed their online math course compelling them to rely on memory.

Delimitations are boundaries set up for the study that may make the finding less likely to be generalized (Joyner et al., 2018). For example, the participants were required to be self-described math-anxious students for this study. The reason for this selection was to guarantee that the participants experienced the phenomenon of math anxiety (Moustakas, 1994). Furthermore, they had to have completed an undergraduate math class online because the focus of the study was online education. Additionally, the participants were further required to be 18 years of age or older to ensure that all participants would be consenting adults.

Moreover, the participants were selected from a college in the Pacific Northwest of the United States due to permissions. The experiences of self-described math-anxious students who completed a math class online at other universities may differ from those in this study. Finally, a transcendental phenomenology study was conducted because the researcher was interested in the description of the lived experience from the participants rather than through an interpretation such as is done in hermeneutical phenomenology (Creswell & Poth, 2018; Moustakas, 1994; van Manen, 1990, 2014).

**Recommendations for Future Research**

Recommendations for future research were based on the limitations and delimitations and findings of this study. First, the recommendations for future research regarding limitations and delimitations will be discussed, followed by the recommendations for future research regarding the findings of this study. The following recommendations for future research are suggested regarding the limitations and delimitations referenced above. First, this study focused on college students who had completed an undergraduate online math class at a specific site. Future
research may expand to include multiple sites or be non-site specific. Next, seventy percent of the participants identified as Caucasian. Additional research is needed regarding the experiences of minority students. Finally, this study was completed after the participants had completed an undergraduate online math class. This study could be replicated during the completion of the math class, so data is collected during the experience rather than collecting referral information.

The findings of this study suggested several directions for future research. First, several participants shared that they had either been misdiagnosed or diagnosed later with conditions that challenged their learning. These conditions included autism, dyslexia, and ADHD. Another topic brought up by participants was English as a second language learners. A narrative study would explore an individual's life through interviews and documents to better understand if their diagnoses affected or cultivated their math anxiety. Second, even though participants explained that there were several ways of asking for help during their online math class, most of them feared asking for help with math. A phenomenological study would be appropriate to explore the experience of this phenomenon and if it was solely a math issue. Next, the participants agreed that social connection is important in an online class, not just with the instructor but also among the students. A grounded theory study would investigate social connection to the online math class to generate a theory regarding how important social connection is in online math classes. Fourth, during an individual interview, a participant wondered how acknowledging math anxiety in the online math class would have affected her and her experience with math anxiety. A case study could be conducted to develop an in-depth description and analysis of how addressing math anxiety within the online math classroom affects students. Finally, one participant shared that she was a military brat. Narrative research could be conducted to further investigate whether
the interruption of math education due to a permanent change of duty stations affects or cultivates math anxiety.

**Conclusion**

Gough (1954) first labeled math anxiety as “mathemaphobia” (p. 290) in the 1950s. Further research on mathematics anxiety flourished, and in 1972 Richardson and Suinn (1972) created the first measurement scale for math anxiety, MARS. Mathematics anxiety has continued to grow and currently affects today’s math students through avoidance of classes, retention in STEM fields both in education and employment (Jen-Mei et al., 2016; Snyder & Cudney, 2017; Xue & Larson, 2015), and graduation rates (Jones, 2015). Research presented math anxiety as a learned behavior (Gough, 1954; Hembree, 1990; John et al., 2020) that could be unlearned through interventions (Gough, 1954; Hembree, 1990; Richardson & Suinn, 1972). Much of what is known about mathematics anxiety emphasized elementary and secondary education on-site. This study was different because it used a qualitative approach to explore mathematics anxiety for college students completing math online. Listening to the students while they described their experiences in an online math classroom provided a greater understanding of their math anxiety. Using phenomenological reduction, three themes emerged from the data collected: teaching presence, social presence, and cognitive presence. It was important to the participants that it was made clear that they did not hate math but hated the way math made them feel. Their lack of confidence in their math abilities stemmed from their lack of understanding the math as it got more complicated. This snowballed into feelings of anxiety and self-doubt as long as they did not understand the subject matter. As soon as understanding reappeared, their math anxiety dissipated. The findings of this study show that the community of inquiry applies to online education – math specifically and that all three elements (teaching presence, social presence, and
cognitive presence) play a vital role in the learning environment created for students. It was also found that the online classroom not be a replica of the on-site classroom but be restructured to accommodate the desired outcomes.
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August 11, 2021

