A PHENOMENOLOGICAL STUDY OF COLLEGE STUDENTS IN DEVELOPMENTAL MATHEMATICS CLASSES EXPERIENCES WITH MATHEMATICS AND COMPUTER ANXIETY

by

Daniel Lee Murphy

Liberty University

A Dissertation Presented in Partial Fulfillment

Of the Requirements for the Degree

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APPROVED BY:

Meredith Park, Ed. D., Committee Chair

Brian Yates, Ed. D., Committee Member

Marlene Corsini, Ed. D., Committee Member

ABSTRACT

No research has been conducted on college students in developmental mathematics classes struggling with both mathematics anxiety and computer anxiety in a qualitative manner. Prior studies have dealt with college students in developmental mathematics classes struggling with mathematics anxiety and college students in developmental mathematics classes struggling with computer anxiety. The purpose of this transcendental phenomenological study was to describe the experiences of students taking developmental mathematics who self-report both mathematics anxiety and computer anxiety. The theory guiding this study was the social cognitive theory by Bandura (1986) as modeling is a key component in the learning of mathematics, especially in a social, computer classroom setting. A purposive sampling of students in developmental mathematics classes located in a Central Virginia university was asked to complete both the Abbreviated Mathematics Anxiety Scale (AMAS) and the Computer Anxiety Rating Scale (CARS). The participants who volunteered took part in an open-ended semi-structured interview, which gathered common themes and rich descriptions of the phenomenon of experiencing mathematics anxiety and computer anxiety.

Keywords: mathematics anxiety, computer anxiety, developmental mathematics, mathematics, computers, self-efficacy

Acknowledgements

When I was in first grade, I remember beginning to notice teachers. When I got to second grade, I had a desire to become a teacher. Throughout the years of teaching I have had a desire to keep learning and pursuing a higher education. I want to thank my God for placing in me these desires. You, Oh Lord, are still working on me for Your glory!

I want to thank my wife Jill. She has given me total support, strength, and encouragement throughout the entire way. In those times that I wanted to give up, she was the one that kept me going and encouraging me. My persistence was because of her.

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Table of Contents

List of Tables

List of Figures

List of Abbreviations

Abbreviated Mathematics Anxiety Scale (AMAS)

American College Testing (ACT)

American Recovery and Reinvestment Act of 2009 (ARRA)

Annual Yearly Progress (AYP)

Common Core State Standards in Mathematics (CCSSM)

Computer Anxiety Rating Scale (CARS)

Elementary and Secondary Education Act (ESEA)

Every Student Succeeds Act (ESSA)

Grade Point Average (GPA)

National Assessment of Educational Progress (NAEP)

National Council of Teachers of Mathematics (NCTM)

National Governors Association (NGA)

No Child Left Behind (NCLB)

Race to the Top (RTTT)

Scholastic Aptitude Test (SAT)

The National Center for Academic Transformation (NCAT)

U.S. Department of Education (USDOE)

CHAPTER ONE: INTRODUCTION

Overview

Nearly 75% of students in the United States leaving high school are not prepared with the needed level of mathematics required at the collegiate level (Center for Community College Student Engagement, 2016; Perry & Steck, 2015). The 2015 National Report Card in mathematics, signifying the measurement of academic preparedness for college, reported a slight drop in mathematics scores since the 2013 National Report Card (U.S. Department of Education [USDOE], 2016b). As a result, 60% of college freshman must enroll in a lower level of mathematics, referred to as developmental mathematics or remedial mathematics, since the required mathematics level has not been obtained to enroll in college mathematics classes (Bahr, 2013; Center for Community College Student Engagement, 2016; Cordes, 2014; Crisp & Delgado, 2014; Davis & Palmer, 2010; Howard & Whitaker, 2011; Melguizo, Kosiewicz, Prather, & Bos, 2014; Silva & White, 2013; Sprute & Beilock, 2016; USDOE, 2010; Venezia & Jaeger, 2013). Of these mathematics students enrolled in a developmental mathematics course, nearly 25% of four-year college students and 80-85% of community college students struggle with mathematics anxiety (Beilock & Willingham, 2014; Perry, 2004; Sprute & Beilock, 2016). Likewise, approximately 25%-50% of college students report struggling with computer anxiety (Crabbe, 2016; Rahardjo & Juneman, 2013). This statistic is important to consider since some colleges have implemented a math emporium setting as a new structure for delivering instruction of mathematics (Twigg, 2011). The math emporium is an institution's computer lab that diminishes or eliminates lectures for learning mathematics through interactive software along with teacher and/or tutorial assistance (Twigg, 2011). With colleges implementing the mathematics emporium setting model where students are learning mathematics through the use of computers, the concern is for students who struggle with mathematics anxiety, but also struggle with computer anxiety. This is a concern since computers are the source of instruction and students are bound to learning by this medium.

The purpose of this transcendental phenomenological study is to describe the experiences of students in developmental mathematics classes who self-report both mathematics anxiety and computer anxiety. At this time, there is no research giving a voice to college students in developmental mathematics classes experiencing both mathematics anxiety and computer anxiety. The study provides insight for educators to consider and have a better understanding of the struggles of college students in developmental mathematics classes that may be experiencing both mathematics anxiety and computer anxiety.

The study was framed by Bandura's (1977, 1986, 1997, 2001) social cognitive theory since the self-belief, fears, and avoidance behaviors are recognized in college students in developmental mathematics classes. The research of the study focused on obtaining a better understanding of the experiences of students in developmental mathematics classes who struggle with mathematics anxiety and computer anxiety. The study employed the Abbreviated Mathematics Anxiety Scale (AMAS) and the Computer Anxiety Rating Scale (CARS) along with rich descriptive semi-structured open-ended interview questions that provided the essence of meaningful experiences of the students experiencing both mathematics anxiety and computer anxiety while taking a developmental mathematics course (Alsup, 2005; Cazan, Cocorada, & Maican, 2016; Eden, Heine, & Jacobs, 2013; Hismanoglu, 2011; Hopko, Mahadevan, Bare, & Hunt, 2003; Sam, Othman, & Nordin, 2005).

Background

Approximately 60% of college freshmen enrolling for courses during the first semester in colleges and universities in the United States are in need of a remedial mathematics course simply because the student is not prepared for collegiate level mathematics (Bahr, 2013; Center for Community College Student Engagement, 2016; Cordes, 2014; Crisp & Delgado, 2014; Davis & Palmer, 2010; Howard & Whitaker, 2011; Melguizo et al., 2014; Silva & White, 2013; Sprute & Beilock, 2016; USDOE, 2010; Venezia & Jaeger, 2013). The National Assessment of Educational Progress (NAEP) defines academic preparedness for college as "mathematics knowledge and skills needed to qualify for placement into entry-level, credit-bearing, non-remedial courses that meet general education degree requirements in broad access four-year institutions" (Fields, 2013, p. 5). Students entering college registering for a developmental mathematics course are already deficient in certain mathematics skills, and may also experience anxiety when attempting to perform mathematical problems. Mathematics anxiety is defined as negative thoughts and avoidance behaviors when solving mathematics problems (Andrews & Brown, 2015). Mathematics anxiety can cause concerns such as health issues, class attendance issues, avoidance tendencies of not doing the expected mathematics work, low self-efficacy toward mathematics, negative attitudes toward mathematics, and low mathematics assessment scores (Andrews & Brown, 2015; Bandalos, Yates, & Thorndike-Christ, 1995; Bandura, 1986, 1997, 2001; Beilock & Willingham, 2014; Eden et al., 2013; Gningue, Menil, & Fuchs, 2014; Hembree, 1990; Jain & Dowson, 2009; Maloney & Beilock, 2012; Perry, 2004; Sprute & Beilock, 2016). Furthermore, preconceived attitudes toward mathematics along with mathematics anxiety at the collegiate level may have a negative impact on successful completion of mathematics courses (Hegeman, 2015). With nearly 25% of four-year college students and

80-85% of community college students enrolled in a remedial mathematics course struggling with mathematics anxiety, there is a need to find ways to assist students in developmental mathematics classes (Beilock & Willingham, 2014; Perry, 2004; Sprute & Beilock, 2016).

At the collegieate level, some colleges have developed a computer lab setting for completing mathematics courses through interactive computer software, referred to as a math emporium. Although there are some advantages of the math emporium, 25%-50% of college students report having some level of computer anxiety (Crabbe, 2016; Rahardjo & Juneman, 2013). Computers are utilized in word processing, internet, social-media, gaming, and many other applications in education, the workplace, and in general communication with other people. Computers have become interwoven in society insomuch as it has become somewhat necessary to function. Despite the widespread use of computers, computer anxiety exists in the use of the computer itself and with the demands of the applications. Computer anxiety is defined as emotional fear or apprehension when using a computer (Chua, Chen, & Wong, 1999). Students enrolled in a computer-based mathematics course are able to work at an individual pace at a computer either in a mathematics emporium setting or in an environment that is convenient for the student. Within the math emporium setting, if a student begins to struggle on a mathematics problem, then the student can receive assistance from the instructor or an available tutor. However, the setup of the emporium can create a problem for those students struggling with computer anxiety since the student may or may not struggle with a traditional mathematics course, but because of the anxiety associated with the use of computers, students may end up struggling in the mathematics course. Similar to mathematics anxiety, there are physical and emotional struggles that students dealing with computer anxiety experience such as frustration, confusion, avoidance, and anger (Chien, 2008; Chua, Chen, & Wong, 1999; Hismanoglu, 2011; Saade & Kira, 2009).

The anxiety that is associated with mathematics or computers creates unpleasant physical and emotioinal feelings that lead to avoidance of the experience triggering the anxiety (Chien, 2008; Chua et al., 1999; Hismanoglu, 2011; Saade & Kira, 2009). Avoidance creates a problem since what the student is avoiding is academic in nature and necessary for the student's pursuit of a degree. Thus, Bandura's (1977, 1986, 1997, 2001) social cognitive theory is the theoretical foundation of this study given that avoidance behaviors are present if the person believes that failure is inevitable.

Up to now, there are many studies focused on mathematics anxiety (Beilock & Willingham, 2014; Perry, 2004; Sprute & Beilock, 2016) or computer anxiety (Crabbe, 2016; Rahardjo & Juneman, 2013) that are primarily quantitative in nature, while no studies investigate the comorbid student anxieties from mathematics and computers. At this point, there are no studies that give a voice to students in developmental mathematics classes struggling with mathematics anxiety and computer anxiety. This qualitative phenomenological study provides insight into the educational field that will be helpful to educators in post-secondary education and other educators working with mathematics students through the use of computers.

Situation to Self

This study exploring the experiences of students in developmental mathematics classes who struggle with both mathematics anxiety and computer anxiety is important to me since I have taught secondary mathematics for over twenty years, and post-secondary developmental mathematics both residentially and online. Each year there are students who struggle in mathematics. These struggling students often question the purpose of mathematics. They typically have difficulty applying mathematics outside of the classroom and experience symptoms of uneasiness, discomfort, nervousness, and are somewhat distressed when completing classwork or assessments pertaining to mathematics. Although these feelings and behaviors are not the case for all students, as an educator, I desire to help these struggling students to overcome their anxiety towards mathematics in any way I can.

As I have been teaching over the years, the technology use in the classroom by educators and by students themselves has also increased. Although there are many people using technology in many ways, not everyone enjoys using technology, and even some have anxiety toward using technology. The use of computers specifically in the pedagogy of mathematics along with student hands-on use of the computer in mathematics has become the structure of learning of mathematics in many colleges across the country in a setting known as a math emporium. As an instructor and tutor in the math emporium, I have noticed students are familiar with learning mathematics by direct instruction using pencil and paper. These students may become frustrated in the learning and completing of the mathematics assignments through the use of computers and thus develop an apprehension and an anxiety in using the computers for learning mathematics. My desire as a post-secondary educator is to help college students in mathematics, which in this technology-driven society, entails helping them with the use of technology as well.

I am interested in learning more about post-secondary students enrolled in developmental mathematics that struggle in both mathematics anxiety and computer anxiety. Using the interview process in a qualitative study, I used the struggling students in developmental mathematics classes that experience both mathematics anxiety and computer anxiety to gain a better perspective and insight into the learning situation. Since I teach mathematics and do not experience the anxiety myself, I hope to gain insight that may help other educators understand and help students experiencing both mathematics anxiety and computer anxiety. I used a constructivist worldview with an epistemological approach since I was relying on the participants' experiences for my research to understand students that I deal with better (Creswell, 2013; Moustakas, 1994).

Problem Statement

Some students believe their personal mathematics abilities are poor and that failure is inevitable (Howard & Whitaker, 2011). At the collegiate level, approximately 60% of freshmen must enroll in some type of a remedial mathematics course (Bahr, 2013; Center for Community College Student Engagement, 2016; Cordes, 2014; Crisp & Delgado, 2014; Davis & Palmer, 2010; Howard & Whitaker, 2011; Melguizo et al., 2014; Silva & White, 2013; Sprute & Beilock, 2016; USDOE, 2010; Venezia & Jaeger, 2013) since it is reported that almost three fourths of high school seniors do not have the needed level of mathematical understanding of the concepts necessary in the required mathematics course (Perry & Steck, 2015). Unfortunately, remedial mathematics courses have the highest failure rates of all college courses with only about a third of the students succeeding academically on the first attempt (Crisp & Delgado, 2014; Hersh & Merrow, 2005; Koch, Slate, & Moore, 2012; Pascal, 2011; Rask, 2010; Silva & White, 2013). Furthermore, as much as 44% of students enrolled in a type of developmental course do not complete the degree being pursued (Bailey, Jeong, & Cho, 2010; Benken, Ramirez, Li, & Wetendorf, 2015; Chen, 2016; Fong, Melguizo, & Prather, 2015; Hegeman, 2015; Melguizo et al., 2014). With this to consider, nearly 25% of four-year college students and 80-85% of community college students enrolled in remedial mathematics courses may struggle with some level of mathematics anxiety (Beilock & Willingham, 2014; Perry, 2004; Sprute & Beilock, 2016). The literature regarding mathematics anxiety is extensive beginning as early as the 1950s, and is primarily quantitative in nature, examined in relationship to constructs such as achievement, gender, age, and self-efficacy (Bahr, 2013; Bessant, 1995; Betz, 1978; Jackson & Leffingwell, 1999; Lyons & Beilock, 2012; Malik, 2015; Mutodi & Ngirande, 2014; Perry, 2004; Sevindir, Yazici, & Yazici, 2014).

At the collegiate level, some developmental mathematics courses are conducted through the use of a computer, which could lead students into a secondary problem of computer anxiety. Approximately 25%-50% of students report some level of computer anxiety (Crabbe, 2016; Rahardjo & Juneman, 2013). Furthermore, computer anxiety can contribute to the avoidance of the use of computers, which in turn hinders the developmental mathematics student enrolled in a computer based developmental math course (Chua et al., 1999; Rahardjo & Juneman, 2013). The literature concerning computer anxiety has primarily dealt with the relationship with constructs such as age, gender, computer experience, and computer self-efficacy (Chien, 2008; Chua et al., 1999; Lee & Huang, 2014; Powell, 2013; Tuncer, Dogan, & Tanas, 2013). However, at this time, there is no research giving a voice to college remedial mathematics students experiencing both mathematics anxiety and computer anxiety.

The problem of the study is the high failure rate of students enrolled in developmental mathematics classes. Identifying students enrolled in developmental mathematics courses that struggle with mathematics and computer anxiety along with exploring common constructs is important, but it does not address an in-depth look at the problem. My study helps give a more in-depth look by exploring the perceptions and experiences of students enrolled in developmental mathematics courses who struggle with both mathematics anxiety and computer anxiety.

Purpose Statement

The purpose of this transcendental phenomenological study is to describe the experiences of students taking developmental mathematics who self-report both mathematics anxiety and computer anxiety. Mathematics anxiety is defined as negative thoughts and avoidance behaviors when solving mathematics problems (Andrews & Brown, 2015). Likewise, computer anxiety is defined as emotional fear or apprehension when using a computer (Chua et al., 1999). This study is framed by Bandura's (1977, 1986, 1997, 2001) social cognitive theory given its emphasis on modeling as a key component in the learning of mathematics, especially in a social, computer classroom setting. As students learn mathematics in a math emporium setting with the use of computers, the examples are being modeled through the use of videos, explained examples, and instructor assistance. Learning mathematics is a scaffolding process that Bruner (1986) and Vygotsky (1978) identified as educators provide the initial stages or examples of the mathematics concept and continue to provide support as the learning of developmental mathematics continues by the student on the computer. Scaffolding in mathematics is the process that educators build on prior student knowledge to assist the student in reaching understanding of the next mathematical concept. Students in a math emporium setting are using computers in primarily an academic setting with instructor assistance if needed to move from one mathematical concept to the next at each student's individual pace. Students may be struggling with mathematics anxiety or computer anxiety, which may lead toward having difficulties in completing assignments, especially when struggling with self-advocating. The difficulties in completing the assignments may lead to frustration, confusion, and other negative emotions. These negative emotions could lead toward having anxiety in completing the assignments since frustration, confusion, fear, and avoidance are common elements of anxiety (Saade & Kira, 2009). The student's perceptions of the homework quality and difficulty directly relates to the student's performance in the mathematics classroom, as indicated in Figure 1 (Dettmers et al., 2011).

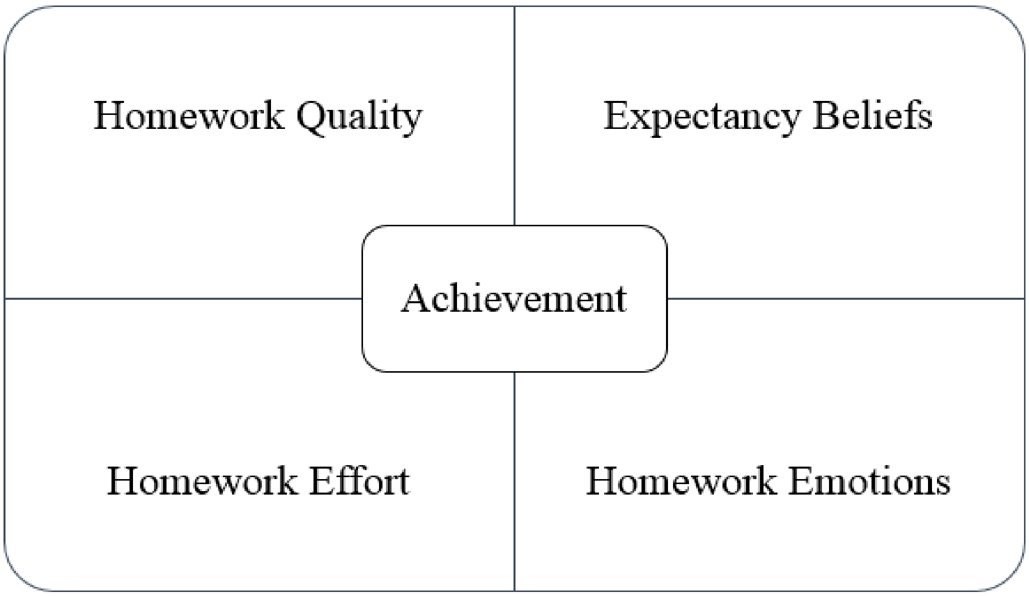

Figure 1. Student perceptions of homework quality can lead to class achievement.

Students experiencing the negative emotions associated with anxiety may have a tendency to avoid the experience altogether. The avoidance behavior is prevalent if the student believes the experience is not worth experiencing or if the student believes that failure is inevitable (Bandura, 1977, 1986, 1997, 2001). Since social cognitive theory is the view of individuals having self-beliefs about "what people think, believe, and feel affects how they behave" (Bandura, 1986, p. 25), it was used as the foundation of this study, giving a voice to college students in developmental mathematics classes who struggle with mathematics anxiety and computer anxiety.