Toni Sawhill
Matthew Ozolnieks

Re: IRB Exemption - IRB-FY20-21-1007 A PHENOMENOLOGICAL STUDY: THE LIVED EXPERIENCE OF SELF-DESCRIBED MATH-ANXIOUS STUDENTS ATTENDING COLLEGE ONLINE

Dear Toni Sawhill, Matthew Ozolnieks,

The Liberty University Institutional Review Board (IRB) has reviewed your application in accordance with the Office for Human Research Protections (OHRP) and Food and Drug Administration (FDA) regulations and finds your study to be exempt from further IRB review. This means you may begin your research with the data safeguarding methods mentioned in your approved application, and no further IRB oversight is required.

Your study falls under the following exemption category, which identifies specific situations in which human participants research is exempt from the policy set forth in 45 CFR 46:104(d):

Category 2.(ii). Research that only includes interactions involving educational tests (cognitive, diagnostic, aptitude, achievement), survey procedures, interview procedures, or observation of public behavior (including visual or auditory recording).

Any disclosure of the human subjects’ responses outside the research would not reasonably place the subjects at risk of criminal or civil liability or be damaging to the subjects’ financial standing, employability, educational advancement, or reputation.

Your stamped consent form(s) and final versions of your study documents can be found under the Attachments tab within the Submission Details section of your study on Cayusa IRB. Your stamped consent form(s) should be copied and used to gain the consent of your research participants. If you plan to provide your consent information electronically, the contents of the attached consent document(s) should be made available without alteration.

Please note that this exemption only applies to your current research application, and any modifications to your protocol must be reported to the Liberty University IRB for verification of continued exemption status. You may report these changes by completing a modification submission through your Cayusa IRB account.

If you have any questions about this exemption or need assistance in determining whether possible modifications to your protocol would change your exemption status, please email us at [redacted].

Sincerely,

G. Michele Baker, MA, CIP
Administrative Chair of Institutional Research
Research Ethics Office
Appendix B

Formal Permission Request from Site

June 3, 2021

[Redacted]

Human Subjects Review Council
[Redacted]

Dear [Redacted],

As a graduate student in the School of Education at Liberty University, I am conducting research as part of the requirements for a doctoral degree. The title of my research project is A Phenomenological Study: The Lived Experience of Self-Described Math-Anxious Students Attending College Online, and the purpose of my research is to describe mathematics anxiety for self-described math-anxious students who have completed an undergraduate mathematics course online. At this stage in the research, mathematics anxiety will be generally defined as “feelings of tension and anxiety that interfere with the manipulation of numbers and solving mathematical problems in a wide variety of ordinary and academic situations” (Richardson & Suinn, 1972, p. 551). The theory guiding this study is community of inquiry (COI) and was first introduced by early pragmatist philosophers Peirce and Dewey (Garrison et al., 2000; Richardson et al., 2012). COI describes how learning occurs for a group of individual learners through the educational experience at the intersection of the three elements of social presence, cognitive presence, and teaching presence (Garrison et al., 2000; Richardson et al., 2012). Mathematics anxiety is a learned behavior based on students’ experiences (Hembree, 1990; John et al., 2020) created at the intersection of social presence, cognitive presence, and teaching presence.

I am writing to request your permission to utilize your student list to recruit participants for my research.

Participants will be asked to complete a questionnaire, participate in an individual interview, and participate in a focus group meeting. All three data collection methods will be conducted online to include a member check focus group meeting once data has been analyzed. Participants will be presented with informed consent information prior to participating. Taking part in this study is completely voluntary, and participants are welcome to discontinue participation at any time.

Thank you for considering my request. If you choose to grant permission, please respond by email to [Redacted]. A permission letter document is attached for your convenience.

Sincerely,

Toni Sawhill
Doctoral Candidate
Appendix C
Site Approval

June 3, 2021

Human Subjects Review Council

Dear Toni Sawhill:

After careful review of your research proposal entitled A Phenomenological Study: The Lived Experience of Self-Described Math-Anxious Students Attending College Online, I have decided to grant you permission to access our student list/contact our faculty/staff/other and invite them to participate in your study.

Check the following boxes, as applicable:

☐ I will provide our student list to Toni Sawhill, and Toni Sawhill may use the list to contact our students to invite them to participate in her research study.

☒ I grant permission for Toni Sawhill to contact the required faculty/staff/other to request the information required to contact undergraduate students who have completed a math course online to invite them to participate in her research study.

☐ I will not provide potential participant information to Toni Sawhill, but we agree to send her study information to undergraduate students who have completed a math course online on her behalf.

☐ I am requesting a copy of the results upon study completion and/or publication.

Sincerely,

[Signature]

Human Protections Administrator
Human Subjects Review Council
Appendix D

Opened-Ended Questionnaire Questions

1. How did the instructor clearly communicate important topics and goals in the online math classroom?
2. How did the instructor provide clear instructions on how to participate in the learning activities in the online math classroom?
3. How did the instructor clearly communicate important due dates or time frames for assignments in the online math classroom?
4. How was the instructor helpful in teaching the topics in the online math classroom in a way that helped you?
5. How did the instructor help keep you engaged and participating in class discussions in the online math classroom?
6. How did the instructor help to focus discussion on relevant issues in a way that helped you to learn in the online math classroom?
7. How was feedback provided to you from the instructor in the online math classroom?
8. In what ways did the instructor provide feedback that helped you understand your strengths and weaknesses in the online math classroom?
9. How did the instructor’s actions reinforce the development of a sense of community among the students in the online math classroom?
10. How did you use online or web-based communication to communicate with classmates or the instructor in the online math classroom?
11. How did you feel communicating with your classmates in the online math classroom?
12. How were you able to form distinct impressions of some of your classmates in the online math classroom?

13. How did getting to know other students in your online math class give you a sense of belonging in the class?

14. What was your comfort level in participating in the discussions in the online math classroom?

15. How did you get your point-of-view across in the online math classroom?

16. How did the online discussions help you to develop a sense of collaboration within the online math classroom?

17. In what ways did the online math class activities pique your interest?

18. How were you motivated to explore the content in the online math classroom?

19. In what ways were discussions in the online math classroom valuable in helping you appreciate different perspectives?

20. In what ways did the learning activities in the online math classroom help you construct explanations or solutions?

21. What resources did you use to help you resolve content-related questions in the online math classroom?

22. How can you apply the knowledge from your online math class to your work or other non-class-related activities?

23. How has a reflection of the content, assignments, or discussions of the online math classroom helped you to understand the fundamentals of the course?
Appendix E

Open-Ended Individual Interview Questions

1. Please tell me a little bit about yourself.
2. How would you describe your relationship with math?
3. Please describe what math anxiety is to you.
4. How did your math anxiety develop?
5. How is your math anxiety triggered?
6. What is your favorite part about math?
7. What is your least favorite part about math?
8. What subjects other than math cause you anxiety?
9. How have you coped with anxiety in those subjects?
10. How can you apply your coping methods in other subjects to math?
11. Why did you decide to pursue an online math course?
12. Why did you decide to take the math class that you identified in your demographics questionnaire?
13. How did you feel upon enrolling in that math course online?
14. How would you describe your math anxiety level while completing that math course online?
15. How did you address your math anxiety while completing that math course online?
16. Please describe your math anxiety during the first week of that math course online.
17. Please describe your math anxiety throughout that math course.
18. How comfortable are you with math now after completing that math course?
19. Do you have any further information you would like to add that I have not asked that you feel would help me better understand math anxiety and your relationship with it?
Appendix F

Focus Group Prompts

1. Describe your prior experience with online education.
2. How do you feel about math?
3. How is math anxiety created?
4. How did the online learning environment affect your feelings towards math?
5. How important is trust in your instructor as it relates to math anxiety?
6. How were you able to build trust in your online math instructor?
7. How important is a social connection with other students as it relates to math anxiety?
8. How were you able to create a social connection with other students in the online math classroom?
9. Do you have any further information you would like to add that was not presented here that you feel would help me better understand math anxiety and your relationship with it?
Appendix G

Email to Experts in the Field to Review Data Collection Methods

Hello Adelaide and Cheryl,

I hope this email finds you both well. Things are well on my end. I am emailing you both to request your assistance. Along with being an adjunct instructor for UMGC, I am a Ph.D. candidate with Liberty University, and I am completing a phenomenological study regarding the lived experience of self-described, math-anxious students attending college online. I am using questionnaires, individual interviews, and focus group meetings as my three different data collection methods. As both of you are experts in this field, would you please review the data collection questions and prompts for clarity and conciseness? This should not require much of your time and would be greatly appreciated.