Significance of the Study

The findings of this study inform postsecondary educators about the experiences of students struggling with both mathematics anxiety and computer anxiety in the hope of helping these students in the success of the mathematics course. Furthermore, the findings could also help educators assess the structure and design of the course and seek possible steps to help differentiate learning styles and especially give targeted support for those students in developmental mathematics classes struggling with mathematics anxiety and computer anxiety.

Although learning mathematics is a scaffolding constructing learning structure (Bruner, 1986; Vygotsky, 1978), a social cognitive theory by Bandura (1986, 1997, 2001) was utilized in this study since a student's emotions and self-beliefs both in mathematics and in computers was. The findings of this study will help educators better understand the struggles of students, specifically students in developmental mathematics classes, dealing with mathematics anxiety and computer anxiety.

Research Questions

The research questions are grounded in the theoretical framework of Bandura's (1977, 1986, 1997, 2001) social cognitive theory. These research questions are the foundation of obtaining a better understanding of the experiences of students in developmental mathematics classes that experience mathematics anxiety and computer anxiety. The research questions are:

RQ: What are the experiences of students enrolled in computer-based developmental mathematics courses who self-report both mathematics anxiety and computer anxiety?

SQ1: What experiences do students enrolled in computer-based developmental mathematics face when completing mathematics work?

SQ2: What experiences do students enrolled in computer-based developmental mathematics face when using the computer?

SQ3: What factors do students enrolled in computer-based developmental mathematics classes identify as assisting them in coping with their mathematics anxiety and computer anxiety?

Research Question Discussion

The primary research question encompasses the other subsections since the primary focus of this study is to gather insight from the combined experiences of students enrolled in computer-based developmental mathematics courses that experience both mathematics anxiety and computer anxiety. According to Moustakas (1994), a qualitative phenomenological study should consist of general questions to the participants that focus on gathering information from the experiences of the phenomenon. The primary question, and the subsection questions, was addressed through the three data collection processes of students who took both the AMAS and CARS tests, a questionnaire, and one-one-one interviews. Through the interview process, participants gave meaning to the phenomenon through the lived experiences of experiencing both mathematics anxiety and computer anxiety. Interviewing participants and seeking to empower the participants to voice their experiences and to understand the setting in which both the mathematics anxiety and computer anxiety take place was a foundation of conducting a qualitative study (Creswell, 2013).

Research Plan

This qualitative transcendental phenomenological design study was used to capture the central phenomenon and insights from students in developmental mathematics classes experiencing both mathematics anxiety and computer anxiety. A purposive sampling of students in developmental mathematics classes enrolled in a Central Virginia university was asked to participate in the study (see Appendix E) and to sign an informed consent form (see Appendix

F). Students who chose to participate in the study were directed to SurveyMonkey to complete a demographics questionnaire (see Appendix B), the AMAS (see Appendix C), and the CARS (see Appendix D) during the first week of the semester. The questionnaire was used to collect general biographical information such as gender, age, course, and the number of times in the course. The AMAS consists of nine questions having a 45-point scale ranging from 9 to 45 with an average score ranging from 20-22 (Carey, Hill, Devine, & Szucs, 2017; Cipora, Szczygiel, Willmes, & Nuerk, 2015; Hopko et al., 2003). The CARS consists of 19 questions having a 95-point scale ranging from 19 to 95 with an average score of 42 (Havelka & Beasley, 2011; Heinssen, Glass, & Knight, 1987; Williams & McCord, 2006). Analyzing the results from the anxiety scales with students scoring higher than average on both the AMAS and CARS provided descriptive data of the participants being identified as having anxiety in mathematics and in the use of computers. Furthermore, participants were chosen with the medium to high anxiety in both mathematics and toward the use of computers that obtained a more selective sample experiencing the phenomenon with greater intensity. According to Moustakas (1994) and Polkinghorne (1989), a phenomenological plan should have a minimum of 10 participants to reach thematic saturation for the phenomenological study. I used 12 participants enrolled in developmental mathematics who scored high anxiety levels on both the AMAS and the CARS and participated in semi-structured open-ended audio-recorded interviews. The semi-structured open-ended interviews of the participants were transcribed, read, and reflected upon to identify significant similar statements by the participants. Themes were identified from the statements and the constructs were described in depth to gather the essence of the participants' common experiences. The participants' essence and experiences need to be voiced clearly without bias from the researcher (Moustakas, 1994).

Delimitations and Limitations

The study participants were limited to college students enrolled in a developmental mathematics course at a Central Virginia university who experience mathematics anxiety and computer anxiety, as identified by the AMAS and the CARS. The study was limited to the methodology, the number of participants, and the selection process of the participants using the AMAS and the CARS scales for the purpose of selecting the participants. The study was also dependent on the university mathematics emporium setting and student access to computers in the developmental mathematics course. A phenomenological study was chosen to collect the combined experiences of the participants since the voices of the participants needed to be heard without the researcher's experience (Moustakas, 1994).

Students were tested for possible mathematics anxiety and computer anxiety. It is possible that participants who experience test anxiety or other anxieties played a role in the initial screening of the possible participants when the students took the AMAS and the CARS. Another possible limitation to the study was in the manner of the deliverance of the AMAS and CARS being conducted on a computer. In addition, the location of the university in Central Virginia may not be reflective of all universities. Furthermore, the university in the study is a private religious institution; the students sampled may not be representative of all university students.

Definitions

For the purpose of this study, the definitions and descriptions of essential terms are described below.

1. *AMAS* – AMAS is an abbreviation for the Abbreviated Version of the Mathematics Anxiety Scale (Alsup, 2005; Carey et al., 2017; Cipora et al., 2015; Eden et al., 2013;

Hopko et al., 2003). It is the shortest mathematics anxiety scale with only nine Likert-type questions that show an inter-consistency $\alpha = .90$ and a test-retest reliability of $r = .85$ when compared to the original 98-question Mathematics Anxiety Rating Scale.

2. *CARS* – CARS is an abbreviation for Computer Anxiety Rating Scale which is a 19-item Likert scale survey and was found to be a reliable test ($r = .95$) (Cazan et al., 2016; Hismanoglu, 2011; Sam et al., 2005).
3. *Computer anxiety* – Computer anxiety is defined as emotional fear or apprehension when using a computer (Chua et al., 1999).
4. *Developmental Mathematics* – Developmental mathematics is a required program in mathematics for students scoring below the needed level on high-stakes placement exams (Benken et al., 2015).
5. *Mathematics Anxiety* - Mathematics anxiety is defined as negative thoughts and avoidance behaviors when solving mathematics problems (Andrews & Brown, 2015).
6. *Math Emporium* – Math emporium is defined as an institution's computer lab that diminishes or eliminates lectures and uses interactive computer software along with teacher and/or tutorial assistance (Twigg, 2011).
7. *Self-efficacy* – Self-efficacy is the personal belief in one's self in ability and performance (Bandura, 1986).
8. *Social Cognitive Theory* – Social cognitive theory is the view of individuals having self-beliefs about "what people think, believe, and feel affects how they behave" (Bandura, 1986, p. 25).

Summary

In conclusion, this section included an introduction and background to this study of students enrolled in a computer-based developmental mathematics course who experience mathematics anxiety and computer anxiety. The problem and the significance of this study are identified, as there is no research giving a voice to college students in developmental mathematics classes experiencing both mathematics anxiety and computer anxiety. The findings will inform postsecondary educators about the experiences of students struggling with both mathematics anxiety and computer anxiety in the hope of helping these students in the success of the mathematics course. The research design was a qualitative transcendental phenomenological study that captured the central phenomenon and insights from students in developmental mathematics classes that experience both mathematics anxiety and computer anxiety. Interviews of the participants were conducted at a Central Virginia university to gather insight and provide helpful information to future educators. In this chapter, limitations and delimitations were delineated and discussed as possible weaknesses and strengths in the study. In the next section, a literature review of the study is given with the topics Theoretical Framework, Recent History of Education, College Developmental Mathematics, Mathematics Anxiety, Computer Anxiety, and Gaps.

CHAPTER TWO: LITERATURE REVIEW

Overview

Approximately 60% of college freshmen enrolling in a mathematics course are required to enroll in a college developmental mathematics course (Bahr, 2013; Howard & Whitaker, 2011; Silva & White, 2013; Sprute & Beilock, 2016). Unfortunately, developmental mathematics courses have the highest failure rates of all college courses with only about a third of the students passing the course on the first attempt (Koch et al., 2012; Pascal, 2011; Rask, 2010; Silva & White, 2013). Course failure in early mathematics courses not only negatively affects a student's grade point average (GPA) and self-efficacy, but also may lead toward a higher college dropout rate (Bremer et al., 2013; Fong et al., 2017; Parker, 2005; Scott-Clayton & Rodriguez, 2015). Therefore, there are benefits, such as increasing college student retention rates, associated with assisting students enrolled in beginning mathematics courses at the collegiate level (Daugherty, Rusinko, & Griggs, 2013). Many colleges use a math emporium setting to help student-teacher interaction and to increase the students' hands-on learning environment (Braun, Bremser, Duval, Lockwood, & White, 2017; Twigg, 2011; Webel, Krupa, & McManus, 2016; Wilder & Berry, 2016). Student engagement, especially applied to real-life applications, is a key component in learning mathematics (Dolezal, Welsh, Pressley, & Vincent, 2003; Hegedus, Dalton, & Tapper, 2015; Pitre & Pitre, 2014). Even with implementing real-life applications, some students still struggle with mathematics anxiety and may find the course difficult. Additionally, the emporium model uses computers in the learning structure of mathematics, which could be a drawback for students who struggle with computer anxiety. A student who experiences mathematics anxiety or computer anxiety may also have a low self-efficacy toward mathematics or toward the use of a computer. Because of the anxiety associated with mathematics or with computers, students may avoid the use of the emporium and set themselves up for failure for the course. Educators need to look for ways to identify students struggling with mathematics anxiety and computer anxiety to know how better to assist them.

This study addresses the experiences of students in developmental mathematics classes who experience both mathematics anxiety and computer anxiety through the theoretical lens of Bandura's social cognitive theory. Hence, this chapter uses Bandura's (1977, 1986, 1997, 2001) social cognitive theory and gives an overview of some of the available literature on college developmental mathematics, the math emporium, mathematics anxiety, computer anxiety, and expresses the gap in the literature.

Theoretical Framework

The theoretical framework of this research study uses the social cognitive theory by Bandura (1977, 1986, 1997, 2001). Using a theory-based approach in qualitative research can provide a foundation of interpreting the results of a study that supports the theory (Gall, Gall, & Borg, 2007). Bandura's (1977, 1986, 1997, 2001) social cognitive theory will focus the study by investigating the combined experiences of students self-reporting both mathematics anxiety and computer anxiety.

Bandura's Social Cognitive Theory

According to Bruner (1986) and Vygotsky (1978) the learning of mathematics is a scaffolding constructing process. In a classroom or mathematics emporium setting though, learning mathematics could be impacted by other factors such as emotions and self-belief of mathematics or with the use of computers. As a result, a social cognitive theory by Bandura (1977, 1986, 1997, 2001) was utilized in this study since a student's emotions and self-beliefs both in mathematics and computers were studied. Self-efficacy is the personal belief in one's self in ability and performance (Bandura, 1986). Prior research indicates there is a correlation between self-efficacy beliefs regarding numerical computation and towards mathematics anxiety (Bandalos et al., 1995; Eden et al., 2013; Jain & Dowson, 2009). Students that typically perform low, specifically in mathematics, develop a mindset that failure is inevitable and mathematics cannot be completed by everyone (Howard & Whitaker, 2011). Students enrolled in developmental mathematics classes may view themselves with an inferiority in mathematics capabilities or skills, and could view the mathematics course with fear tendencies and anxiety. Moreover, Bandura (1977) states, “people fear and tend to avoid threatening situations they believe exceed their coping skills, whereas they get involved in activities and behave assuredly when they judge themselves capable of handling situations that would otherwise be intimidating” (p. 194). Bandura (1977) further stated,

> Efficacy expectations determine how much effort people will expend and how long they will persist in the face of obstacles and aversive experiences. The stronger the perceived self-efficacy, the more active the efforts. Those who persist in subjectively threatening activities that are in fact relatively safe will gain corrective experiences that reinforce their sense of efficacy, thereby eventually eliminating their defensive behavior. (p. 194)

According to Bandura (1997), the past performance of a student in mathematics is the primary factor to efficacy beliefs toward mathematics. This aligns with mathematics anxiety since students experiencing mathematics anxiety tend to avoid doing mathematics because of their low self-efficacy in doing mathematics (Andrews & Brown, 2015; Maloney & Beilock, 2012). On the other hand, students with a high self-efficacy, specifically in mathematics, approach difficult problems and tasks more optimistically and as a challenge (Wigfield & Eccles, 2000). Moreover, the persistence and accuracy needed in mathematics is affected by the efficacy of a student toward mathematics since students with high self-efficacy tend to be more accurate in the computation of mathematics while still showing greater persistence on the more difficult problems than do students who have low self-efficacy (Akin & Kurbanoglu, 2011).

Likewise, since this study explores the learning of mathematics in a mathematics emporium setting with the use of computers, students struggling with computer anxiety will have the tendency to have the behavior of avoidance since the use of computers brings tension and other physical or emotional factors associated with a low self-efficacy with using computers. Furthermore, computer anxiety plays a significant relationship in computer self-efficacy, which could lead toward individuals avoiding the required work needed on a computer (Hsi-Chi, Ya-Ling, & Yuh-Rong, 2010). The social cognitive theory is the view of individuals having self-beliefs about "what people think, believe, and feel affects how they behave" (Bandura, 1986, p. 25). Bandura (2001) also believed that people who do not foresee a successful outcome in a particular area, such as a mathematics classroom or in the use of a computer, will have little desire to persevere through the difficulties for a successful outcome. In other words, if students who are enrolled in a mathematics computer-based course who already have struggled in a previous mathematics course or with the use of computer will most likely have little desire to overcome those struggles and be successful in the course. This could be a factor in the high percentage of students not succeeding in a mathematics developmental course (Bremer et al., 2013; Fong et al., 2017; Parker, 2005; Scott-Clayton & Rodriguez, 2015).

The developmental mathematics classroom setting entails aspects of learning mathematics, learning with the use of a computer, and learning in a social setting. The cognitive factor of learning mathematics on a computer can be influenced because of the social environment. Likewise, the social environment can also affect the cognitive factor of learning mathematics. The self-efficacy Bandura refers to influences a student's behavior and ultimately academic choices. Specifically, self-efficacy can be used to help predict a student's success and behavior, specifically in mathematics (Bandura, 1997; Foshee, Elliott, & Atkinson, 2016; Wigfield & Eccles, 2000). When a student achieves satisfaction from a behavior then the individual is more likely to have repetition of the steps producing the behavior (Bandura, 1986). This repetition could help build a foundation of knowledge in a subject area which may help with a better retention level of the subject material (Foshee et al., 2016; Wilder & Berry, 2016). The social cognitive theory by Bandura (1986, 1997, 2001) was utilized in this study since a student's emotions and self-efficacy both in mathematics and computers were studied.

Literature Review

Learning mathematics can be difficult for some students for a myriad of reasons. A prevalent reason is students struggle with mathematics anxiety. Educators use different strategies in an attempt to help these struggling students. One such pedagogical tool is with technology in the classroom. Technology in the classroom can be used to enhance the educational experience for most students, but educators need to consider the impact for students having anxiety from using the technology. This consideration is important for all levels of education, but particularly important for college students who are seeking a degree leading to the future workforce. In the collected research, the literature provides background information for this transcendental phenomenological study and informed the research question: What are the experiences of students in developmental mathematics classes who experience both mathematics anxiety and computer anxiety?

Recent History of Mathematics Education

Mathematics is one of the core subjects in the education field. Its scaffolding hierarchical learning process has at its foundation concepts that must be learned, and hopefully mastered, before moving on to the next mathematical concept for a full understanding and successful continuance. Students that tend to struggle on early concepts will most likely have increasing difficulties in later concepts in mathematics (Bremer et al., 2013; Fong et al., 2017; Howard & Whitaker, 2011; Parker, 2005; Scott-Clayton & Rodriguez, 2015). The emphasis of mathematics as a core subject has been investigated with organizations and laws over the years to help improve learning through the effectiveness of teaching seen in concrete ways such as test scores.

Educational history. One of the educational reformations came in the 1940s with the invention of atomic weapons, and in 1957 when the Soviet Union launched Sputnik. The space age began at that point, and the United States was concerned with not only national security, but also with its international academia competition (Woodward, 2004). The educational push into science and mathematics was emphasized at this time because of the comparison of the two nations and the possible fears of the United States falling behind in these two subjects. Educational reforms began to appear every few years to help the United States succeed in the space race. In addition, educational psychologists Piaget and Bruner began to have an influence on the upcoming educational reforms, specifically in mathematics. The 1960s “New Math” and the 1970s through the 1980s “Back to the Basics” educational reforms emphasized test scores, basic math calculations, and rote memory with an emphasis on critical thinking through problem solving (Burris, 2014; National Council of Teachers of Mathematics [NCTM], 1980; Woodward, 2004).

Elementary and Secondary Education Act. The Elementary and Secondary Education Act (ESEA) was signed into law in 1965 by President Lyndon Johnson. The ESEA was designed to promote educational opportunities for all students, but it was primarily a civil rights law. Specifically, ESEA's purpose is to "ensure that all children have a fair, equal, and significant opportunity to obtain a high-quality education and reach, at a minimum, proficiency on challenging State academic achievement standards and state academic assessments" (USDOE, 2005, p. 15). ESEA also provided grants to schools serving low-income students, federal grants for books, funding to institutions providing for special education, and federal grants to the educational agencies in each state to help in the process of improving the quality of both elementary and secondary schools (Dee & Jacob, 2010b; USDOE, 2017). The ESEA reformation was a commitment by the federal government to not only begin the educational accountability process, but to commit to the foreseeable future its role in public education with billions of dollars and with educational opportunities for all students. The ESEA was an educational reform that was needed, but as the time passed educators realized achievement gaps still existed and more needed to be done.

Nation at Risk. President Ronald Reagan in 1983 introduced a pivotal educational report called "Nation at Risk" which challenged excellence in education in schools (Deming & Figlio, 2016; Woodward, 2004). This reform began by stating some of the American academic deficiencies such as the low international comparison rankings, the increased number of functionally illiterate adults, and the declining Scholastic Aptitude Test (SAT) testing results (Gardner, 1983). The educational report further challenged educators to work hard in developing all students to their potential. Furthermore, educators should expect the same results, reaching high standards and being committed to continued learning, from all students rather than settle for mediocrity (Gardner, 1983). The report also gave many recommendations covering multiple areas such as raising admission requirements in colleges and universities, administering standardized tests regularly, updating all schools' curriculum, assigning more homework, and increasing attendance requirements. The report was instrumental in challenging educators and bringing forth other critical mathematics educational policies and statements such as the 1989 Curriculum and Evaluation Standards for School Mathematics released by the NCTM, and Everybody Counts, a report to the nation on the future of mathematics. These educational challenges allowed educators to consider changes in the curriculum, in technology, and in other teaching practices (Burris, 2014; Deming & Figlio, 2016; Woodward, 2004).

One of the educational considerations that paved the way in the 1990s was a list of six national educational goals that was developed by a gathering of political leaders at the National Governors Association (NGA) Summit. The six goals that were encouraged to reach by the year 2000 were to:

- ensure that all children started school ready to learn;
- achieve a high school completion rate of 90%;
- improve achievement for all Americans in all basic subjects;
- make American students first in the world in math and science;
- ensure that all adults were literate and had access to lifelong learning opportunities; and finally
- make all schools safe, disciplined, and drug-free. (Stallings, 2002)

These changes in the 1990s led educators and lawmakers to another major mathematics educational reform in 2001, No Child Left Behind (NCLB).

No Child Left Behind. The educational reform that transformed the United States educational system was the NCLB Act of 2001, which was a revision of the ESEA. Since the results indicated a rise of mathematics scores being the highest gains with an educational accountability program in place, NCLB somewhat modeled these states' accountability programs to assure the educational gaps would address all students in all states (Dee & Jacob, 2010b; Hanushek & Raymond, 2002). This gap can be seen when comparing the test scores from the states that adopted the accountability educational programs and those that did not. The accountability provisions by NCLB, or by the states that implemented accountability educational programs before NCLB, did initially significantly increase mathematics achievement scores among fourth and eighth graders, specifically among African American students, Hispanic students, and students who qualified for subsidized lunch (Dee & Jacob, 2010b; Hanushek & Raymond, 2002). Furthermore, accountability programs in education have both direct and indirect positive results toward academic achievement. President George W. Bush speaking on education in Washington, D.C. at the National Urban League Conference on August 1, 2001, in preparation of NCLB, stated

> …we need true accountability, the centerpiece of reform. Consequences for school officials must be determined by proven results for children. Those in authority must show responsibility. The purpose of education, after all, is not jobs for adults, it's learning for students. Accountability is an exercise in hope. (The White House, 2001)

NCLB required school systems in all states to be accountable by regularly testing public school students throughout the system annually. The national testing was from 3rd grade to 8th grade and at least once in 10th through 12th grades in the core subjects of reading and mathematics to help assess the overall progress of students' achievement with making positive progress toward state proficiency goals (Dee & Jacob, 2010a; Deming & Figlio, 2016; Woodward, 2004). NCLB set deadlines for all states to expand the frequency of academic testing for accountability purposes to all students and to include low-income students, minority students, disabled students, or special needs students (Deming & Figlio, 2016; Hanushek & Raymond, 2002; McLaren & Farahmandpur, 2006). Specifically, the concentration on NCLB was for three primary reasons: increased accountability of schools and educators through testing and teacher certification, implemented a voucher system to increase school choice, and granted more flexibility to school systems to spend at their discretion the government attained money once the Annual Yearly Progress (AYP) was reached (Pederson, 2007; Stallings, 2002). The emphasis of this monumental educational reformation was the requirement of all states to participate and to develop individual state standards that could be statistically compared to a national benchmark (Stallings, 2002).

The proficiency standards that were set in NCLB established an accountability level for public schools to help students achieve proficiency and to also set rewards and consequences or sanctions to schools that did or did not meet the set proficiency benchmarks. The purpose of the schools receiving rewards or consequences was to help educators of all levels to work diligently to educate all students to the set benchmark levels (Dee & Jacob, 2010a; Deming & Figlio, 2016; Woodward, 2004).

In the 1990s, several states put into practice accountability measures that would assist schools within their states to address the achievement gaps. The educational accountability programs within certain states for fourth graders through eighth graders did show progress in mathematics scores in the 1990s obtained from the NAEP (Hanushek & Raymond, 2002; Wei, 2012). The NAEP assesses student performance in mathematics at the fourth, eighth, and 12th grades across the nation in both public and private schools. Recent performance shows a drop in national scores from 2013 to 2015, but it overall has a better national average when compared to 1990 (NAEP, 2017). To be more precise, approximately 82% of fourth graders, 71% of eighth graders, and 62% of twelfth graders performed at or above the Basic achievement level in mathematics with the most recent information of 2015. Furthermore, it indicates 40% of fourth graders, 33% of eighth graders, and 25% of twelfth graders performed at or above the Proficient achievement level in mathematics. The NAEP achievement levels define the Basic level as students having partial mastery of fundamental mathematical skills, and Proficient level as students having competency over more challenging mathematical concepts (NAEP, 2017).

The rise of mathematics scores can be attributed to many factors. One of these factors is the educational reformation of NCLB, which was primarily attributed to the determination by educators and government officials in an attempt to not let one student be left academically behind. Unfortunately, like many past educational reformations, there are opponents against NCLB stating that its emphasis is on a high-stakes test and not necessarily on the knowledge of what students know in the core subject materials. The role of the federal government in education has also increased with the enactment of NCLB is also a controversy amongst educators. Furthermore, some educators have criticized NCLB for the emphasis on testing in the core subjects, which resulted in less emphasis on the non-core subject curriculum. NCLB did require testing in mathematics, reading, and eventually science, but testing in social studies, physical education, the arts and humanities, and in technology decreased or ceased altogether (Pederson, 2007; Price, 2016).

Moreover, if the subject material is emphasized, then the impact on the results of the assessment will be evident; in other words, “what is measured is treasured” (Dee & Jacob, 2010b; Pederson, 2007, p. 291). There are also too many variables to account for to primarily state that NCLB was the sole cause of the rise of the NAEP mathematics scores. Other educational, political, and social factors both at the federal and local levels could have played a role in determining the drive and initiative that each school district was able to assist the students in training the students for the achievement tests to attain proficiency. For instance in 2000, just prior to NCLB, the NCTM approved a set of new standards that could have had an impact on the curriculum of the math instruction in the school systems (Dee & Jacob, 2011). Taking those states that already had an accountability program into place and then implementing the additional policies of NCLB, the fourth-grade mathematics achievement scores still rose approximately two thirds of the average annual gain by 2007. This scenario is equivalent to a fourth grader being tested at the beginning of the year compared to a fourth grader being tested two thirds through the year. This leap in noticeable mathematics improvement by the NCLB accountability initiative has been helping many students by performing at the Basic or Proficient level according to the NAEP achievement levels (Dee & Jacob, 2010b).

Another aspect and possibly a huge impact on the improvement of student mathematics scores reported by the NAEP achievement levels is due to the increased emphasis and governmental financial support toward professional development. Before NCLB, approximately one third to one half of secondary mathematics classes were taught by a teacher that was not qualified with a certified degree in mathematics or even having a minor in the mathematics content area (Ingersoll, 1999; Neville, Robinson, & Finance Project, 2003; Zhoa, 2009). Teachers should be competent and qualified in the content area being taught to teach students effectively to not only learn the mathematical concepts but also to be expected to perform well on standardized mathematics tests. One of the many mandates of NCLB was to require professional development for educators to be highly qualified and to ensure that the impact of the policy would be immediate (USDOE, 2005). Furthermore, NCLB required professional development would continue for teachers to maintain not only teacher state certification, but also to continue to develop current educational practices and methods that could be implemented in the classroom including technology integration. The professional development was necessary not only in content areas such as mathematics, but also in teaching methods that would assist existing teachers to help develop effective methods of instruction (Neville et al., 2003). After the signing of NCLB in 2002, professional development of educators across the nation that were now considered as highly qualified was reported in 2007 to be as high as 92% for both elementary and secondary classrooms. Professional training from the NCLB mandate helped educators become academically more qualified in content areas and various teaching methods (Wieczorek, 2017). The professional development assisted teachers in helping not only the high achieving students but also the students that tended to struggle more in mathematics (USDOE, 2009).

Even with the higher educational standards, the federal mandated regulations and sanctions, and the professional development put into place from the presidential signing of the 2002 NCLB, the proficiency standards set in place by NCLB, with the expectations of every student being proficient in mathematics, were not being obtained. Although many factors, such as low achievement scores, inexperienced or undertrained teachers, and ongoing absenteeism, can contribute to low state achievement scores and schools being labeled as failing, NCLB was an educational reformation attempting to make a positive impact affecting the entire United States education system. After a few years into NCLB, the achievement scores were rising, but there were still some adjustments since many of the states were not meeting the required minimum level of proficiency (Childs & Russell, 2017; Price, 2016). In 2009, the fourth grade NAEP mathematics scores for most states performed in the Basic or below with only one state performing in the proficient range. Since students were being tested in fourth and eighth grades, the eighth-grade mathematics results were similar for many of the states (USDOE, 2009). Many of the states were not meeting the *Basic* proficiency level by 2009 mandated by NCLB, which allowed the federal government to begin issuing other options, changes, and exemptions to NCLB. State schools have been the conduit of the federal policies and regulations of NCLB, but have had a limited role in fully helping their own school districts (Childs & Russell, 2017).

Race to the Top. In 2009, the USDOE along with President Barrack Obama and his administration signed a $4.35 billion educational initiative called Race to the Top (RTTT). RTTT was part of the American Recovery and Reinvestment Act of 2009 (ARRA), which was a federal attempt not only to stimulate the economy and support job creation, but also to invest in the education sector (USDOE, 2009). The significant difference between the NCLB and the RTTT educational plans was that NCLB was an educational mandate whereas RTTT was only a voluntary incentive program for states to seek extra federal grants in conjunction with NCLB. “Race to the Top was designed to identify states with compelling ideas and viable plans for improving their educational systems, fund them, learn from them, and share their lessons widely” (Weiss & Hess, 2016, pp. 51-52). RTTT essentially used the educational accountability program, as did NCLB, by using the students’ testing results for not only school accountability, but additionally making it more personal and applying the accountability to the teachers and principals (Wong, Wong, & Martin, 2017). This educational reformation and incentive program rewards states that demonstrate positive growth of achievement scores and models the program for other states to follow. RTTT is a competitive grant looking for schools to

> achieve significant improvement in student outcomes, including making substantial gains in student achievement, closing achievement gaps, improving high school graduation rates, and ensuring student preparation for success in college and careers; and implementing ambitious plans in four core education reform areas. (USDOE, 2009, p. 2)

The four core educational areas are adopting standards and assessments, building data systems measuring student growth which could influence future educational choices, recruiting along with retaining the most effective teachers, and making a definite change in the lowest-achieving schools (USDOE, 2009, 2016a).

A key component in RTTT, and a significant change from NCLB, was the core subject emphasis. In NCLB, the emphasis was in reading, mathematics, and science while the RTTT emphasis was science, technology, engineering, and mathematics (STEM) (USDOE, 2009). RTTT also challenged educators to reevaluate and recreate stronger assessments that allowed for higher-order skills and abstract thinking along with better communication. More specifically, 43 states along with the District of Columbia have higher standards and expectations for stronger assessments, and 38 states have revised the method of choosing an effective teacher, which includes measuring the achievement of a student (Weiss & Hess, 2016). The RTTT grant is issued if states agree to adopt or to develop standards combining the efforts and works of other combined common state standards. The educational reformation of RTTT provided an incentive program that empowered educators to reach for higher standards while reaching every student. The focus shifted from the federal level down to the state level, and even down to individual school districts. This shift allowed for more accountability and successful implementations to be shared with other states or localities (Weiss & Hess, 2016). Although states worked together on standards and assessments, an educational program was begun to develop a common set of standards that can be used in mathematics across the nation to have a unified curriculum. In 2010, most of the states had agreed upon the Common Core State Standards in Mathematics (CCSSM) that sought to improve the mathematics students' achievement gap in the United States (Khaligi, 2016; Venezia & Jaeger, 2013). Since the enactment of NCLB, the standards-based accountability educational system has shown some mathematics improvement on achievement scores, particularly in typical low-achieving groups (Dee & Jacob, 2010a; Khaligi, 2016; Macartney, 2016). The standards, set by the CCSSM, do not create or mandate the curriculum states are to choose, but are a guide for mathematical content describing student engagement (Khaligi, 2016). State educators need to consider implementing CCSSM since states adopting the standards or similar to the CCSSM have shown better results on prior NAEP assessments when compared to states that have not adopted the standards. Furthermore, CCSSM attempt to focus on preparing students for college readiness by boosting the rigors of the mathematics content through increased critical thinking skills training, and by allowing for synthesis and accuracy of the mathematics concepts (Schmidt, Houang & Shakrani, 2009; Venezia & Jaeger, 2013).

The RTTT incentive program was just a start for the Obama administration to make changes to the educational policies of NCLB. One such change was signed into law on March 13, 2010 and was the blueprint for revising the ESEA. The blueprint continues to build from the changes of RTTT in the areas of improving educator effectiveness, improving better communication to families, improving student learning and achievement in the lowest performing areas, and implementing college-and-career standards (USDOE, 2010). The blueprint empowers educators and differs from NCLB in that NCLB focused on tests, sanctions for not meeting the goals, and narrowing of the curriculum, namely only mathematics, reading, and science, whereas the blueprint raised the assessment standards that were geared toward college and careers, allowed for a more rounded curriculum, and emphasized educator collaboration toward common goals (USDOE, 2011). President Barack Obama, in his opening letter in "A Blueprint for Reform," stated that over 10 countries have surpassed the United States in college completion rates. As a result, the President set a goal for the country to be a world leader in this area by the year 2020. The foundation of the blueprint was to help students not only graduate from high school, but also to be well prepared for a successful completion of college or a career (USDOE, 2010). The blueprint seeks to change significant aspects of NCLB, which can be generalized by Figure 2, such as all students being proficient in mathematics by 2014 and having high school graduates being prepared for post-high school education or training. More specifically, a main focus of the new role for the federal government with the blueprint is to prepare students to be better prepared for training into a future career or ready to successfully enter a postsecondary educational path regardless of prior training, ethnicity, language, race, or disability status. The preparation for training the students to this high expectation is for states to adopt or to develop higher standards so that students leaving secondary education are well prepared and do not need to take remedial coursework when entering into the postsecondary institutions (Price, 2016; USDOE, 2010).

No Child Left Behind	Blueprint for Reform
All students must be proficient in mathematics and reading by 2014	All high school graduates must be ready for college or ready for a career by 2020
Focus is on proficiency tests and narrow curriculum of primarily mathematics, reading, and science	Focus is on student progress or growth with a more broad curriculum such as literacy, science, technology, engineering, and mathematics
Consequences or more requirements for not meeting standards or proficiency scores	Incentives for academically growing schools, especially in past low achieving schools
Individual state standards	Create or develop new standards in conjunction with other states
Yearly progress reports for all schools	Focus is on the lowest 5% performing schools
Accountability for schools is based on student achievement scores	Accountability for teachers is based on performance of students from state to state

Figure 2. General differences of NCLB and the Blueprint for Reform (Berry & Herrington, 2011; Dee & Jacob, 2010b; USDOE, 2010).

Even though RTTT and the Blueprint for Reform were not directly an educational policy or reformation that made a drastic change as the NCLB educational policy did, they did adjust the state and school requirements and somewhat shifted the focus of NCLB as illustrated in Figure 2. These incremental changes increased the federal role in education and set the educational platform for the next policy change.

Every Student Succeeds Act. In 2015, the NCLB educational program was replaced by the Every Student Succeeds Act (ESSA), which empowers states with the implementation of testing and lowers the federal mandated testing requirements (Deming & Figlio, 2016; Editorial Projects in Education Research Center, 2016). A major background component of the ESSA is that the role of the federal government in education is more focused on the states. The ESSA educational plan focuses on the low achieving schools and allows school districts to not only reach all students but also to refocus on a commitment by ESEA, written into law over 50 years ago, and to provide equal opportunity for all students. The statement of purpose for the ESSA states it is to provide a high-quality education for all children and to assist educators in closing the achievement gaps (USDOE, 2016a). More specifically,

> the passage of the Every Student Succeeds Act (ESSA) in December 2015 does not really resolve the impasse over the nature of educational reform and governance in the United States; it simply shifts the debate away from the federal level and back to the states. (Nelson, 2016, p. 369)

Moreover, ESSA is a major educational reformation that replaces NCLB. However, ESSA still requires states to provide plans to show support for the lowest five percent performing schools in the state along with plans to improve schools that do not graduate one-third or more of their students. Although schools have latitude in the manner in which the improvement plans may be implemented, schools must use evidence-based interventions that demonstrate the results of the plans from year to year (Straus & Miller, 2016; USDOE, 2017). With the liberty given to the states for implementing improvement plans in the school systems, opportunities were also given to states for defining and setting up proficiency levels. Unfortunately, the differences between states setting individual proficiency levels creates possible uneven proficiency ratings since some states set state standards at a high level while others set their state standards based on minimum proficiency levels. The ESSA educational legislation attempts to outline a common set of standards that encourage state educators' collaboration with other state educators in the creation and adoption of a common set of standards. This process will not only help to unify the set of mathematics curricular standards, but also to allow for future state proficiency test results to be more equally balanced (Khaligi, 2016; Mintrop & Sunderman, 2009; Peterson & Hess, 2013).

College Scorecard. From ESEA, to Nation at Risk, to NCLB, to RTTT, to the Blueprint for Reform, to ESSA, each of the federal mandated educational reformations primarily revolved around K-12 education. President Obama attempted in 2013 to take an accountability educational program to higher education institutions to rate colleges based on access, affordability, and eventual student outcomes. Although the initial plan did not succeed, eventually the College Scorecard was created in an attempt to standardize information concerning graduation rates, post-graduation earnings, and the annual costs associated with higher educational facilities. By looking at an overall view of each of the educational reformations of accountability for K-12 schools and the success and failures as a whole, it is clear that accountability in the field of education has positive results (Dee & Jacob, 2011; Deming & Figlio, 2016). In 1970, almost $6,000 per student per year was being spent with totals climbing to $12,008 in the year 2000 and to over $13,000 by 2013. Mathematics scores during this time period, according to the NAEP, had risen slightly and specifically more so since the signing of the NCLB educational legislation (Deming & Figlio, 2016). Furthermore, in the same time period since the signing of NCLB, graduation rates for high school seniors had risen more than 10% compared to the prior three decades (Murnane, 2013). These educational trends in K-12 are an improvement which could make a significant difference in the years to follow as students seek to further their education in post-high school institutions. Even though there are positive statistics to consider, there are also academic setbacks and struggles that students are facing not only in the K-12 educational system, but also as students prepare, enter, and work through the academic struggles in college. An example of this is although the high school dropout rate is decreasing with over 80% of students graduating, only about two-thirds of the high school graduates go further and seek a post-high school education (Balfanz et., 2014; Fry & Taylor, 2013; Tierney & Garcia, 2011). Although the recent Blueprint for Reform and ESSA educational programs attempt to support and promote an educational culture of college or career readiness, many of the high school students entering into a two- or four-year postsecondary educational facility may be unprepared for a successful transition which could lead to students taking remedial courses to fill the gap.

Decades of governmental interventions in the educational realm may have affected the policies of equal education for all students along with mandating higher assessment scores with an attempt to better prepare students. However, the problem of high school students arriving on secondary educational campuses without the necessary skills to successfully complete the required college level work still exists. Moreover, because students entering into college may be underprepared for the academic rigor needed at the college level, colleges have created remedial courses, primarily referred to as developmental courses, which help students learn or review the needed information (Benken et al., 2015). More specifically, college developmental mathematics courses are a major concern since 60% of students entering college must enroll into the course (Bahr, 2013; Crisp & Delgado, 2014; Davis & Palmer, 2010; Howard & Whitaker, 2011; Melguizo et al., 2014; Silva & White, 2013; Sprute & Beilock, 2016; USDOE, 2010; Venezia & Jaeger, 2013).