I have attached the data collection methods for your convenience. I appreciate any feedback that you can provide me as I move forward in my dissertation work.

Respectfully,

Toni Sawhill
Appendix H

Email to Pilot Study Participants

Dear Scholar,

I hope this email finds you well. As you may know from my introduction, I am a graduate student in the School of Education at Liberty University. As part of the requirements of my doctoral degree in curriculum and instruction, I am conducting research regarding self-described math-anxious college students. The purpose of my research is to describe the lived experience of college students who completed a mathematics course online.

I am writing this email to invite you to participate in a pilot study for my dissertation research. My research is a phenomenological study of the lived experience of self-described math-anxious students attending college online. The purpose of the pilot study is to ensure the clarity and wording of my questions and prompts for the data collection methods. Participation is voluntary and would take no more than an hour of your time via telephone or Zoom meeting, whichever you prefer. To participate, you must be 18 years of age or older and describe yourself as math-anxious.

If you are interested in participating, please reply to this email with dates and times you are available to participate from the dates and times given below and your preferred method of communication (via telephone or Zoom meeting). If you prefer telephone communication, please provide your telephone number. Once I receive your requested date, time, and communication method, I will send a confirmation email to you.

Again, participation is voluntary and in no way will affect the outcome of this class.
Thank you for your assistance.

Respectfully,

Toni Sawhill

Doctoral Candidate

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Appendix I

Request for Public Records from Site for Potential Participants

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| In the space below, please describe the University records which you are requesting. When possible, include the person(s) referenced, type, content and date range of the records. Please also note, that effective September 1, 2018 and pursuant to RCW 42.56.120(2)(b) & (3), (4): RCW 42.56.130 there is a charge for records that are requested. A fee schedule can be found at this link: [link]

☐ I choose to inspect the records at no charge before selecting copies. ☐ I choose to request reproduction of the records.

RCW 42.56.070(8) prohibits public agencies and institutions from providing access to lists of individuals for commercial purposes. If the records you are requesting includes a list of individuals, then by submitting this form you agree that these records will not be used for commercial purposes.

Requester's signature: ____________________________ Date: ________________

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Appendix J

Commercial Purpose Declaration for Public Records Request from Site

Re: Public Records Request

COMMERCIAL PURPOSE DECLARATION
Public Records Requests under RCW 42.56 for Lists of Individuals

Your organization has requested a list of individuals from a public agency.

The State Public Records Act (PRA) at RCW 42.56.070(8) directs that:

This chapter shall not be construed as giving authority to any agency, the office of the secretary of the senate, or the office of the chief clerk of the house of representatives to give, sell or provide access to lists of individuals requested for commercial purposes, and agencies, the office of the secretary of the senate, and the office of the chief clerk of the house of representatives shall not do so unless specifically authorized or directed by law: PROVIDED, HOWEVER, That lists of applicants for professional licenses and of professional licensees shall be made available to those professional associations or educational organizations recognized by their professional licensing or examination board, upon payment of a reasonable charge therefor: PROVIDED FURTHER, That such recognition may be refused only for a good cause pursuant to a hearing under the provisions of chapter 34.05 RCW, the Administrative Procedure Act.

The PRA at RCW 42.56.080 authorizes agencies to require a requester to provide information as to the purpose of a request “to establish whether inspection and copying would violate RCW 42.56.070(8).”

The State Court of Appeals ruled that in responding to a public records request that includes a list of individuals, an agency must investigate if that list might be used for commercial purposes, in order to comply with the obligations of RCW 42.56.070(8). SEIU Healthcare 775NW v. State, 193 Wn. App. 377, 377 P.3d 214 (2016). The Court also ruled that information to be provided by a requester to an agency includes the purpose of the request, the identity of the requester, the nature of the records requested, and other information necessary to determine if the list of individuals can be provided under RCW 42.56.070(8).

Instructions:

In order to ensure compliance with this obligation please complete the declaration on the reverse of this form and return it to the Public Records Officer. If our agency does not receive a completed declaration, we will be unable to process your request for the list and the request for the list will be administratively closed. If we have questions for you after you complete the declaration, we will contact you. Therefore, make sure you also provide contact information at the bottom of the declaration.