College Developmental Mathematics

Some students entering into college may not be prepared for the academic work that lies ahead in order to be successful to complete the college program. The NAEP, which helps determine the mathematics achievement level of a student from knowing basic, proficient, or advanced subject material and how it applies to real-world scenarios, reported for 2009 that only 26% of high school seniors performed at the level of proficient in the area of mathematics (Venezia & Jaeger, 2013). Furthermore, the SAT and the American College Testing (ACT) are both standardized assessments assessing the college readiness of a potential college student. Only about 46% of high school juniors and seniors in 2012 taking the SAT or the ACT met the mathematics benchmark of the likelihood of being successful of obtaining a letter grade of a B or better in mathematics at the college level (Venezia & Jaeger, 2013). Thousands of high school graduates each year must enroll in a developmental mathematics class simply because their performance level when leaving twelfth grade and entering college is below what is expected for mathematics (Foshee et al., 2016; Tierney & Garcia, 2011). High school graduates pursuing a higher education may need to take extra courses, namely developmental courses which are below the required courses for the degree being pursued, to help develop the necessary skills required at the collegiate level.

College developmental mathematics courses were created for students scoring below the needed level on high-stakes placement exams in order to better prepare the student with knowledge and skills needed in the required degree being pursued (Benken et al., 2015; Davis & Palmer, 2010; Tierney & Garcia, 2011). Developmental courses provide academic support and tutoring as well as help students improve academic weaknesses (Davis & Palmer, 2010). Although there is research suggesting developmental courses have no positive impact on a student's academic achievement (Brewer, 2009), the overwhelming research does show an increase in the likelihood of course completion along with degree attainment (Ariovich & Walker, 2014; Bahr, 2008, 2013; Krupa, Webel, & McManus, 2015; Twigg, 2005). In fact, a study conducted in Florida, where students are no longer required to take developmental math courses even if their entrance test is low, has shown a sharp increase of 20% in failure rates among students taking math courses simply because students are not prepared (Pain, 2016).

These developmental courses offered at the postsecondary education have been in education since the colonial period but became more widespread in the 18th and 19th centuries (Arendale, 2011). Many of the courses in the past used the term remediation instead of the term developmental. The term developmental, which implies an ongoing learning process, is being more widely used since many believe the term remedial has a negative connotation associated with having a deficit (Davis & Palmer, 2010; Kurlaender & Howell, 2012; Tierney & Garcia, 2011). In the 1960s, the Civil Rights Act of 1964, the Higher Education Act of 1965, and Elementary and Secondary Education Act of 1965 gave equal educational opportunities to students seeking to achieve a higher education. These new federal policies gave a surge to student enrollment in developmental programs at the postsecondary educational institutions since many of the incoming students did not have the needed academic skills in all subjects at the collegiate level (Davis & Palmer, 2010). The knowledge and academic skills gathered in high school have been shown to be one of the best predictors of the successful completion of a college degree or performance toward a degree (Adelman, 1999; Geiser, Santelices, & University of California, 2007; Kurlaender & Howell, 2012; Radunzel, Noble, & ACT, 2013; Westrick, Le, Robbins, Radunzel, & Schmidt, 2015).

Despite the efforts of educators and the federal policies aimed toward education, approximately 60% of freshman are not prepared for the required level of collegiate mathematics, so they must enroll in a developmental mathematics course that will help prepare the college students for the required college mathematics courses (Bahr, 2013; Crisp & Delgado, 2014; Davis & Palmer, 2010; Howard & Whitaker, 2011; Melguizo et al., 2014; Silva & White, 2013; Sprute & Beilock, 2016; USDOE, 2010; Venezia & Jaeger, 2013). Furthermore, almost 80% of students enrolled in a remedial course at the postsecondary education level were surprised to know of the suggested prerequisite remedial courses since these students received a high school GPA of 3.0 or higher (Tierney & Garcia, 2011). Furthermore, Winerip (2011) reported students entering college and taking the college placement tests felt unprepared for the college placement test. This unpreparedness could stem from several reasons, such as differences in high school level course content, students' socioeconomic background, peer and parental influences, and academic preparation (Venezia & Jaeger, 2013). This educational situation may lead lawmakers and educators to further contemplate teaching and testing techniques to address these concerns.

Studies show if a student successfully completes the needed developmental programs, the student is more likely to have a higher rate of retention and successfully complete college (Attewell, Lavin, Domina, & Levey, 2006; Bahr, 2013; Davis & Palmer, 2010; Ulmer, Means, Cawthon, & Kristensen, 2016). Since most developmental courses offered at a college do not normally count for credits toward the degree, students could be enrolled in college for a longer period when compared to students not taking college developmental course. Of these students enrolling in developmental mathematics courses, only about a third pass the course on the first time (Crisp & Delgado, 2014; Gabbard & Mupinga, 2013; Hersh & Merrow, 2005; Koch et al., 2012; Pascal, 2011; Rask, 2010; Silva & White, 2013). Moreover, approximately 44% of students enrolled in some type of developmental course never complete their degree (Bailey et al., 2010; Benken et al., 2015; Chen, 2016; Fong et al., 2015; Melguizo et al., 2014). Although the struggles of collegiate mathematics are primarily attributed to struggles in mathematics at an earlier age, the negative attitudes toward mathematics typically carries from year to year (Howard & Whitaker, 2011). It is important for educators, specifically mathematics educators, to look for ways to help students struggling in mathematics. Furthermore, mathematics educators need to find ways to motivate students to succeed in mathematics since motivation plays a significant role in a student's achievement (Hemmings, Grootenboer, & Kay, 2011).

Moreover, the successful achievement of a student in mathematics has been indicated to be an indicator of predicting the success of a student in college (Foshee et al., 2016; Lee, 2012).

A student who struggled in mathematics at the high school level may again have trouble in mathematics at the collegiate level as well (Gningue et al., 2014), specifically if the delivery method of instruction is the same. Since the traditional direct instruction of mathematics is often the method of delivery in high schools, many colleges and universities have established a math emporium model of instruction for learning mathematics.

Math emporium. A math emporium is defined as an institution's computer lab that diminishes or eliminates lectures and uses interactive computer software along with teacher or tutorial assistance (Twigg, 2011). The emporium-learning model using computer-based instruction was first introduced in a STEM high school and then developed by Virginia Tech in 1999. The model is focused on active learning by students while using technology to work toward mastering the mathematics concepts that result in longer retention of the content knowledge (Twigg, 2011; Wilder & Berry, 2016). The computer-based instruction uses software, such as Pearson's MyMathLab, Enable Math, or ALEKS, that models the typical classroom while assessing students with learning from homework, quizzes, and tests (Epper & Baker, 2009; Taylor, 2008; Webel et al., 2016). Although each college mathematics emporium may be structured differently, the rows or pods of computer stations are set up for easy access to the students. In addition, typically there may also be smaller conference or tutoring rooms set up in the mathematics emporium for instructors or tutors to meet with the students. In the emporium model, students work through the learning material at their own pace while using computer-based instruction. They receive instant feedback during the learning process of completing homework, while also having access to mathematics instructors and trained peer tutors to assist the students with any difficult concepts (Epper & Baker, 2009; The National Center for Academic Transformation, 2005; Twigg, 2011; Webel et al., 2016).

According to the National Center for Academic Transformation (NCAT, 2005), there are eight key components that are the base of a successful math emporium. These eight components are establishing a greater course consistency when redesigning the course, requiring frequent active learning from the students while practicing and reinforcing the concepts, holding class instruction and assessments in a computer lab or classroom while using computer-based instruction software, building on the prompt feedback of homework and assessments, providing students with more individualized interaction with faculty and trained tutors, ensuring sufficient time is built into the learning process of each lesson, monitoring and assisting student progress, and continually measuring student learning and completion. Furthermore, in 2013, NCAT added two additional elements for having a successful model: to modularize the course materials along with the course structure and to require mastery learning (NCAT, 2013).

The math emporium-learning model is becoming more prominent in the learning process of undergraduate mathematics courses across the United States at postsecondary institutions (Bahr, 2008; Webel, Krupa, & McManus, 2015, 2016). Research suggests nearly 70% of students learn mathematics better when the use of technology is used in the learning process when compared to the traditional direct instruction of lecture (Eyyam & Yaratan, 2014; House & Telese, 2012; Itler, 2009; Taylor, 2008). Learning through the use of technology, specifically computers, allows students to learn using different types of media such as images, videos, and sound which can attribute to a higher interest in learning and increased kinesthetic activity (Allsopp, McHatton, & Farmer, 2010; Brill & Galloway, 2007; Edwards, 2008; Mitchem et al., 2009). In contrast to traditional passive learning in a lecture setting, the math emporium model increases student-teacher interaction since approximately 75% of student learning takes place in the emporium where students are actively learning while completing assignments (Bartscherer, 2010; Webel et al., 2015, 2016). Students that are passively learning when compared to actively learning tend to be less motivated (Zakaria, Solfitri, Daud, & Abidin, 2013).

Furthermore, a study conducted in a mid-sized university located on the east coast compared computer-based instruction in a math emporium setting to the traditional lecture method of instruction (Krupa et al., 2015). In the study, half of the students enrolled in the traditional lecture method while the other half enrolled in the computer-based instruction in the math emporium setting using the MyMathLab software. The results of the study showed higher test results along with an overall higher final exam rate. One additional finding of the study reported students scored higher in the computer-based instruction if the student's SAT score was higher. Likewise, in a recent study comparing instructional methods of the math emporium and the traditional lecture method revealed the emporium-enrolled students outperformed the traditional method of instruction irrespective of the gender, high school GPA, SAT score, and ACT score (Cousins-Cooper, Staley, Kim, & Luke, 2017).

The math emporium model's success can be attributed to several factors, one of which is much of the required class time is utilized by students actively working on mathematics compared to the student just listening to a lecture. Furthermore, concepts already known by students go faster, students receive assistance when mathematical concepts become difficult, more personal teacher-student interaction, immediate feedback on homework and assessments, and students have required attendance are other factors attributed to the math emporium's success (Twigg, 2011; Webel et al., 2015, 2016). In addition, since implementing the math emporium setting, there has been an average increase of 51% of college students in developmental mathematics classes completing the course (Twigg, 2011). This is a significant amount of students in helping the students toward not only success in developmental mathematics courses, but also success toward the pursuit of a degree. The use of computers when learning mathematics has shown to be successful toward college developmental mathematics achievement scores, student confidence levels, class attendance, and retention rates (Asante, 2012; Butler & Butler, 2011; Gninque et al., 2014; Twigg, 2011; Wilder & Berry, 2016). Specifically, the use of technology in mathematics can help reduce mathematical errors as much as 75%, increase problem-solving techniques, increase attention of students, and increase student motivation and attitude towards mathematics (Celik & Yesilyurt, 2013; Hegedus et al., 2015; Nielson, 2013; Wadlington & Wadlington, 2008). The instructional delivery method implementing technology allows students to use familiarity in the learning process (Bausch, Ault, Evmenova, & Behrmann, 2008). Despite the positive results of computer-aided instruction in the math emporium, there is research that suggests the learning environment is not for every student. Specifically, a qualitative study discovered many students may have liked the overall outcome of the computer-aided class, but some of the students would prefer the direct instruction from the professor instead of the instructional delivery given by the computer (Ariovich & Walker, 2014).

Mathematics Anxiety

Although the math emporium has its strengths, there may also be hindrances for educators to consider. Since mathematics anxiety is defined as negative thoughts and avoidance behaviors when solving mathematics problems (Andrews & Brown, 2015), some students enrolled in developmental mathematics courses struggle in mathematics because of the anxiety associated with doing mathematics. The anxiety toward mathematics that a student may experience may slow or hinder the student's progression toward a degree (Beilock & Willingham, 2014; Perry, 2004; Sprute & Beilock, 2016). In general, academic anxiety affects the emotions of a student, which in turn can influence cognitive performance, psychological well-being, and physical health (Pekrun, Goetz, Titz, & Perry, 2002). Pekrun and his colleagues (2002), in their qualitative study of college students, discovered anxiety was the most frequent emotional experience reported. Furthermore, when the student perceives possible failure, anxiety is triggered (Pekrun et al., 2002). The researchers stated academic anxiety may initially reduce intrinsic motivation for students, but some students may manage with the anxiety and produce actions that may be academically profitable. Essentially, for some students, anxiety can be an extrinsic motivator to perform stronger academically, whereas with other students the anxiety can negatively hinder to the point of becoming a handicap. This academic anxiety, specifically mathematics anxiety, is the focal point of this study.

Learning mathematics for some at the collegiate level may be difficult since approximately 20% of students suffer with a high level of math anxiety (Ashcraft & Kirk, 2001). Students who struggle with mathematics anxiety attempting computations or learning new concepts tend to worry about the process of the problem and with completing it accurately (Maloney & Beilock, 2012). These worries students develop can be distracting to the necessary cognitive tasks associated with mathematical tasks (Ashcroft & Krause, 2007). Students having anxiety while doing mathematics typically will have low achievement in mathematics as well, along with avoidance tendencies (Andrews & Brown, 2015; Beilock & Willingham, 2014; Eden et al., 2013; Hembree, 1990; Maloney & Beilock, 2012; Perry, 2004; Sprute & Beilock, 2016). The low achievement in mathematics, especially at the collegiate level, can be problematic as students are in pursuit of a degree. Overall, the mathematics struggle can be a deterrent for college success. With approximately 60% of college freshman in need of a developmental mathematics course to help prepare the student for the required mathematics course, the need is great to assist students in their mathematical struggles (Bahr, 2013; Howard & Whitaker, 2011; Silva & White, 2013; Sprute & Beilock, 2016). Mathematics anxiety has been shown to have a negative effect on assessment performance and attitudes toward mathematics (Hembree, 1990; Jameson & Fusco, 2014). In contrast, Taylor (2008) reported lower math anxiety levels among students during the time the students were using computer-based instruction in a math emporium setting.

In particular, Hembree's (1990) meta-analysis study reported slightly higher mathematics anxiety levels among females than males. Hembree asserted a possible reason for higher mathematics anxiety levels from females could be simply because females are more willing to report anxiety than males. Furthermore, male students with mathematics anxiety showed higher levels of avoidance in the assigned class work or in class attendance when compared to female students with mathematics anxiety. Hembree also suggested a possible explanation for this difference is that females may cope with mathematics anxiety or with anxiety in general better than males. In addition, students that performed academically higher showed less mathematics anxiety. Furthermore, Hembree reported a negative correlation between mathematics anxiety and the mathematical performance of a student. The study, which included students from K-12 and postsecondary students, used a combination of frequent desensitization and anxiety management training which yielded the greatest mathematics anxiety reduction rates.

Similarly, Sprute and Beilock (2016) in a recent meta-analysis study with over 3,000 students enrolled in college developmental math courses reported that students with higher math anxiety ended the course with lower final grades, and this finding was primarily true for female students. In this study, the anxiety was measured by performing the AMAS with an average anxiety score ranging from 2.2 to 3.3 on a five-point scale for four-year universities. The study also suggested students who frequently reappraised their anxiety, specifically those students with higher math anxiety, could result in a lower level of math anxiety.

Another recent study of 180 college students enrolled in a developmental math course by Andrews and Brown (2015) compared math anxiety, standardized tests scores, math placement scores, and the academic success of the math course. The AMAS was administered to the students in this study before classes began in the freshman orientation meeting and was used to measure the student's level of pre-course math anxiety. Andrews and Brown recognized some students may perform higher with increased anxiety levels, but this finding was not true for most students with higher levels of math anxiety. One of the biggest findings from the study revealed students had a higher level of math anxiety during a math assessment when compared to simply math instruction.

Mathematics performance can be affected by several variables. However, studies that evaluate math anxiety often do not take into account all possible constructs. In particular, testing for math anxiety in students could receive mixed data merely with the construct of test anxiety. Devine, Fawcett, Szucs, and Dowker (2012) in their study toward relating math performance to math anxiety took into account the variable of test anxiety. With 433 British secondary students participating in the study using the AMAS to measure levels of math anxiety, and taking into account test anxiety as a possible construct, the study revealed similar results in gender showing females having slightly higher math anxiety levels than males. Despite the higher levels of math anxiety reported by the females, math performance amongst both genders was equal. Devine and her colleagues suggested as a possible reason of having equal math performance by both genders despite the higher self-reported math anxiety of females is females may have the potential to outperform males in mathematics if it was not for the construct of math anxiety.

Although gender may play a role in self-reported mathematics anxiety, self-efficacy beliefs toward mathematics computation, or mathematics in general, also may play a role toward not only mathematics anxiety but also a student's performance in mathematics (Bandura & Locke, 2003; Eden et al., 2013; Jain & Dowson, 2009). These studies confirm Bandura's theory of self-efficacy asserting a change of performance or behavior because of the low self-efficacy beliefs, specifically toward mathematics anxiety (Bandura, 1977, 1986, 1997, 2001). Students struggling with mathematics anxiety often are in a cyclic motion toward mathematics. Since mathematics anxiety can cause poor performance in mathematics which could lead toward mathematics avoidance and more negative self-beliefs toward mathematics, this situation in turn could create more mathematics anxiety (Ashcraft & Kirk, 2001; Ashcraft & Krause, 2007; Cipora et al., 2015; Hembree, 1990; Jain & Dowson, 2009; Jameson & Fusco, 2014; Ma, 1999; Maloney & Beilock, 2012; Peker, 2016; Wu, Barth, Amin, Malcarne, & Menon, 2012).

Daughtery, Ruskinko, and Griggs (2013) in their study confirmed the self-belief of the student toward the performance in a mathematics course revealed a high correlation to the actual outcome of the course. In their study of 437 college students enrolled in an introductory mathematics course, students were given a self-reported mathematics anxiety test on the first day of class to help predict the students' success in the course. The students' math section of the SAT was used, which has been shown to be a moderate predictor of a successful performance in college mathematics courses (Atkinson & Geiser, 2009), along with the mathematics anxiety test in an attempt to accurately predict students' outcome in a college level mathematics course. The results indicated students who considered themselves likely to fail the course were more apt to end the course with a failing grade. The study resulted in a 72% accuracy rate of predicting at risk students for the mathematics course. The study also showed students with moderate or high anxiety levels toward mathematics who believed extra tutoring, homework, or extra assistance in some manner resulted with a higher success rate in passing the course.

In a cross cultural study with 250,000 participants across 41 countries, Lee (2009) investigated the closely related constructs of math self-concept, math self-efficacy, and math anxiety in an attempt to discover their distinctiveness. Lee discovered the three constructs of math self-concept, math self-efficacy, and math anxiety are indeed three different constructs and each construct can play a role in a student's performance in a mathematics course. According to Lee, math self-concept is the personal perception of how others may perceive oneself regarding math, whereas math self-efficacy is the personal perception of the math capabilities of oneself. The study also found that Asian students, who typically consider academics more seriously with stricter standards, scored high with math anxiety while scoring low in both math self-concept and math self-efficacy. The United States was reported in the middle of the countries with math anxiety, high with math self-efficacy, while scoring the highest of the countries with math self-concept. Lastly, Lee also found within the 41 countries, math anxiety showed the strongest relationship to math performance when compared to the other constructs.

Another common variable that may contribute toward a student's math anxiety is the age of the student. Math anxiety has been studied and reported as early as with first and second graders. Ramirez, Gunderson, Levine, and Beilock (2013) studied 154 first and second graders and found that math achievement is affected by the level of math anxiety even in the early grades. Using the Child Math Anxiety Questionnaire, students reported being nervous when completing math related problems. The report also found the relationship between math anxiety and math performance was not evident in all children in the study. Furthermore, Ramirez and his colleagues reported math anxiety could interfere with short-term and even long-term memory from even remembering basic facts. Confirmation of math anxiety beginning at an early age and effecting math assessment was also conducted in another study with second and third graders (Wu et al., 2012). In this particular study, the researchers showed a significant negative correlation between math anxiety and math performance. Even more so, the study revealed students having math anxiety would have more difficulty with math problems dealing with reasoning skills and problem solving compared to just computational skills.

Even though many mathematics anxiety studies are quantitative, some studies help shed a different perspective and a more in-depth look into possible correlations and common themes of the participants dealing with mathematics anxiety. One qualitative study in particular studied the roots of mathematics anxiety through the experiences of college students, specifically with pre-service elementary teachers. Through the interviews of the five participants, common themes appeared. These similarities of the participants' background included negative classroom experiences and specifically in a mathematics classroom, minimal family support, mathematics testing anxiety, and fears of teaching mathematics (Trujillo & Hadfield, 1999). Trujillo and Hadfield (1999) and confirmed with other studies (Jackson & Leffingwell, 1999; Jain & Dowson, 2009; Sloan, 2010; Sprute & Beilock, 2016; Woodard, 2004; Wu et al., 2012), reported an instructor's disposition, attitude, and methodologies, specifically in a student's early years of education, along with self-regulation methods can help minimize a student's mathematics anxiety.

Mathematics anxiety beginning in the early years can be more problematic and more pronounced for the students in later mathematics classes. There are many studies involving math anxiety and other constructs in the upper elementary, middle school, and high school years (Alkan, 2013; Beilock & Willingham, 2014; Hsi-Chi et al., 2010; Jackson & Leffingwell, 1999; Maloney & Beilock, 2012; Ramirez et al., 2013; Wigfield & Eccles, 2000; Wigfield & Meece, 1988). Likewise, students having math anxiety in these early years will most likely still have similar fears and habits in postsecondary education when enrolled in a mathematics course (Andrews & Brown, 2015; Ashcraft & Krause, 2007; Bessant, 1995; Benken et al., 2015; Cordes, 2014; Daughtery et al., 2013; Davis & Palmer, 2010; Fong et al., 2017; Geiser et al., 2007; Hembree, 1990; Jameson & Fusco, 2014; Sevindir et al., 2014; Wu et al., 2012). Furthermore, recognizing and dealing with a student's mathematics anxiety becomes increasingly important since research has shown mathematics anxiety can become more pronounced with higher levels of mathematics, in particular with middle school students and older (Ashcraft & Krause, 2007; Betz, 1978; Daughtery et al., 2013; Jackson & Leffingwell, 1999; Jain & Dowson, 2009; Woodard, 2004).

The literature regarding mathematics anxiety has primarily been quantitative dealing with constructs such as academic achievement, gender, age, and self-efficacy (Bahr, 2013; Bessant, 1995; Betz, 1978; Jackson & Leffingwell, 1999; Lyons & Beilock, 2012; Malik, 2015; Mutodi & Ngirande, 2014; Perry, 2004; Sevindir et al., 2014; Sprute & Beilock, 2016). With all of the different constructs concerning mathematics anxiety, it is important for educators to consider student-learning patterns, to investigate affective learning environments, and pedagogical techniques to help explain the many facets of mathematics anxiety (Bessant, 1995). This is especially relevant since mathematics anxiety is related to a person's belief in performing mathematics (Jain & Dowson, 2009; Peker, 2016).

Computer Anxiety

In the math emporium setting, students use computers to go through the mathematics lessons. Using technology, specifically computers, for learning may be problematic for students struggling with computer anxiety since 25%-50% of students struggle with some level of computer anxiety (Chua et al., 1999; Crabbe, 2016; Rahardjo & Juneman, 2013). When students have computer anxiety, there is a higher tendency to procrasitinate on assignments that require the use of a computer (Rahardjo & Juneman, 2013). In addition, computer anxiety could be linked to mathematics anxiety since computers are used in many mathematics courses (Lindbeck & Dambrot, 1986; Rosen & Maguire, 1990). In contrast, the use of computers can alleviate some fear and anxiety toward mathematics (Meagher, 2012). Furthermore, computer-based instruction has shown to help in improving learning outcomes and test results (De Witte, Haelermans, & Rogge, 2015; Webel et al., 2016).

Computer anxiety is defined as emotional fear or apprehension when using a computer (Chua et al., 1999). There are different levels of anxiety experienced from students ranging from frustration, to confusion, to anger, to anxiety, to avoidance, and to other physical or emotional reactions (Saade & Kira, 2009). The unpleasant emotions associated with anxiety, specifically computer anxiety, can lead to fear and to avoidance of the experience. Students experiencing computer anxiety also have a lower self-efficacy toward computers since the component of avoidance with the use of computers is there (Hsi-Chi et al., 2010). This finding is directly associated with Bandura's (1986, 2001) social cognitive theory where avoidance behaviors are prevalent when fears will be avoided if the person believes failure is inevitable. If the student believes the task on the computer is too overwhelming, then the tendency for the student might be to avoid the computer lab in the math emporium. Beckers, Wicherts, and Schmidt (2007) state the fear associated with computer anxiety for some students should be viewed as a potential affliction on the student. Moreover, students struggling with computer anxiety using computers in a learning environment with a social setting for academic reasons, such as the math emporium, may experience a mental and emotional disorder that leads students to reevaluate their own self-worth not only in the course subject, but also in their personal worldview (Beckers et al., 2007).

Computer anxiety has been studied for several decades, especially since computers have been incorporated into the educational field. One of the early studies on computer anxiety, with a sample of 356 participating students ranging from middle school through college, investigated math anxiety with the constructs of gender and computer anxiety (Gressard & Loyd, 1987). Since the students were learning mathematics with computers in this study, mathematics anxiety was measured using a modified version of the Mathematics Anxiety Scale while computer anxiety was measured through the Computer Anxiety Scale. The tests were conducted within each of the three age groups of middle school students, high school students, and college students, taking into account gender as a variable, and the results were then compared with each group. One of the findings of the study compared computer experience with computer attitudes. The study suggested the more computer experience a student had corresponded to the student having a more positive attitude toward the use of the computer, especially in an academic setting. In their study, Chua et al. (1999) agreed with Gressard and Loyd (1987) when suggesting computer anxiety decreases as exposure to computers increases. In contrast, Rosen & Maguire (1990) indicated the more computer experience does not help a student with computer anxiety, but in actuality it strengthens the negative emotions associated with computer avoidance. Furthermore, Beckers & Schmidt (2003) reported the amount of computer experience did not necessarily affect a person's level of computer anxiety, but the positive experiences of using the computer was the primary reason why computer anxiety was reduced. Results from the comparison of mathematics anxiety and computer anxiety in Gressard and Loyd's research showed students with more positive attitudes toward the use of the computer had lower anxiety toward mathematics. In addition, the variable of gender did not play any significant correlations in any of the three groups dealing with learning mathematics with the use of a computer. The researchers also suggested mathematics anxiety could be a factor with students having high computer anxiety and low computer confidence.

In a meta-analysis of 276 studies of computer anxiety covering the decade of 1990 to 2000, common variables associated or compared with computer anxiety were categorized, grouped, and summarized (Powell, 2013). Some of the most common constructs associated with computer anxiety in these studies consisted of gender, age, other anxieties, and education. From the 276 studies, gender had mixed results which depended on the age group being studied. In approximately two thirds of the studies involving only college students, there was no significant difference in computer anxiety between male and female college students. Whereas in other age groups such as children, college students, adults, and seniors there was a significant difference in computer anxiety among gender with females rating higher than males. With the construct of age, there were mixed results as well from the 276 studies. Some of the studies specifically looking at age as a construct showed there was a positive correlation between computer anxiety and age, whereas other studies showed results of a negative correlation or no correlation at all. Some of these studies included all age groups while some studies only used participants of a certain age group. When considering the construct of other anxieties relating to computer anxiety, computer anxiety showed positive correlations to math anxiety, trait anxiety, and state anxiety. The variable of a person's educational level compared to the level of computer anxiety was negatively related. In other words, the higher the education a person had, the less computer anxiety that person had as well.

In a recent study of 471 pre-service teachers, computer anxiety, computer self-efficacy, and the attitude toward technology were compared to help predict the attitude of the teacher-candidate toward computer supported education (Celik & Yesilyurt, 2013). Data from the pre-service teachers was collected by giving the participants the Technology Attitude Scale, the Perceived Computer Self-Efficacy Scale, the Computer Anxiety Scale, and The Attitude Scale toward Applying Computer Supported Education. One of the major findings from this study was the attitude of the person toward technology affects computer anxiety. The importance of this study could help predict the possible success of a student's education delivered or supplemented with the use of technology. Furthermore, the researchers Celik and Yesilyurt (2013) suggested students who may have computer anxiety should take measures to overcome the anxiety since technology is vastly incorporated in education and in many areas of employment.

Since technology can be used in many college courses and in many careers, it is important for students to overcome any computer anxiety. Shah, Hassan, and Embi (2011) conducted a study on computer anxiety for employees in commercial banks. Although previous research has shown a person's computer experience and computer attitude are strong predictors of computer anxiety (Beckers & Schmidt, 2003; Celik & Yesilyurt, 2013; Chua et al., 1999; Gressard & Loyd, 1987; Rosen & Maguire, 1990), the researchers wanted to apply similar tests concerning the usage of various computer applications in a non-academic setting. To test the 319 participants, the CARS was used to discover several things. First, even though 95% of the employees used various computer applications, 43% of the participants experienced low computer anxiety. The researchers suggested the high percentage could be a lack of experience, or lack of training on the computer applications could be causing the computer anxiety. Secondly, there were no significant differences of computer anxiety with respect to gender. Lastly, younger adults experienced higher computer anxiety when compared to older employees, which the lack of experience could be probable cause for the increased computer anxiety. The researchers suggested proper training, having a collaborative learning environment, promoting social interaction, and avoiding negative consequences will help minimize the level of computer anxiety.

In a sample of 155 participants including employees and students, Lee and Huang (2014) conducted a study to investigate the level of computer literacy effecting computer anxiety with analyzing the construct of gender. The study referenced the social cognitive theory, which states a person's behavior and motivation is affected by a combination of personal, cognitive, and environmental factors (Bandura, 1986). The researchers used gender as the variable since some previous studies have shown males to have more computer literacy and lower computer anxiety than females (Balogun & Olanrewaju, 2016; Brosnan, 1998; Chua et al., 1999; Erfanmanesh, 2016; He & Freeman, 2010), despite some studies showing no significant difference based on gender concerning computer anxiety (Cam, Yarar, Toraman, & Erdamar, 2016; Cazan et al., 2016). Moreover, much of the software and gaming industry have tailored the market to males, which would account for males having more computer-related skills and familiarity than females (Keisler, Sproull, & Eccles, 1985; Terlecki et al., 2011). Familiarity with the use of computers implies a higher literacy level with the use of computers, in which males have been shown to have higher computer literacy than females (Ikolo & Okiy, 2012; Lee & Huang, 2014). Recent research to the contrary shows there are no significant differences between genders with computer literacy (Demirel & Akkoyunlu, 2017; Li & Lee, 2016). Lee and Huang (2014) confirmed He and Freeman’s (2010) study having results show the positive relationships between gender, computer anxiety, and computer self-efficacy. Furthermore, research by Beckers and Schmidt (2001), and now confirmed by Lee and Huang (2014), have shown increasing computer literacy can decrease levels of computer anxiety, which is especially true for females.

Students struggling with computer anxiety can have issues with a mathematics course even if the student does not typically struggle in mathematics. The research indicates computer self-efficacy and computer anxiety are directly correlated to each other (His-Chi et al., 2010). Like the literature on mathematics anxiety, the literature regarding computer anxiety has primarily been quantitative, dealing with constructs such as age, gender, computer experience, and computer self-efficacy (Chien, 2008; Chua et al., 1999; Hismanoglu, 2011; Lee & Huang, 2014; Powell, 2013; Tuncer et al., 2013).

Gaps

The literature regarding mathematics anxiety has primarily been quantitative dealing with constructs such as academic achievement, gender, age, and self-efficacy (Bahr, 2013; Bessant, 1995; Betz, 1978; Jackson & Leffingwell, 1999; Lyons & Beilock, 2012; Malik, 2015; Mutodi & Ngirande, 2014; Perry, 2004; Sevindir et al., 2014). Likewise, the literature regarding computer anxiety has primarily been quantitative dealing with constructs such as age, gender, computer experience, and computer self-efficacy (Chien, 2008; Chua et al., 1999; Lee & Huang, 2014; Powell, 2013; Tuncer et al., 2013). At this point, there are no qualitative studies investigating college students in developmental mathematics classes who struggle with both mathematics anxiety and computer anxiety. Future research has been identified as being needed in this area of study, especially in a qualitative manner (Alkan, 2013; Andrews & Brown, 2015; Betz, 1978;

Cazan et al., 2016; Chua et al., 1999; Malik, 2015; Pekrun et al., 2002; Powell, 2013; Webel et al., 2016). Therefore, the study will provide insight into the experiences of college students in developmental mathematics classes who struggle with both mathematics anxiety and computer anxiety.

Summary

Developmental mathematics courses have the highest failure rates of all college courses (Pascal, 2011; Rask, 2010). Furthermore, the success of a developmental mathematics course is a predictor of student retention (Parker, 2005; Wilder & Berry, 2016). The math emporium model is one pedagogical method that has significant data demonstrating student success in developmental mathematics. Furthermore, educators must also help identify those students in developmental mathematics classes struggling with mathematics anxiety and computer anxiety so those students succeed as well. If the student believes the task on the computer is too overwhelming, then the tendency for the student might be to avoid the computer lab in the math emporium. Students struggling with computer anxiety can have issues with a mathematics course even if students do not typically struggle in mathematics. Furthermore, computer anxiety may help predict the success of a student's academic success in the course (Saade & Kira, 2009). Likewise, there is a negative correlation between mathematics anxiety and mathematics achievement (Betz, 1978; Woodard, 2004). Educators need to help students in developmental mathematics classes who struggle with mathematics anxiety and computer anxiety. There is a lack of research studying students in developmental mathematics classes who struggle with mathematics anxiety and computer anxiety. The students struggling with both mathematics anxiety and computer anxiety have not had their experiences voiced. In the next chapter, the methods to the qualitative study will be discussed.

CHAPTER THREE: METHODS

Overview

The primary purpose of this study was to describe the experiences of college students in developmental mathematics classes who struggle with mathematics anxiety and computer anxiety. The experiences of the participants were voiced in order to help future educators understand mathematics students who experience both mathematics anxiety and computer anxiety. The transcendental phenomenological qualitative design was chosen because it is inductive and provides an approach to understand the perspectives of the participants who share common experiences with mathematics anxiety and computer anxiety (Creswell, 2013; Moustakas, 1994). At this point, there are no qualitative or quantitative studies investigating the combined mathematics and computer anxieties of college students in developmental mathematics classes. The study is explained in the following sections of design, research questions, setting, participants, procedures, the researcher's role, data collection, data analysis, trustworthiness, and ethical considerations.

Design

A qualitative design was selected as the method to gain a better understanding through firsthand experiences of selected participants in a natural setting to capture the meanings of emerging themes (Creswell, 2013).

This qualitative transcendental phenomenological research design was used in the study to gather insights from developmental mathematics college students who struggle with mathematics anxiety and computer anxiety regarding their experiences while taking mathematics courses on a computer. A transcendental phenomenology study was conducted since the common experiences of the participants was explored to gather the essence of the lived experiences of students with both math anxiety and computer anxiety enrolled in a developmental math course (Moustakas, 1994). Specifically, transcendental studies focus more on the rich descriptions of the experiences of the participants and less on the possible biased interpretations of the researcher (Creswell, 2013). This transcendental approach allowed me to bracket myself out as one who does not experience neither mathematics nor computer anxiety. As a result, a deeper perspective toward the phenomenon of students experiencing both mathematics anxiety and computer anxiety was garnered.

Research Questions

The research questions were grounded in the social cognitive theory of Bandura (1977, 1986, 1997, 2001). These research questions were the foundation of obtaining a better understanding of the experiences of students in developmental mathematics classes that experience mathematics anxiety and computer anxiety. The research questions were:

RQ: What are the experiences of students enrolled in computer-based developmental mathematics courses who self-report both mathematics anxiety and computer anxiety?

SQ1: What experiences do students enrolled in computer-based developmental mathematics face when completing mathematics work?

SQ2: What experiences do students enrolled in computer-based developmental mathematics face when using the computer?

SQ3: What factors do students enrolled in computer-based developmental mathematics classes identify as assisting them in coping with their mathematics anxiety and computer anxiety?

Setting

This study was conducted on the campus of a Central Virginia university, a liberal arts university with over 14,500 residential students and having a 24:1 undergraduate student to professor ratio. Within this university population, 45% are male, 55% are female, nearly 54% live on campus, and approximately 46% are commuting students. The diverse population includes students from all 50 states and more than 85 countries.

The math emporium setting is a learning center for learning mathematics with computers. Residential students enrolled in mathematics courses that require the use of the math emporium have required class time in the emporium setting in addition to having access to work in the math emporium at the student's convenience. The math emporium is staffed by mathematics faculty and tutors to assist the students in the learning process as needed. Students attend one class of direct instruction a week but do approximately 75% of the learning of mathematics in the math emporium setting through interactive computer software (Bartscherer, 2010). Students can complete the mathematics assignments in the emporium or outside the emporium setting from a computer, but students are required to take all tests in the emporium setting. Students have the flexibility when to go to the math emporium to complete the weekly assignments, quizzes, or tests. Some of the advantages of the emporium model of completing mathematics courses compared to the traditional direct instruction from the professor are that students can spend the bulk of their time actually working on mathematics instead of just listening to someone talk about doing math, students spend less time on concepts that are mastered and more time on concepts they have not mastered, and finally students can get assistance when needed by faculty or tutors (Twigg, 2011).

Participants

Students entering into a Central Virginia university must have a placement score that is based on the SAT, the ACT, the high school GPA, and the Math and English Assessment tests. Based on this placement score, if students are in need of fundamental mathematics concepts before enrolling in the required mathematics course for the particular degree, then students are directed toward enrolling in developmental mathematics course(s). The participants were purposively selected since students in developmental mathematics classes are the base of the study. Students enrolled in the developmental mathematics courses were asked to complete an informed consent for possible participation in the study. Furthermore, along with giving the informed consent, students were given a questionnaire that gathered various demographic variables to help maximize variation and to assess possible correlations in the information provided by the participants. After the informed consent from the students, the students were asked to complete both the AMAS and the CARS at the beginning of the semester to determine the level of mathematics anxiety and computer anxiety in students in developmental mathematics classes. Students scoring with medium anxiety levels to high anxiety levels on both the AMAS and the CARS were selected as participants in the study. These 46 participants were contacted through email asking to participate in an interview. From the 46 qualifying participants, 12 students responded and agreed to participate in an open-ended semi-structured audio-recorded interview. The 12 participants and the experiences they gave were enough for thematic saturation (Francis et al., 2010; Moustakas, 1994; Polkinghorne, 1989).

Procedures

I secured Institutional Review Board (IRB) approval from a Central Virginia university (see Appendix I), and the consent of the developmental math emporium coordinator (see

Appendix H). Students located in a Central Virginia university were asked during the first week of the semester to complete an informed consent (see Appendix F), a list of various demographic questions (see Appendix B), the Abbreviated Mathematics Anxiety Scale (AMAS; see Appendix C), and the Computer Anxiety Rating Scale (CARS; Appendix D). The demographic questions included questions of age, gender, ethnicity, course enrolled in, and the number of times taking the course. Analyzing the results from the anxiety scales provided descriptive data of the participants identified as having anxiety in mathematics and in the use of computers. Furthermore, the possible participants with the medium anxiety levels to high anxiety levels in both mathematics and toward the use of computers were chosen to obtain a more selective sample for an interview. Polkinghorne (1989) recommends a phenomenological study have 5 to 25 participants, whereas Moustakas (1994) suggests 10 to 15 participants are needed. Furthermore, Francis et al. (2010) reported 12 interviews hold a robust sample of the saturated codes while conducting interview studies. In this study, there were 46 participants scoring high anxiety levels on both the AMAS and the CARS. These 46 participants were contacted through email and 12 of them agreed for an open-ended semi-structured audio-recorded interview.