Return this completed declaration form (both sides) to the Public Records Officer or other designated person at: [Redacted]

This declaration is a public record.
DECLARATION UNDER PENALTY OF PERJURY

I have requested a list of individuals from [Redacted]

2. I am requesting the list of individuals on behalf of (specify which one applies):
   _____ My Own Personal Behalf (skip to 3.)
   _____ Organization or Business (complete a. – d. before proceeding to 5.)
   
   a. If an organization or business, the name of the organization or business is:

   b. If an organization or business, the purpose of the organization or business is:

   c. If an organization or business, the mailing address and website address are:

   d. If an organization or business, (i) it is a professional association or educational organization recognized by the professional licensing or examination board, and (ii) the request is for a list of applicants for professional licenses and of professional licensees of the subject area of the association or organization: _____ Yes _____ No

3. The purpose in making this request for the list of individuals is:

4. I or the organization intend to generate revenue or financial benefit from using the list of individuals:
   _____ Yes _____ No

5. I or the organization intend to solicit money or financial support from any of the individuals on the list:
   _____ Yes _____ No

6. I or the organization intend to make individuals on the list aware of business opportunities:
   _____ Yes _____ No

7. I or the organization/business intend to supply or sell the list of individuals to any organization or business, third party individual (someone other than myself or the organization or business listed in paragraph 2), or any other entity: _____ Yes _____ No

   > If yes, to whom:

8. I or my organization/business attest that another law authorizes or directs the agency to provide me or my organization/business the list of individuals requested: _____ Yes _____ No

   > If yes, provide specific citation:

I certify under penalty of perjury under the laws of the State of Washington that the foregoing is true and correct. I certify under penalty of perjury that I have read the first page of this declaration form and I understand that a list of individuals cannot be provided to me or to my organization or business by a public agency if the list will be used for a commercial purpose. I certify under penalty of perjury that any list of individuals I or my organization or business receive pursuant to request [Redacted on: date/name] to Toni Sawhill will not be used for any commercial purpose in violation of RCW 42.56.070(8).

DATED this _____________ of ____________, 2021 in __________________________.
(Day) (Month) (City, State)

__________________________________________  _____________________________
Signature of Declarant                     Print Name

Declarant’s Title (if any):

Declarant’s Contact Information (Phone or email, or both):

Declaration on Commercial Purposes (2016) - Page 2
Appendix K

Responsive Records from Site

[EXTERNAL EMAIL: Do not click any links or open attachments unless you know the sender and trust the content.]

9/9/2021

Toni Savhill
VIA EMAIL
RE: Public Records Request Received 8/16/2021
File Number: [redacted]

Dear Toni Savhill,

Following this letter you will find all the responsive records from [redacted], which are being provided in response to your records request that was received in our office on 8/17/2021. “This was a student directory listing for the Spring 2021 semester” (we have quarters, so this is for Spring 2021 quarter)
Less than 20 responsive pages were produced electronically, therefore, the reproduction fee has been waived.
As a result, as of the date of this letter, your records request is considered closed. If you have any questions, do not hesitate to call [redacted]

Thank you,

[ program specialist ]
Appendix L

Recruitment Email Sent to Potential Participants

DATE

Hello Scholar,

As a graduate student in the School of Education at Liberty University, I am conducting research as part of the requirements for a doctoral degree. The purpose of my research is to better understand mathematics anxiety in college students attending college online. Mathematics anxiety can be defined generally as “feelings of tension and anxiety that interfere with the manipulation of numbers and solving mathematics problems in a wide variety of ordinary and academic situations” (Richardson & Suinn, 1972, p. 551). I am writing to invite eligible participants to join my study.

Participants must be 18 years of age or older, be self-described as math-anxious, and have completed an undergraduate math course online. Participants, if willing, will be asked to complete an online questionnaire and a demographics survey via Microsoft Forms, be interviewed online individually by the researcher via Zoom, and participate in an online focus group meeting conducted by the researcher via Zoom with other students. Participants will also complete an interview transcript review focus group meeting at the conclusion of the study to check the preliminary findings and inform if anything is missing. The demographics questionnaire will take approximately five minutes to complete, the study questionnaire should take no more than an hour to complete, and the individual interviews and focus group meetings will take no more than one hour each. Names and other identifying information will be requested as part of this study, but the information will remain confidential.
If you are interested in participating in this study, please complete the screening survey provided at this link [LINK]. Individuals who meet the inclusion criteria will receive a welcome email.