From the 12 chosen students, a semi-structured open-ended audio-recorded interview with each participant was conducted. Semi-structured open-ended interviews of the participants were audio-recorded, transcribed, read, and reflected upon to identify significant similar statements by the participants. Themes were identified from the statements and the constructs were described in depth to gather the essence of the participants' common experiences. The participants' essence and experiences were voiced clearly without bias from the researcher (Moustakas, 1994).

The Researcher's Role

I have been teaching secondary mathematics for 24 years and college developmental mathematics for 6 years. I love teaching students mathematics at both the secondary and collegiate level, but helping students who struggle in mathematics, especially those that tend to get anxious, nervous, or somewhat distressed when doing mathematics is particularly a motivation of mine to assist these students. In the last decade, some students using computers, tablets, or other technology in mathematics class have gotten frustrated using the technology in the classroom, and have commented "why can't we just use paper and pencil?" Because of this, I have a passion for helping students struggling with both mathematics and technology. I want to understand these students' perspectives in a deeper manner to provide help to future students. My intent was to listen, record, and gather combined experiences and struggles from college students in developmental mathematics classes experiencing both mathematics anxiety and computer anxiety so that future educators will understand these students better with the end goal of helping these students.

In the study, I will be a human instrument describing the meanings of the phenomena shared by the participants (Denzin & Lincoln, 2003). I have been a tutor in the math emporium for several years and am familiar with the procedures and the learning process of the developmental mathematics courses. I did not collect any data from students that I assisted since I did not participate as a tutor in the math emporium during the data collection process.

Data Collection

Data was collected from several sources for data triangulation to occur in helping to establish credible findings. Data triangulation, using multiple sources of data to help produce a deeper understanding, in a qualitative study in a natural setting helped triangulate a more complete description and captured the true essence of the voices of the participants (Creswell, 2013; Denzin, 1978; Patton, 1999). Specifically, in this study, data collection began after IRB approval (see Appendix I) and after participants signed the informed consent forms. During the first week of the semester, data collection began by administering the AMAS, the CARS, and the demographics questionnaire to students in developmental mathematics classes (see Appendices B, C, and D). The instructors of the developmental mathematics classes sent a link to students directing students to SurveyMonkey to begin the study. Participation was completely voluntary. The AMAS and CARS was used to help identify students that met the intended participants of students in developmental mathematics classes struggling with mathematics anxiety and computer anxiety. The AMAS consists of nine questions based on a 5-point Likert-type scale ranging from 1 to 5, representing low anxiety to high anxiety respectively. The average mathematics anxiety score from undergraduate students using the AMAS is 21.1 on a 45-point scale (Hopko et al., 2003). The CARS consists of 19 questions based on a 5-point Likert-type scale ranging from 1 to 5, representing low anxiety to high anxiety respectively. The average computer anxiety score from undergraduate students using the CARS is 43.6 on a 95-point scale (Heinssen et al., 1987). The results from the AMAS and CARS surveys taken were quantified and categorized into high, medium, and low anxiety levels. In this study, students scoring with the combined highest mathematics anxiety and computer anxiety were selected. More participants were chosen by purposely selecting from the next highest combined anxiety levels. This process continued until a minimum of 10 participants were chosen since it is an accepted amount for a thematic saturation in a phenomenological study (Francis et al., 2010; Moustakas, 1994; Polkinghorne, 1989). The questionnaire (see Appendix B) was used to collect general biographical information such as gender, age, course, and the number of times in the course.

Once the questionnaires, the anxiety scales, and a purposeful sample with maximum variation were completed, a semi-structured open-ended interview was conducted with each participant to get a deeper understanding of the phenomenon of experiencing both mathematics anxiety and computer anxiety. Interviews were audio recorded and transcribed by the researcher.

Abbreviated Mathematics Anxiety Scale

The purpose of this study was to find the purposive sample of students in developmental mathematics classes who struggle with both mathematics anxiety and computer anxiety. To identify the possible participants in the study, students in developmental mathematics classes were asked to participate in the study to take both the AMAS and the CARS, with prior IRB and professor approval. The students in developmental mathematics classes in this study were administered two anxiety scales, the AMAS (Alsup, 2005; Eden et al., 2013; Hopko et al., 2003) and the CARS (Cazan et al., 2016; Hismanoglu, 2011; Sam et al., 2005) during the first week of the semester. The mathematical anxiety rating scale (MARS) was developed in 1972 by Richardson and Suinn containing a 98-item Likert-type tool. Later in 1982, the revised and shorter version, the MARS-R, was created by Plake and Parker having only 24 questions and having a .98 coefficient alpha and a .97 correlation to the MARS (Hopko et al., 2003). From here, a more condensed version was sought out and the AMAS was created with only having nine questions of Likert-type and were found to have internal consistency ($\propto = .90$) and test-retest reliability ($r = .85$) (Hopko et al., 2003). Because of its reliability, simplicity, and convenience for the students and professors alike, the AMAS is the best test for mathematics anxiety for high schools and colleges (Eden et al., 2013).

Computer Anxiety Rating Scale

The second anxiety scale given to the students in developmental mathematics classes during the first week of the semester was the CARS. The 19-item Likert-type instrument was created by Heinssen et al. (1987) and was found to be a reliable test ($r = .95$) (Cazan et al., 2016; Hismanoglu, 2011; Sam et al., 2005). The CARS was used to help identify students in developmental mathematics classes struggling with computer anxiety as part of the process of having a purposive sample.

Questionnaires

Students in developmental mathematics classes testing with combined high anxiety from the AMAS and the CARS were also given a questionnaire that was voluntary including an informed consent page for approval of the study. The questionnaire contained both structured and open-ended questions regarding the participants' age, gender, ethnicity, and current or past mathematics courses taken. Participant responses to the questionnaire were used along with the AMAS and the CARS to help select a purposeful sample of students with highest anxieties coupled with maximum variation in terms of gender, race, age, and other factors on the questionnaires.

Interviews

Once participants were identified through the AMAS and the CARS as students in developmental mathematics experiencing both mathematics anxiety and computer anxiety, then open-ended semi-structured interviews were given individually to participants. I followed a set of questions (see Appendix A) for each participant that allowed for consistency and ultimately looked for common threads of the participants' experiences of mathematics anxiety and computer anxiety. In addition, I employed an open-ended interview to provide for greater flexibility while engaging the participant in conversation, which allowed the opportunity to probe for more details when it was necessary (Conrad & Serlin, 2006). The face-to-face audio-recorded interviews were conducted with participant permission at a place and time convenient for the participant with minimum to no interruptions that lasted approximately 10 minutes. Interviews were semi-structured since there were a set of structured questions asking each participant, but interviews were also open-ended which provided the opportunity for the participants to be more descriptive. The interviews were audio recorded and transcribed for the purpose of the study. The participants were kept anonymous in the study by giving pseudonyms in the findings, were informed of the study, and were reminded their participation was voluntary.

Data Analysis

Data analysis for this phenomenological study involved several methods to interpret the data, which gathered the essence of the experiences from the participants. Participants were purposively selected by using only college students enrolled in developmental mathematics courses and administering the AMAS and CARS. Students scoring high in both mathematics anxiety and computer anxiety were contacted through email to ask them to participate further in the study with an interview. After quantitatively totaling the anxiety tests, analyzing the results, selectively choosing the participants with the highest mathematics and computer anxiety levels, and considering other factors such as age, gender, and race to maximize variation of the participants, further data analysis was collected and analyzed. According to Moustakas (1994) phenomenological reduction will occur through the questionnaires and reading through the transcripts, memoing, coding, reflection, and identifying significant statements from the participants. In a horizontalization process (Moustakas, 1994), the statements were grouped, analyzed, and synthesized into themes. From the synthesized themes, constructions of in-depth textural descriptions of the essence of the experience were developed along with structural descriptions to help capture the setting of the phenomena.

Trustworthiness

This phenomenological study was based on the experiences of participants. Consequently, there were procedures that had to be implemented to ensure trustworthiness. I used Lincoln and Guba's (1985) model of ensuring trustworthiness in this study by employing credibility, dependability, confirmability, and transferability.

Credibility

Credibility in this study was addressed with prolonged engagement with participants, peer reviews, triangulation of data, participant review of the findings, maximum participant variation, and through prior IRB approval. First, credibility was maintained through prolonged engagement with the participants. Prolonged engagement is investing the necessary time to build trust (Lincoln & Guba, 1985). Through the personal interviews with each participant and any follow up interviews, if necessary, I built sufficient trust as an educator seeking real and personal experiences from each participant. Furthermore, I have been an adjunct professor for several years and spent many hours in the mathematics emporium setting, so I understood the process of the mathematics course for the participants. Lincoln and Guba (1985) stated prolonged engagement involves the researcher be involved in a site location long enough to be able to recognize possible events. Secondly, credibility was also established in the research through peer reviews. Lincoln and Guba (1985) stated peer briefing is the most valuable for establishing credibility since the peer will be playing "the devil's advocate" to be sure that all questions and methods are "substantive, methodological, legal, ethical, or any other relevant matters" (p. 308).

Credibility was also enhanced in the study by triangulation of data. Data was collected using multiple methods such as the AMAS, the CARS, a questionnaire, and an interview. Several data collection methods used in triangulation complement one another and help provide insight into the phenomenon (Creswell, 2013; Denzin, 1978; Patton, 1999). Credibility can be further established in the study by providing participants with the opportunity to review transcripts and findings. Feedback of the initial findings from the participants can provide more insight of what was or was not intended, permits participants to make additions or corrections, and allows a chance for the participant to verify the accuracy of the findings (Lincoln & Guba, 1985). I sent each participant following the interviews a copy of the transcript for this verification process. To establish credibility, maximum participant variation was used. Once the AMAS and the CARS were conducted and mathematics anxiety and computer anxiety was established in the participants, participants were purposefully selected with respect to participants' age, gender, course, and possibly other factors. Using maximum variation sampling allows for greater strength in the value of the shared experience (Patton, 1990).

Dependability

Dependability is to be consistent and reasonably constant across other studies (Conrad & Serlin, 2006). In the process of analyzing the data, not only was peer reviews used as mentioned above, but also the process of analyzing and reanalyzing the themes assured that I am getting to the true essence of the phenomenon (Creswell, 2013). Dependability of this study was established by giving a detailed description of the setting and procedures.

Confirmability

Confirmability is when the data collected can be confirmed by someone else other than the researcher. I used detailed descriptions of the study so that peer reviews, as mentioned above, participant reviews, educators, or other researchers can follow the process and conclusions. Lincoln and Guba (1985) suggested using an audit trail so that anyone would be able to follow the data trail.

Transferability

Rich, detailed descriptions were given about the participants, setting, and the procedures along with using maximum variation in the sample so that other readers and educators can transfer the information to other situations and settings (Creswell, 2013; Lincoln & Guba, 1985). Transferability can be confirmed by peer reviews and participant reviews as mentioned above.

Ethical Considerations

The study sought to understand the phenomena of students in developmental mathematics classes experiencing mathematics anxiety and computer anxiety. In the study, confidentiality, informed consents, open honesty, general friendliness, and an overall appropriate and professional behavior was conducted to help provide a positive environment for participants to express their experiences. Considering the importance of these items, the study also included privacy to participants by using pseudonyms for names of the participants and specific location. Consent to the AMAS, CARS, questionnaire, and interviews were obtained from the participants, informing the participants of the voluntary nature at all times of the study. As mentioned, debriefing of the findings to the participants was used to be sure the trustworthiness of the study. All data was electronically stored and secured in a password-protected computer that only I was privy to. IRB approval (see Appendix I) for all data collection was obtained before the study was conducted. Furthermore, counseling referrals were made available to students who responded with a medium anxiety level to a high anxiety level in mathematics anxiety or computer anxiety. Finally, credibility was established in the study by obtaining prior approval of each step of the study through the IRB. Obtaining prior approval for the study by the IRB helps minimize any risk to participants or other individuals (Creswell, 2013).

Summary

In this chapter, I described the methods of this qualitative transcendental phenomenological design focused on the primary research question: What are the experiences of students enrolled in developmental mathematics courses that experience both mathematics and computer anxiety? The college students enrolled in developmental mathematics courses who struggle in mathematics anxiety and computer anxiety in a math emporium setting at a Central Virginia university were used in this study to help voice their experiences since there is a gap in the literature. The participants were selected through the data generated from the AMAS and CARS that identified those students in a developmental mathematics course who experience mathematics anxiety and computer anxiety. Participants voluntarily voiced their experiences through further data collection of biographical questionnaires and personal semi-structured open-ended interviews. Data analysis of the findings were analyzed and submitted to participants, and other educators to assure in the credibility, dependability, confirmability, transferability, and ethical considerations of the study.

CHAPTER FOUR: FINDINGS

Overview

The purpose of this transcendental phenomenological study was to describe the experiences of students in developmental mathematics classes who self-report both mathematics anxiety and computer anxiety. Phenomenology seeks to gather the descriptions of the experiences while using the researcher's personal interest in the guiding of the questions (Moustakas, 1994). My desire for the study began while instructing developmental mathematics students. While doing this, I noticed students who already struggled with mathematical concepts were also seemingly becoming frustrated learning mathematics using a computer. I started to wonder if developmental mathematics students who struggled not only in mathematics, but also struggled with the use of a computer had similar experiences. I used a phenomenological methodology for the study so the focus would be on the lived experiences of students who struggled with both mathematics and computer anxiety.

Looking at the literature, there were studies dealing with students struggling with mathematics anxiety, and studies dealing with students struggling with computer anxiety, but there were no qualitative studies focusing on students dealing with both mathematics anxiety and computer anxiety. Thus, this study focused on the shared experiences of developmental mathematics students dealing with both mathematics anxiety and computer anxiety. The foundation of the study was based on the research question: What are the experiences of students enrolled in computer-based developmental mathematics courses who self-report both mathematics anxiety and computer anxiety? This chapter presents the participants, demographics, the findings for the research study, and a summary.

After participants signed an informed consent form (see Appendix F), I employed a demographics questionnaire (see Appendix B), the AMAS (see Appendix C), and the CARS (see Appendix D) using a link to SurveyMonkey and sent to developmental mathematics students enrolled in a Central Virginia university. In the study, 303 of the 433 developmental mathematics students enrolled in the Central Virginia university decided to participate in the study. From the 303 participants, 54% were male and 46% were female with 79.4% of the participants being in the 18-20 year age bracket, 19.6% being in the 21-29 year age bracket, and less than 1% in the 30-49 age brackets. Furthermore, the participants' ethnicities were as follows: 70% Caucasian or white; 16% Black or African-American; 8% Hispanic; 3% Asian; and 3% other.

The AMAS consisted of nine 5-point Likert-type questions ranging from 9 to 45 points with an average score ranging from 20-22 (Carey et al., 2017; Cipora et al., 2015; Hopko et al., 2003). In this study, from the 303 participants AMAS scores ranged from 9 to 42 with an average score of 21.24. The CARS consisted of nineteen 5-point Likert-type questions having a 95-point scale ranging from 19 to 95 with an average score of 42 (Havelka & Beasley, 2011; Heinssen et al., 1987; Williams & McCord, 2006). From the 303 participants in this study, CARS scores ranged from 19 to 74 with an average score of 42.56. The results in this study confirmed the average anxiety scores from the AMAS and CARS among other college students.

Furthermore, 135 of the 303 participants had an average score or higher in the AMAS, while 103 participants had an average score or higher in the CARS. A purposeful sample was narrowed by the 46 participants scoring above the average score on both the AMAS and the CARS. These 46 students were contacted by email to participate in the study for a semi-structured open-ended audio-recorded interview. Twelve of the 46 students responded, and I individually interviewed each of the 12 participants. To protect identities, pseudonyms were given to each participant.

Participants

The twelve participants of the study were all students enrolled in developmental mathematics classes at a Central Virginia university using the math emporium as the learning environment. The participants scored above average anxiety levels in both mathematics and computers, with the average mathematics anxiety level of 31.67 from a possible 45-point AMAS score along with the average computer anxiety level of 57.75 from a possible 95-point CARS score.

Abigail

Abigail was a Hispanic female within the 18-20 year age bracket. She was enrolled in the same developmental mathematics class for the second time. Abigail's AMAS score was a 28 while her CARS score was a 56. During the interview, Abigail expressed struggling in mathematics since early elementary school, especially on quizzes and tests. She also expressed frustration and confusion in elementary school and middle school when she was asked to complete a task using a computer.

Bailee

Bailee was a Caucasian female within the 18-20 year age bracket. She was enrolled in the same developmental mathematics course for the second time. Bailee's AMAS score was a 33 while her CARS score was a 61. Bailee shared during the interview that she received a concussion during her sophomore year in high school, which caused her to have some memory loss. The memory loss that Bailee sustained affected her academics and she was placed back into Algebra 1 even though she had completed the course as a freshman. She said before the concussion she was okay in mathematics, but afterwards, she knew it was more difficult in grasping the subject material. Bailee admitted she often cried and felt overwhelmed in doing her mathematics homework.

Bailee also expressed frustration and confusion of using computers when teachers would use the flipped-classroom learning environment. Bailee did not like the flipped-classroom learning environment, where learning a lesson is typically done through a video at home, since she prefers the personal one-on-one learning environment or the classroom setting where questions could be asked and answered immediately.

Caleb

Caleb was a Caucasian male within the 18-20 year age bracket. This was his first attempt at a developmental mathematics course. Caleb's AMAS score was a 35 while his CARS score was a 59. During the interview, Caleb shared the middle school years was when he had first noticed mathematics becoming difficult. He expressed stress in trying to understand the information and in attempting to ask questions in mathematics. Caleb also had to get a tutor to help him understand the material. His attempt to pass the eighth-grade mathematics class ended with failure and him having to repeat the same mathematics class in the ninth grade.

Caleb also shared there had been many negative experiences with the use of a computer, specifically when asked to complete a task. He indicated he had not felt comfortable using computers since he started using them in school during his sixth-grade year. Caleb stated, "I'm not really good with Excel and some of the Microsoft…I don't know what you call them, like office apps or whatever. I'm not really good with those, but those are pretty frustrating for me to use" (personal communication, February 8, 2018).

DeShawn

DeShawn was a Hispanic female within the 18-20 year age bracket. She was enrolled in the same developmental mathematics course for the second time. DeShawn's AMAS score was a 41 while her CARS score was a 50. During the interview, DeShawn indicated she had confidence in her elementary and middle school years, especially her eighth-grade Algebra course, but her difficulties toward mathematics began her freshman year in high school while taking geometry. Likewise, with the use of a computer, DeShawn stated learning seemed easier in elementary school while playing educational games on the computer.

Emilie

Emilie was a Caucasian female within the 18-20 year age bracket. This was her first attempt at a developmental mathematics course. Emilie's AMAS score was a 38 while her CARS score was a 59. She stated in the interview she had to receive extra help in mathematics as early as the first grade. Emilie stated she felt "overwhelmed or like something was wrong with me, even though I'm just bad at math" (personal communication, February 13, 2018). Emilie had to seek extra math help throughout her entire educational experience. Even though she had to put extra work into the subject of mathematics, her determination was evident and stated, "…if you work hard, you can do better, and just putting more work in" (Emilie, personal communication, February 13, 2018).