A consent document will be attached to the welcome email. The consent document contains additional information about my research. If you choose to participate, you will need to sign the consent document and return it to me via email at tnsawhill@liberty.edu by the date provided in the welcome email.

Participants will receive a $30 electronic Amazon gift card at the end of the study.

Respectfully,

Toni Sawhill

Doctoral Candidate
Appendix M

Screening Survey

1. What is your current age?
   17 or below
   18 to 34
   35 to 41
   42 to 48
   48 or older

2. How would you describe your math anxiety?
   I do not describe myself as having math-anxiety.
   I do describe myself as having a low level of math-anxiety.
   I do describe myself as having a medium level of math-anxiety.
   I do describe myself as having a high level of math-anxiety.

3. How many college math courses have you completed?
   I have not completed any college math courses.
   I am currently taking a college math course, but I have not yet completed a college math course.
   I have completed 1 college math course.
   I have completed 2 to 4 college math courses.
   I have completed more than 4 college math courses.

4. How many college math courses have you completed in a strictly online class (not hybrid or on-site/on campus)?
   I have not completed any college math courses strictly online.
I am currently taking a college math course strictly online, but I have not yet completed a college math course strictly online.

I have completed 1 college math course strictly online.

I have completed 2 to 4 college math courses strictly online.

I have completed more than 4 college math courses strictly online.

5. Please provide your first and last name and email address below.
Appendix N

Welcome Email to Participants

DATE

Dear [INSERT PARTICIPANT’S FULL NAME],

Thank you for your interest in my dissertation research on the lived experiences of mathematics anxiety for students attending college online. After reviewing your screening survey, you have been selected as a participant for this study. I value the unique contribution that you can make to my study, and I am excited about the possibility of your participation in it.

Please complete the attached consent form and return it to me at tnsawhill@liberty.edu by [DATE]. Once I have received your completed consent form, you will receive an email from me to complete the demographics questionnaire. Upon completion of the demographics questionnaire, you will receive two additional emails from me. One of the emails will ask you to complete the study questionnaire, and the other email will ask you to schedule your individual interview and focus group meeting times.

Again, I value your participation and thank you for the commitment of time, energy, and effort. If you have any further questions or concerns, please do not hesitate to contact me.

Respectfully,

Toni Sawhill

Doctoral Candidate
Appendix O

Consent

Title of the Project: A Phenomenological Study: The Lived Experience of Self-Described, Math-Anxious Students Attending College Online

Principal Investigator: Toni Sawhill, Ph.D. student in the School of Education, Liberty University

---

Invitation to be Part of a Research Study

You are invited to participate in a research study. In order to participate, you must be 18 years of age or older, have completed an undergraduate math course online, and be self-described as math anxious. Taking part in this research project is voluntary.

Please take time to read this entire form and ask questions before deciding whether to take part in this research.

---

What is the study about and why is it being done?

The purpose of the study is to gather a better understanding of the lived experience of math-anxious college students who have taken an undergraduate math course online.

---

What will happen if you take part in this study?

If you agree to be in this study, I would ask you to do the following things:

1. Complete a 5-minute demographics questionnaire via Microsoft Forms (online).
2. Complete a questionnaire consisting of 23 questions via Microsoft Forms (online). The questionnaire should take no longer than an hour to complete.
3. Participate in an individual interview via Zoom. The interview should take no longer than an hour to complete. This interview will be audio and video recorded for transcription purposes.
4. Participate in a focus group with other participants of the study via Zoom. The focus group meeting should take no longer than an hour to complete. This focus group meeting will be audio and video recorded for transcription purposes.
5. Participate in a focus group meeting via Zoom at the conclusion of the study to check the preliminary findings and inform if anything is missing. The focus group meeting should take no longer than an hour to complete. This focus group meeting will be audio and video recorded for transcription purposes.
How could you or others benefit from this study?
Participants should not expect to receive a direct benefit from taking part in this study.