Emilie also felt frustration with the use of computers as well. In her elementary experience, online education was made available, and the process of listening to a video and then practicing the concept was difficult for Emilie. She stated, "…it would crash halfway through a test or things would get lost or not sent properly. I found those experiences really frustrating….it just didn't click for me" (personal communication, February 13, 2018).

Jalen

Jalen was a Caucasian male within the 30-39 year age bracket. He was enrolled in his second developmental mathematics course. Jalen's AMAS score was a 27 while having a high 73.9 CARS score. He indicated during the interview his first struggles in mathematics began in Algebra during his sophomore year in high school. Jalen stated he felt frustrated and had a hard time understanding the material. Jalen was seeking a psychology major and stated it seemed more frustrating doing math at his age while his classmates were mostly coming straight out of high school. He also was only taking two courses that semester since he knew the amount of time he would have to commit to be successful in the mathematics course.

Jalen's earliest memory of using computers was when "we had a computer that had a green screen and we had a floppy disk" (Jalen, personal communication, February 14, 2018). He indicated playing games, such as Oregon Trail, was interesting but using computers in any other way "didn't do anything for me" (Jalen, personal communication, February 14, 2018). His frustration with the use of computers was also noticed when he stated, "there was technology I feel like moves so quickly" (Jalen, personal communication, February 14, 2018). Jalen also mentioned he sustained a brain injury in combat, and was told he would now have a more difficult time learning. He was told he has a cognitive disability and he mentioned he was nervous about learning new things.

Faith

Faith was a Caucasian female within the 18-20 year age bracket. This was her first attempt at a developmental mathematics course. Faith's AMAS score was a 40 while her CARS score was a 53. During the interview, Faith believed her mathematics struggles began in the middle school. Even with parental support and teacher help during her lunchtime, she continued to struggle in mathematics even through high school. Faith remembers her parents being supportive but also upset at her receiving bad grades in mathematics. Her senior year in high school she took a course about decision making using math, as she stated, “because in my mind I was like dumb with math, so I just did that and then was a lot easier” (Faith, personal communication, February 14, 2018).

Faith’s computer experience, as she remembered, started in the middle school. She enjoyed playing games on computers, but thought using a computer for schoolwork felt different. Specifically, she stated using a computer “was strange, it was really weird that I was doing things on a computer in school. I just thought it was weird” (Faith, personal communication, February 14, 2018). She also mentioned she preferred paper-and-pencil for math and often mixed up the numbers and signs when transferring it to the computer.

Iris

Iris was a Caucasian female within the 21-29 year age bracket. She was enrolled in the same developmental mathematics course for the third time. Iris’ AMAS score was a 23 while her CARS score was a 57. Iris shared in the interview her mathematical struggles began in the ninth-grade Algebra class. She repeatedly failed Algebra for 3 years until she was diagnosed with dyscalculia. She stated, “The numbers actually blended together in my head. I just felt like I knew I had struggled and it was like, I don’t know, it just felt hurtful, I guess, that I couldn’t do it and everyone else could” (Iris, personal communication, February 14, 2018). Unfortunately, Iris decided to avoid that hurtful feeling, and she had decided to give up that year. She mentioned she felt she had been trying to catch up in math ever since that year, and still carried the hurtful memories.

Iris mentioned she remembered using a computer for playing some games in elementary school and using computers a little in a computer lab setting. Although she experienced some fun with different aspects of using the computer, she thought it was discouraging when she used different programs. Iris also pointed out she did not enjoy the games or programs on the computer that were related to mathematics.

Micaiah

Micaiah was an African-American male within the 18-20 year age bracket. This was his first attempt at a developmental mathematics course. His AMAS score was a 26 while his CARS score was a 57. Micaiah mentioned in the interview his mathematics struggles began as early as early as first grade or even kindergarten. He also indicated he never fully understood mathematics. In addition, he stated he simply did not see the need for mathematics and therefore did not apply himself. Micaiah also expressed frustration and confusion in high school when he was asked to complete a task using a computer. He stated he did not know what to do with computers since they were new to him in high school. He also shared that he only learned what was required and did not spend much time with computers since he did not own his own.

Rachel

Rachel was a Caucasian female within the 18-20 year age bracket. She was enrolled in the same developmental mathematics course for the second time. Rachel's AMAS score was a 28 while her CARS score was a 54.9. She shared in the interview mathematics became an academic struggle starting in eighth grade Algebra. Rachel indicated her stress was almost daily in the course throughout the year. Part of the reason for the frustration and stress toward mathematics, she believed, was the fast pace the teacher went with each lesson. Rachel had to seek another teacher's help to pass the course. Rachel believed this experience and weak foundation in Algebra hindered her and gave her an overall dislike for mathematics. Even with this stress toward mathematics, she stated she had "learned to seek help early instead of letting it get so far of not knowing how to do something" (Rachel, personal communication, February 19, 2018).

Rachel's use with the computer started in the middle school when Student Learning Assessment testing for computers began. She expressed a feeling of confusion and would rather have a teacher who knew what they were doing instead of a computer since "computers don't really…they can't talk back to you or help you" (Rachel, personal communication, February 19, 2018).

Raeanne

Raeanne was a Hispanic female within the 21-29 year age bracket. This was her third attempt at a developmental mathematics course. Raeanne's AMAS score was a 27 while her CARS score was a 49. She shared during the interview mathematics has always been her weakest subject since first grade. Raeanne stated,

> I felt kind of anxious and dumb, like why I wasn't getting it compared to other students. I didn't understand how somebody could get the number, like how to count money, and I was just having trouble understanding it. I think because I probably learn differently. So, maybe I'm more hands-on and I can't always understand something when someone's lecturing on a board. Sometimes my mind goes other places. I think that was one of the reasons, and it started making me feel anxious, like I wasn't capable. I never looked forward to doing math, I guess you could say. (personal communication, February 19, 2018)

Raeanne had also attended three community colleges. With each college, and the current Central Virginia university, her math entrance test scores had always required her to enroll in a developmental mathematics course.

Raeanne also started feeling intimidated with the use of a computer as early as fifth grade. She stated the intimidation was primarily from some of her classmates saying similar to "oh, come on. You can't get this? Why are you taking so long?" (Raeanne, personal communication, February 19, 2018). Raeanne repeatedly stated during the interview that taking an entrance test or a course subject test, primarily on a computer, had been the main struggle progressing through college. Raeanne expressed her difficulty in this course was the combination of her struggles in mathematics, computers, and taking tests.

Francis

Francis was a Caucasian female within the 18-20 year age bracket. This was her third attempt at a developmental mathematics course. Francis' AMAS score was a 33.8 while her CARS score was a 63. She mentioned in the interview her mathematics struggles began in fourth or fifth grade. Francis stated she felt "stress, anxiety, and just something was missing. I wasn't like the other students who, where it would click for them, it didn't for me" (personal communication, February 20, 2018). She also stated,

> In order to fully understand a topic or subject, I had to work harder, and really figure out a way around just doing problem after problem after problem, 'cause that didn't work for me. I need to understand it in a different way, so it's always been a struggle ever since the beginning of like, after addition and subtraction. I feel everything after that, it just jumbled up my brain, and all confusing to me. And to this day, it's not easy. (personal communication, February 20, 2018)

Francis indicated the faster pace at which other students were moving in mathematics made her feel bad and more stressed.

Francis also had felt intimidated in using a computer ever since her first experience in fourth grade. She knew it was something she needed in college to complete assignments but did not feel successful when she was using the computer. With regards to having negative experiences while using computers, Francis expressed she has had many negative experiences when using a computer. Specifically, she sometimes had a blank document even though she thought it was saved. Likewise, she stated she was afraid in even using the computer since she thought it would explode. These experiences, as she shared, often gave her anxiety. Francis further expressed fear and apprehension taking mathematics courses on computers since she believed computers may not register her work or grades correctly.

Demographics Survey

Participants were asked to complete a demographics survey (see Appendix B), which asked the following questions: name, gender, age, ethnicity, and number of times enrolled in developmental mathematics class. From the 12 participants, nine were female while three were males. Nine of the participants were in the 18-20 age category, with two participant in the 21-29 age category, and one participant in the 30-39 age category. Furthermore, the ethnicities of the participants numbered eight Caucasians, three Hispanics, and one was African-American. Only four of the participants were taking a developmental mathematics course for the first time, whereas the other eight participants were taking a developmental mathematics class for their second or third time. It is important to see the individual differences between the participants, so their participant demographics are displayed together in Table 1.

Table 1

Participant Demographics

Pseudonym	Gender	Age	Ethnicity	Number of times taken
Abigail	Female	18-20	Hispanic	2
Bailee	Female	18-20	Caucasian	2
Caleb	Male	18-20	Caucasian	1
DeShawn	Female	18-20	Hispanic	2
Emilie	Female	18-20	Caucasian	1
Jalen	Male	30-39	Caucasian	2
Faith	Female	18-20	Caucasian	1
Iris	Female	21-29	Caucasian	3
Micaiah	Male	18-20	African-American	1
Rachel	Female	18-20	Caucasian	2
Raeanne	Female	21-29	Hispanic	3
Francis	Female	18-20	Caucasian	3

Abbreviated Mathematics Anxiety Scale

Participants were also asked to complete a nine-question 5-point Likert-type survey, which measures a participant’s mathematics anxiety. The AMAS (see Appendix C) was used for this measurement with the following possible responses: Low Anxiety, Some Anxiety, Moderate Anxiety, Quite a bit of Anxiety, and High Anxiety. The participants’ responses from the AMAS are presented in Table 2.

Table 2

Abbreviated Mathematics Anxiety Scale (AMAS) Participant Responses

	Abigail	Bailee	Caleb	DeShawn	Emilie	Jalen	Faith	Iris	Micaiah	Rachel	Reanne	Francis
Having to use the tables in the back of a math book.	2	2	3	3	3	2	5	2	1	3	1	2
Thinking about an upcoming math test 1 day before.	5	5	4	5	5	4	5	4	3	4	4	5
Watching a teacher work an algebraic equation on the blackboard.	1	3	3	5	4	4	4	1	1	2	2	3
Taking an examination in a math course.	5	5	4	5	5	5	5	5	4	4	4	5
Being given a homework assignment of many difficult problems that is due the next class meeting.	5	4	4	5	5	4	5	5	5	2	5	5
Listening to a lecture in math class.	2	3	4	4	3	3	3	1	3	2	1	NR
Listening to another student explain a math formula.	1	5	3	4	3	1	3	1	1	3	3	3
Being given a "pop" quiz in math class.	5	3	5	5	5	2	5	3	5	4	4	5
Starting a new chapter in a math book.	2	3	5	5	5	2	5	1	3	4	3	2

Note. Abbreviated Mathematics Anxiety Scale (AMAS) numeric values: Low Anxiety (1); Some Anxiety (2); Moderate Anxiety (3); Quite a bit of Anxiety (4); High Anxiety (5); No Response (NR)

To take a more comprehensive and diverse view of the participants, each of the response categories were given a numeric value as noted in Table 2. The numeric values were added together for each participant to give an overall mathematics anxiety rating score of the participants. The AMAS total rating scores for each participant are listed in Table 3. To further depict an accurate comparison of the mathematics anxiety of the twelve participants, Figure 3 displays each of the participants' AMAS rating score along with their average score compared with the overall 303 participants average AMAS rating score.

Table 3

Participant Rating Scores

Pseudonym	AMAS Score	CARS Score
Abigail	28.0	56.0
Bailee	33.0	61.0
Caleb	35.0	59.0
DeShawn	41.0	50.0
Emilie	38.0	59.0
Jalen	27.0	73.9
Faith	40.0	53.0
Iris	23.0	57.0
Micaiah	26.0	57.0
Rachel	28.0	54.9
Raeanne	27.0	49.0
Francis	33.8	53.0

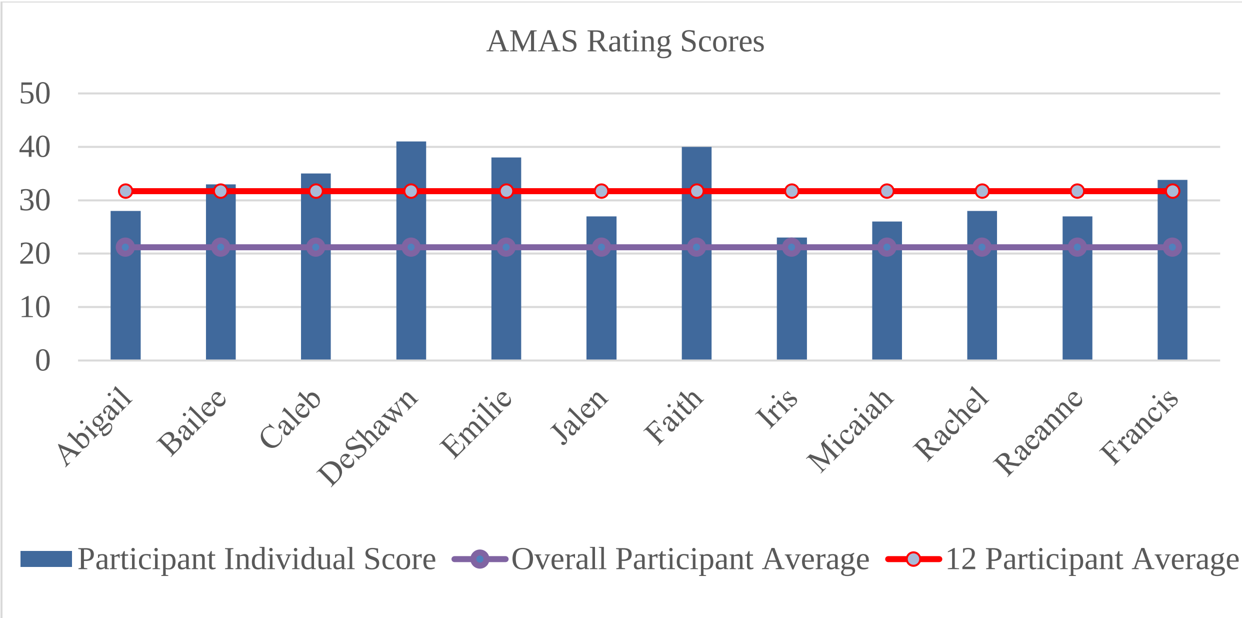

Figure 3. Abbreviated Mathematics Anxiety Scale (AMAS) rating scores for each of the 12 participants compared with 12-participant average and overall 303-participant average.

Computer Anxiety Rating Scale

In addition to the demographics survey and the AMAS, participants were also asked to complete the CARS (see Appendix D), which measures a participant's computer anxiety. CARS is a 19-question 5-point Likert-type survey asking participants how strongly they agree to the particular statement. The 5-point scale was numerically assigned to each participant's responses with a 1 representing Strongly Disagree through a 5 representing Strongly Agree. Higher participant scores represent higher levels of computer anxiety. The participants' responses from the CARS are presented in Table 4. To further depict an accurate comparison of the computer anxiety of the 12 participants, Table 3 displays each of the participant's CARS score while Figure 4 displays each of the participants' CARS score along with their average score compared with the overall 303 participants average CARS score.

Table 4

Computer Anxiety Rating Scale (CARS) Participant Responses

	Abigail	Bailee	Caleb	DeShawn	Emilie	Jalen	Faith	Iris	Micaiah	Rachel	Reanne	Francis
I feel insecure about my ability to interpret a computer printout.	3	3	4	2	5	3	4	4	4	3	2	2
I look forward to using a computer in my job.*	4	4	3	2	5	5	3	3	1	4	3	5
I do not think I would be able to learn a computer programming language.	4	4	4	3	5	5	3	3	4	4	2	5
The challenge of learning about computers is exciting.*	4	5	4	4	5	5	4	4	4	4	3	5
I am confident that I can learn computer skills.*	2	4	4	3	3	3	1	2	4	2	2	3
Anyone can learn to use a compute if they are patient and motivated.*	2	3	3	3	1	2	1	2	3	2	2	2
Learning to operate computers is like learning a new skill – the more you practice, the better you become.*	2	2	4	3	1	2	1	2	1	3	2	2
I am afraid that if I begin to use computers I will become dependent upon them and lose some of my reasoning skills.	4	4	3	3	1	3	3	2	2	3	3	2
I am sure that with time and practice I will be as comfortable working with computers as I am in working with a typewriter.*	2	3	3	3	5	4	3	3	2	3	3	2

	Abigail	Bailee	Caleb	DeShawn	Emilie	Jalen	Faith	Iris	Micaiah	Rachel	Reanne	Francis
I feel that I will be able to keep up with the advances happening in the computer field.*	3	4	3	2	1	5	3	3	5	4	3	5
I dislike working with machines that are smarter than I am.	2	2	3	3	1	5	3	2	2	3	2	3
I feel apprehensive about using computers.	2	2	2	3	3	4	3	3	4	2	3	3
I have difficulty in understanding the technical aspects of computers.	4	5	3	2	5	5	3	5	3	3	3	4
It scares me to think that I could cause the computer to destroy a large amount of data by hitting the wrong key.	4	5	3	4	5	5	4	2	1	3	4	5
I hesitate to use a computer for fear of making mistakes that I cannot correct.	4	2	2	3	1	4	2	4	2	2	2	4
You have to be a genius to understand all the special keys contained on most computer terminals.	3	2	4	2	3	5	3	4	4	2	2	3
If given the opportunity, I would like to learn about and use computers.*	2	5	2	2	5	3	3	4	5	3	3	4
I have avoided computers because they are unfamiliar and somewhat intimidating to me.	3	1	2	1	3	5	3	4	4	2	2	2
I feel computers are necessary tools in both educational and work settings.*	2	1	3	2	1	1	3	1	2	3	3	2

Note. * indicates items that are reverse-scored.

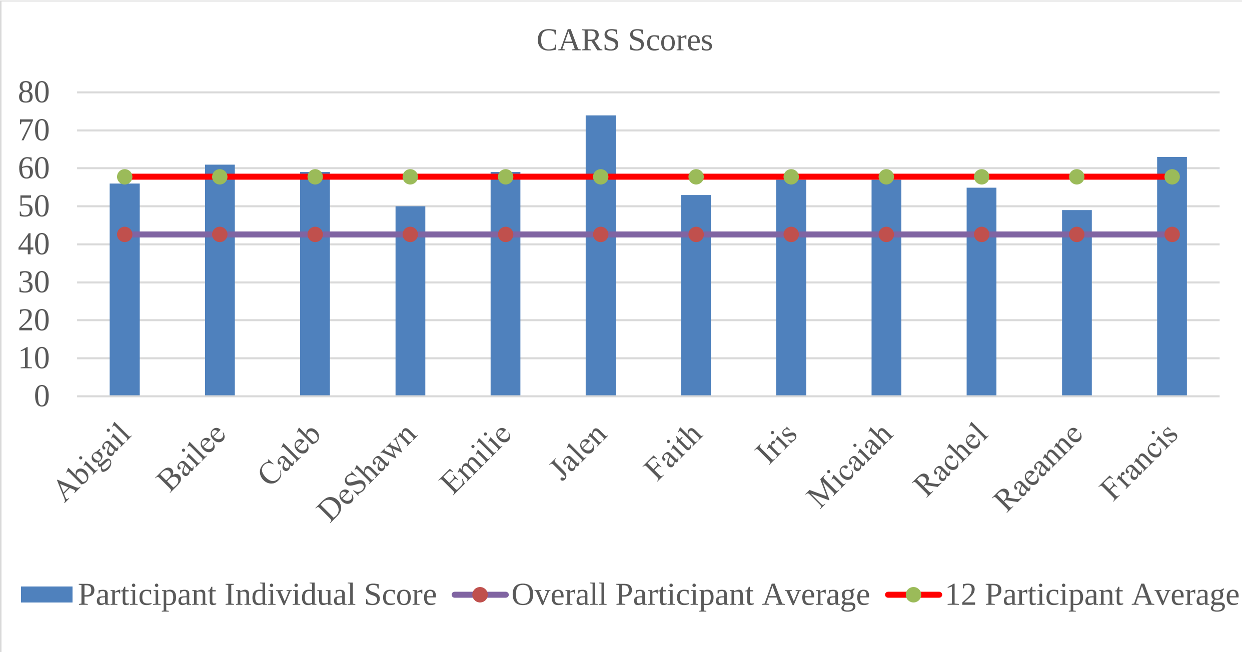

Figure 4. Computer Anxiety Rating Scale (CARS) scores for each of the 12 participants compared with 12-participant average and overall 303-participant average.