Benefits to society include a better understanding of several aspects of mathematics anxiety and E-learning for math-anxious students who completed a college mathematics course online. The first aspect being a better understanding of the lived experiences of mathematics anxiety for self-described math-anxious college students who completed a mathematics course online. The second being a better understanding of what variables or experiences contributed to the cultivation of mathematics anxiety in college math students. The third being a better understanding of how math-anxious students addressed their mathematics anxiety while completing an online mathematics course. The final aspect being a better understanding of how the three elements of community of inquiry (teacher presence, cognitive presence, and social presence) attribute to math-anxious students’ completion of an online mathematics course.

What risks might you experience from being in this study?
The risks involved in this study are minimal, which means they are equal to the risks you would encounter in everyday life.

How will personal information be protected?
The records of this study will be kept private. Published reports will not include any information that will make it possible to identify a subject. Research records will be stored securely, and only the researcher will have access to the records. Data collected from you may be shared for use in future research studies or with other researchers. If data collected from you is shared, any information that could identify you, if applicable, will be removed before the data is shared.

- Participant responses will be kept confidential through the use of pseudonyms. Interviews will be conducted in a location where others will not easily overhear the conversation.
- Data will be stored on a fingerprint-protected computer and may be used in future presentations. After three years, all electronic records will be deleted.
- Interviews and focus group meetings will be recorded and transcribed. Recordings will be stored on a fingerprint-protected computer for three years and then be erased. Only the researcher will have access to these recordings.
- Confidentiality cannot be guaranteed in focus group settings. While discouraged, other members of the focus group may share what was discussed with persons outside of the group.

How will you be compensated for being part of the study?
Participants will receive an electronic $30 Amazon gift card upon completion of the study as compensation for participating in this study.

Is study participation voluntary?
Participation in this study is voluntary. Your decision whether or not to participate will not affect your current or future relations with Liberty University. If you decide to participate, you are free to not answer any question or withdraw at any time without affecting those relationships.
What should you do if you decide to withdraw from the study?

If you choose to withdraw from the study, please contact the researcher at the email address included in the next paragraph. Should you choose to withdraw, data collected from you, apart from focus group data, will be destroyed immediately and will not be included in this study. Focus group data will not be destroyed, but your contributions to the focus group will not be included in the study if you choose to withdraw.

Whom do you contact if you have questions or concerns about the study?

The researcher conducting this study is Toni Sawhill. You may ask any questions you have now. If you have questions later, you are encouraged to contact her. You may also contact the researcher’s faculty sponsor, Matthew Ozolnieks, at

Whom do you contact if you have questions about your rights as a research participant?

If you have any questions or concerns regarding this study and would like to talk to someone other than the researcher, you are encouraged to contact the Institutional Review Board or email at

Disclaimer: The Institutional Review Board (IRB) is tasked with ensuring that human subjects research will be conducted in an ethical manner as defined and required by federal regulations. The topics covered and viewpoints expressed or alluded to by student and faculty researchers are those of the researchers and do not necessarily reflect the official policies or positions of Liberty University.

Your Consent

By signing this document, you are agreeing to be in this study. Make sure you understand what the study is about before you sign. You will be given a copy of this document for your records. The researcher will keep a copy with the study records. If you have any questions about the study after you sign this document, you can contact the study team using the information provided above.

I have read and understood the above information. I have asked questions and have received answers. I consent to participate in the study.

☐ The researcher has my permission to audio-record and video-record me as part of my participation in this study.

Printed Subject Name

Signature & Date
Appendix P

Questionnaires & Scheduling Email

Hello [First Name],

You consented to participate in a phenomenological study regarding the lived experiences of self-described math-anxious students attending college online. I would ask that you complete the following three items. I have included the items, a description of the items, and the links below. Please complete these at your earliest convenience, and thank you for your participation.

1) **Demographics Questionnaire** – This is a brief questionnaire to collect demographic information about you. This data will be used in the study in a general manner and will not be attached to any specific participant. A response is required for each question presented. The demographics questionnaire should take no more than five minutes to complete. Click the link [LINK] to complete the survey.

2) **Phenomenological Study Questionnaire** – Your input to the following questionnaire is greatly appreciated. A response is required for each question presented. Please be as detailed as possible in your responses. Click the link [LINK] to complete the survey. The phenomenological study questionnaire should take no more than an hour to complete.

3) **Scheduling of Individual Interview** – Please provide the date(s) and time(s) (in Pacific Standard Time) that you are available to participate in the individual interview. Remember that the individual interview will take place via Zoom and should take no more than an hour. Once I receive your requested date(s) and time(s), I will send a
confirmation email to you. Click the link [LINK] to complete the scheduling of your individual interview.

Respectfully,

Toni Sawhill

Doctoral Candidate
Appendix Q

Demographics Questionnaire

1) What gender do you identify as?

2) What is your current age?

3) Please specify your ethnicity:
   - Caucasian
   - African American
   - Latino or Hispanic
   - Asian
   - Native American
   - Native Hawaiian or Pacific Islander
   - Middle Eastern/Arabic
   - Two or more
   - Other: ____________

4) Please specify your location:
   - North America
   - Central America
   - South America
   - Europe
   - Asia
   - Africa
   - Australia
   - Caribbean Islands
Other: ____________

5) How many online college classes have you completed?

6) What is your current college grade level?
   
   1st year – never attended college before
   1st year – attended college before
   2nd year – sophomore
   3rd year – junior
   4th year – senior
   5th year – undergraduate
   More than 5th year - undergraduate

7) You are a
   
   Part-time student
   Full-time student

8) Select the answer that best describes your student status.
   
   Traditional (only attending school, no work or other responsibilities)
   Working
   Parent
   Working parent
   Other: ____________

9) Please identify the specific undergraduate math course that you took online that you would like to discuss throughout this study.
Appendix R

Email Confirmation for Online Individual Interviews

Hello [INCLUDE PARTICIPANTS FULL NAME],

Your individual interview date and time for the phenomenological study regarding the lived experiences of self-described math-anxious students attending college online has been scheduled.

DATE:
TIME:

[INSERT ZOOM INFORMATION]

Please let me know if you have any questions, concerns, or need to reschedule.

Respectfully,

Toni Sawhill

Doctoral Candidate
Appendix S

Email Reminder with Invitation to Online Individual Interview

Dear [INSERT PARTICIPANT’S FULL NAME],

This is just a friendly reminder that your Individual Interview takes place tomorrow via Zoom. I have included the invitation for the Individual Interview for you below.

I look forward to speaking with you.

[INSERT ZOOM INFORMATION]

Respectfully,

Toni Sawhill

Doctoral Candidate
Appendix T

Email Confirmation for Online Focus Group Meetings

Hello [INCLUDE PARTICIPANTS FULL NAME],

Your online focus group meeting date and time for the phenomenological study regarding the lived experiences of self-described math-anxious students attending college online has been scheduled.

DATE:
TIME:

I will send you an invitation via email closer to your focus group meeting date.

Please let me know if you have any questions, concerns, or need to reschedule.

Respectfully,

Toni Sawhill
Doctoral Candidate
Appendix U

Email Reminder with Invitation to Online Focus Group Meeting

Dear [INSERT PARTICIPANT’S FULL NAME],

This is just a friendly reminder that your Focus Group Meeting takes place tomorrow via Zoom. I have included the information required to attend the Focus Group for you below.

I look forward to speaking with you.

[INSERT ZOOM INFORMATION]

Respectfully,

Toni Sawhill

Doctoral Candidate
Appendix V

Email of Gratitude for Participation in the Study and Invitation for Member Check

DATE

Dear [INSERT PARTICIPANT’S FULL NAME],

Thank you for completing the online questionnaire and meeting with me during our individual interview and focus group meeting. I greatly appreciate your willingness to share your unique and personal thoughts, feelings, events, and situations about your math anxiety experience.

I would like to discuss the preliminary findings of the study with you and ask that you participate in one final step in the research process. That is to reflect on the accuracy of the preliminary analysis and ensure that nothing is missing from the descriptions or themes presented.

I greatly value your participation in this research study and your willingness to share your experience. Please review the attached document and provide your feedback via email. Upon receipt of your feedback, I will send you the $30 electronic Amazon gift card for your participation in this study. I will send the gift card to the email I have on file unless you specify another one in your response.

Again, I greatly appreciate your time, knowledge, and experience. It was fabulous to have met you and I wish you all the best in your education and daily lives. Happy Thanksgiving.

Best,
Toni Sawhill

Doctoral Candidate