Results

Data triangulation uses multiple sources to shed light on a phenomenon or common theme to increase the reliability of the study (Creswell, 2013). A triangulation of the data collected from the AMAS, CARS, and interviews were used as corroborating evidence to shed light on the phenomenon (Creswell 2013; Lincoln & Guba, 1985; Patton, 1990). The following research questions provided a reference point for analyzing the gathered data and helped in providing evolving themes from the common experiences of the participants.

RQ: What are the experiences of students enrolled in computer-based developmental mathematics courses who self-report both mathematics anxiety and computer anxiety?

SQ1: What experiences do students enrolled in computer-based developmental mathematics face when completing mathematics work?

SQ2: What experiences do students enrolled in computer-based developmental mathematics face when using the computer?

SQ3: What factors do students enrolled in computer-based developmental mathematics classes identify as assisting them in coping with their mathematics anxiety and computer anxiety?

According to Francis et al. (2010), Moustakas (1994), and Patton (1990), data collection should conclude after emerging codes and themes become redundant with no further insight into the phenomenon. After examining and analyzing the multiple data sources, specifically the voices of the participants, the common themes emerged. The themes are discussed in relation to the guiding research questions.

Theme Development

The emerging themes for the formal study were attained after a comprehensive review of the surveys and the individual interviews. After reading and rereading the transcripts, I considered common elements, phrases, and words the participants stated of the phenomenon in the study. I grouped these common elements for further consideration and developed the overall arching themes. The list of common words and phrases are listed in Table 5.

Table 5

Repeated Words and Phrases Mentioned by Participants

Mathematics	**Computers**	**Assisting Factors**
Frustrated	Frustrated	Working ahead
Stressed out	Confused and lost	Ask questions
Anxious	Can't answer questions	Working a little at a time
Discouraged	Afraid of crashing or not saving	Don't procrastinate
Overwhelming	Technology moves too fast	
Couldn't get it	Intimidating	
Had to get extra help	Stressed me out	
Not good enough		
Something was wrong with me		
Just bad at math		
Struggling on tests and quizzes		
Everyone else could understand it		

Themes

The following themes emerged from data concerning the research questions. Participant quotes are used to reinforce the themes in addition to supplying an answer to the research question.

Research Sub-Question 1

The first research sub-question examined the experience of completing mathematics work. Two major themes emerged as it related to the research question: self-assessment and self-efficacy.

Self-assessment. The first major theme to research question one was self-assessment. When a student performs a self-assessment, then the student is making a self-judgement about his or her own learning experiences or achievements (Boud & Falchikov, 1989). A person's self-judgement, which may lead to a person's self-concept, may affect the performance and attitude of the person toward a particular task. According to Lee (2009), math self-concept is the personal perception of how others may perceive oneself regarding math, whereas math self-efficacy is the personal perception of the math capabilities of oneself. All of the participants reported how they felt from their learning experiences when dealing with mathematics. The anxiety the participants had when attempting mathematics were expressed in the subthemes of frustration, feeling overwhelmed, or being stressed-out.

Frustration. This subtheme emerged when participants reported their frustration or discouragement when doing mathematics. Participants reported the frustration or discouragement came when doing homework, learning a new lesson, taking quizzes and tests, or at the pace in which they were learning. Abigail stated in her interview "when I was in elementary just kind of struggling with it in general with tests and quizzes, and homework, and stuff. I was more frustrated just because I couldn't understand it" (personal communication, February 6, 2018). Jalen also got frustrated learning the material. He stated, "I just completely couldn't understand the material. So, I was frustrated by that. It was algebra" (Jalen, personal communication, February 14, 2018). Likewise, Emilie stated, "I think I struggled with math throughout my whole education. It's just something I've learned to work around and know that I have to put extra work towards that subject. It was frustrating" (personal communication, February 13, 2018).

Overwhelmed. This subtheme emerged with several participants reporting feeling overwhelmed when doing mathematics. Some of the participants reported such emotion came over them that crying became routine in doing mathematics. Bailee reported,

> I've never been really good at math. I was never fantastic. Yeah. Okay. Yeah. No, I definitely always have struggled. I would always cry, every class, or every time I did

> homework. After I got it, I was okay, but learning it was always overwhelming, and I just did struggle a lot. (personal communication, February 6, 2018)

Emilie also felt overwhelmed to a point where she thought something was wrong with her. She explained,

> I didn't really know what I didn't get or where I was getting lost, and I felt like the tutors also were struggling with finding that point. So, it made me feel just kind of overwhelmed or like something was wrong with me, even though I'm just bad at math. (Emilie, personal communication, February 13, 2018)

Stressed-out. The subtheme of participants feeling stressed-out emerged when participants attempted to learn the material but could not get the help needed or stay at the learning pace that was expected. Caleb stated,

> I was very stressed-out that I wasn't understanding the information, and I was trying to go to my teacher for help, and they wouldn't give me tips to do what they need me to do, and I wasn't able to understand it, so I actually had to go to a tutor outside of school, and luckily, they were able to help me a little bit. (personal communication, February 8, 2018)

Rachel also stated she felt "…stressed out most of the time. I didn't really understand it" (personal communication, February 19, 2018). Rachel further explained she felt as if the pace was moving too fast for her. She stated, "I was kind of upset because it stressed me out because I didn't know how to do it and she would just keep assigning assignments so I eventually went to another teacher and got help" (Rachel, personal communication, February 19, 2018).

Francis also felt stress when dealing with mathematics. She stated she felt “stress, anxiety, and just something was missing” (Francis, personal communication, February 20, 2018). Later in the interview she further explained

> math as never easy, or come easy for me. So in order to fully understand a topic or subject, I had to work harder, and really figure out a way around just doing problem after problem, ‘cause that didn’t work for me. I need to understand it in a different way, so it’s always been a struggle ever since the beginning of like, after addition and subtraction. I fell everything after that, it just jumbled up my brain, and all confusing to me. And to this day, it’s not easy. (Francis, personal communication, February 20, 2018)

Self-efficacy. The second major theme emerging to research question one is self-efficacy. Self-efficacy is the personal belief in one’s self in ability and performance (Bandura, 1986). As stated before, students experiencing mathematics anxiety tend to avoid doing mathematics because of their low self-efficacy in doing mathematics (Andrews & Brown, 2015; Maloney & Beilock, 2012). A person’s self-efficacy toward mathematics can influence their academic choices and can be used to help predict a student’s success in mathematics (Bandura, 1997; Foshee et al., 2016; Wigfield & Eccles, 2000). The participants expressed their feelings and experiences when dealing with mathematics with the following common phrases: “something must be wrong with me”; “I’m just bad at math”; “I’m not good enough”; “everyone else could understand it”; “I had to get extra help”; and “I couldn’t get it”.

Abigail, as mentioned before, stated she had a hard time understanding mathematics. She stated, “I was frustrated just because I couldn’t understand it” (Abigail, personal communication, February 6, 2018). Caleb, likewise, stated, “I wasn’t able to understand it. Since seventh grade, I have progressively gotten harder and harder to do math for me" (personal communication, February 8, 2018).

Furthermore, Micaiah stated, "I just never got math" (personal communication, February 15, 2018). Micaiah described a few moments when he did understand mathematics but overall his learning experience in mathematics was a struggle. He stated,

> It always feels good when you get things or be good at something but I'm clumsy with math so I just never feel like it's a field when I can't say that I wanna be special if then. 'Cause I feel like it's not my thing, I'm not really good at this. (Micaiah, personal communication, February 15, 2018)

Bailee compared herself to other students expressing that she felt "Stupid. Definitely not intelligent, because it was like I wasn't to the level that I used to be. Then, I think everybody else talked about all this different stuff that I didn't know. It was really hard" (personal communication, February 6, 2018).

DeShawn, during the interview, expressed her struggles began in ninth grade Geometry class. She stated that the class had made her feel "scared and nervous" (DeShawn, personal communication, February 8, 2018). DeShawn further expressed her personal belief in her mathematics ability, as she felt "not dumb, but not good enough for math I guess" (personal communication, February 8, 2018). She later stated in the interview "math is not something that everyone can do" (DeShawn, personal communication, February 8, 2018).

Faith also not only struggled in understanding mathematics, but the struggle affected her grades, her time, and her relationship with her parents. Faith stated,

> I couldn't get it right, like I didn't know what to do. I mean I would ask my teachers, but you know? It's just difficult, math's always been difficult for me. I mean I obviously

> started getting bad grades and so my parents were upset, and so they were like "You need to go in for help." My teachers and my parents talked, and so I would usually just go in for help, or I would have to spend my lunch in the teacher's room getting help or something...the same thing happened all through high school…because in my mind I was like dumb with math. (personal communication, February 14, 2018)

Similarly, when working on mathematics, Raeanne stated she felt

> kind of anxious and dumb, like why I wasn't getting it compared to other students. I didn't understand how somebody could get the number, like how to count money, and I was just having trouble understanding it. I think because I probably learn differently. So, maybe I'm more hands-on and I can't always understand something when someone's lecturing on a board. Sometimes my mind goes other places. I think that was one of the reasons, and it started making me feel anxious, like I wasn't capable. I never looked forward to doing math, I guess you could say. (personal communication, February 19, 2018)

Iris stated, "the numbers just blended together in my head. I just felt like I knew I had struggled and it was like, I don't know, it just felt hurtful, I guess, that I couldn't do it and everyone else could" (personal communication, February 14, 2018). Iris shared in her interview that later in high school she was diagnosed with dyscalculia which explained her struggles with numbers. She also stated, "when I get behind, it's hard for me to get caught back up because I get discouraged and I guess I just, I'm like, okay, just time to give up. It's hard for me to push through, I guess" (Iris, personal communication, February 14, 2018).

Francis also compared her mathematics progress with her peers by expressing her stress in doing mathematics trying to keep up with her classmates. Francis stated, "I felt just discriminated in a way, because other students were ahead of me, and I was still behind, or I definitely didn't feel good about it" (personal communication, February 20, 2018).

Research Sub-Question 2

The second research sub-question focused on investigating the participants' experiences when using a computer. Two major themes emerged as it related to the research question: computer perception and self-efficacy.

Computer perception. The 12 participants in this study all scored above average computer anxiety on the CARS. Many of the responses by the participants on the CARS were marked with high anxiety scores to phrases such as "I feel that I will be able to keep up with the advances happening in the computer field," "I feel apprehensive about using computers," "It scares me to think that I could cause the computer to destroy large amount of data by hitting the wrong key," or "I hesitate to use a computer for fear of making mistakes that I cannot correct." The perception of a computer from the participants during the interviews involved phrases such as "afraid of crashing or not saving," "technology moves too fast," or "computers can't answer questions."

Abigail indicated in her interview, when using a computer, she often felt confused and she was unsure of what to do with it. Abigail stated she had many negative experiences with using a computer, especially "whenever there was like a technical glitch or maybe I didn't know exactly how to use some of the applications. That's when it was a little bit hard" (personal communication, February 6, 2018).

Similarly, Iris got discouraged when she had to learn something new on the computer. She indicated, even though for the assignment she had to push through it, she still found it troublesome when working with different programs.

Bailee did not like her first experience of using a computer, which also affected her current perception of using a computer in an academic setting. Her first experience was in the ninth grade when the math teacher implemented a flipped-classroom learning environment. Bailee stated,

> I hated it. It was terrible. I didn't do any of it. I did it for one time, and I didn't understand it, because of the video. I didn't understand what he was saying. I couldn't ask any questions. So I remember writing down a notepad of all of my questions, and still was beyond confused. (personal communication, February 6, 2018)

She later indicated learning in her college mathematics class while using a computer was still frustrating because she could not ask the necessary questions to the computer since the computer could not help her with her mistakes.

When using computers, Emilie felt frustrated especially when a required academic task on the computer was assigned. Emilie stated she felt frustrated

> because there would things like, it would crash halfway through a test or things would get lost or not sent properly. I found those experiences really frustrating. Or we would have…In my elementary school you'd do classes online sometimes, and it would explain stuff on the computer. A lot of the times I wouldn't really understand that fully, or be able to…I don't know. It just didn't click for me. (personal communication, February 13, 2018)

Emilie later explained her frustration in using a computer was that it would not tell her what she was doing wrong. She specifically stated, "since it is not a person, it can't re-word it or try and say it from a different perspective like a person could, since it's a computer" (Emilie, personal communication, February 13, 2018).

Francis indicated in her interview of her confusion and struggles she had with computers. She stated from her experience she had failed her developmental mathematics course two times, and this was her third time taking the course. Francis stated,

> it's not because I can't do it, or 'cause it's too hard. But I think it is the whole like computer, electronic thing where it's not going to register my grades right. Or it's not going to fully count, like it doesn't matter. It's not down on paper, you know. It was just confusing to me, and my mind was jumbled. (personal communication, February 20, 2018)

Jalen, having then been in his mid-30s, mentioned he felt anxious about returning to school after many years since so many things had changed in education. One thing he specifically was referring to was the use of technology in education. Jalen stated

> technology I feel like moves so quickly that if you're not constantly up to date, for example, when I came back to school, I had no idea what a Google doc was or Microsoft Outlook. I knew nothing about that stuff. So, I had to totally learn pretty much everything about the use of the internet. I used it up until now, the internet. No, I take that back. I went three years without the internet at my house or anything. So, I don't know. It's never been a priority. Technology. If you don't stay maintain and get the next upgrade, then I think they call it planned obsolescence. You become obsolete. (personal communication, February 14, 2018)

Self-efficacy. Bandura (1986) defined self-efficacy as the personal belief in one's self in ability and performance. As stated earlier, students experiencing computer anxiety also have a lower self-efficacy toward computers since these students will tend to avoid using computers

(Hsi-Chi et al., 2010). Several of the participants expressed being frustrated, confused, intimidated, and stressed-out with the use of computer.

Caleb explained there were definitely negative experiences ever since his first time he used a computer in the sixth grade. Caleb stated there are

> negative times, like especially with certain programs. Like, I'm not really good with Excel and some of the Microsoft…I don't know what you call them, like office apps or whatever. I'm not really good with those, but those are pretty frustrating to me to use. (personal communication, February 8, 2018)

Micaiah repeatedly expressed in the interview he got confused when using a computer. He stated, "I felt confused 'cause I didn't know what to do, you know? It was new for me. I felt confused" (Micaiah, personal communication, February 15, 2018). He further explained his overall feelings toward the use of a computer by stating, "I don't really know how to use computers like really, really well like that I don't think I feel like nothing about it, I don't know why" (Micaiah, personal communication, February 15, 2018). Micaiah also shared he did not own a computer and had not had any positive experiences with using a computer.

Raeanne shared during the interview her experiences of using a computer were intimidating. During the interview, she stated three times that she felt intimidated learning new aspects of a computer or a program. Raeanne, when she was younger and tried to learn something on the computer, said she remembered a friend of hers mocking her and stating, "Oh, come on. You can't get this?" (Raeanne, personal communication, February 19, 2018). She expressed that she still struggled a little with computers, but tried to overcome each struggle.

Francis has been intimidated since her first experience of using computers in the fourth grade. She stated she felt intimidated and "like it was something I wasn't able to control or grasp or fully understand" (Francis, personal communication, February 20, 2018). She also expressed her many negative experiences of using a computer. Francis stated,

> I just thought, I guess, it was my luck or whatever when it came to writing papers and…But I always felt like they were never fully saved on my computer. I don't know, I always felt like things got deleted or whatever. And a bunch of my classes in high school, I would go to turn something in, and the document would be blank, or just by the click of one button, like, it could explode. So, that really stressed me out, gave me so much anxiety. And to this day it does. But definitely in the past like lots of experiences of it just being not the most positive thing ever. (personal communication, February 20, 2018)

Research Sub-Question 3

Each of the college participants, although struggled with both mathematics anxiety and computer anxiety, have implemented successful techniques and strategies that have helped them overcome the anxieties in their previous college or high school mathematics courses. Examining the students' perceptions of assisting factors coping with both mathematics anxiety and computer anxiety, two themes emerged. The themes were working ahead and asking questions.

Working ahead. The participants commented on what has helped them be successful on an assigned task despite the high anxiety levels in the areas of mathematics and computers. One of the common elements many of the participants mentioned was to not procrastinate and work ahead.

What has helped Abigail in the past has been working ahead, so the deadline of the assignments was not as stressful for her. She stated,

> For me, it was doing problems ahead of time, so before the next class before they were due, and then if I needed help, I could get help on those and it wouldn't take as much time, and wouldn't be, I guess as strenuous. I work on a lot of them in class, but if I needed help, I'd ask the teacher and I try to work on them a little bit ahead of time, so I didn't feel so rushed to get to the deadline. (Abigail, personal communication, February 6, 2018)

Similarly, Bailee's suggestion was to stay ahead in the coursework. She expressed she had friends who waited until the due date before they even began their assignments. Bailee also stated, "I'm going to get the whole week ahead done. That way I don't have to stress out about it, and that way I have time to learn. Especially with quizzes and tests, I stress out" (personal communication, February 6, 2018).

Faith also expressed what has worked for her was to look at her weekly assignments and get them done as soon as possible during the week. Her suggestion was to arrive early to class or plan to stay after class. Faith said those few minutes each class made a difference and it made the class less stressful.

Francis, much like Faith, had experienced success with working ahead whenever the chance arose. She specifically suggested working at a faster pace toward the beginning of the course when the material was easier. Francis also tried to use her time wisely by showing up early to class and staying a few minutes after class. Since Francis did struggle with computer anxiety she suggested working on it throughout the week; shorter increments helped her to get ahead, and as she stated, it "gives me a lot of security in just knowing that, look, I'm ahead in this" (Francis, personal communication, February 20, 2018).

Jalen was more specific with his response of his experience. He suggested,

> Do math daily. I think it's a skill that is perishable I think is the word and it just the more you practice, the more you hone your skill if you will, the better off you become. I think that doing it that way daily, little chunks is what is really key. I tell people it's like I have this little tank. A picture that's like a little cup of information that I can retain. Then after that, more information can go into that cup, but it'll just overflow and I won't retain that information. So, a little bit every day I can retain a little bit every day. If I continue that and just chugging right along, I can retain the information that I need to hopefully pass this course. (Jalen, personal communication, February 14, 2018)

Asking questions. Many of the participants liked the availability of the professors and the tutors staffed by the mathematics emporium. Typically, in a mathematics emporium setting, as the participants agreed upon, when the students had mathematics questions, there was always someone there to answer the questions.

Abigail mentioned she liked working independently in the mathematics emporium but also stated, “I like having help from teachers if I need it” (personal communication, February 6, 2018).

Micaiah expressed his appreciation with the faculty and the tutors of the mathematics emporium with answering his questions. He stated being a good listener and having the mindset to learn from asking questions was an important aspect of his success thus far.

Likewise, Caleb mentioned he enjoyed the mathematics emporium setting because, as he stated,

> there is people there that are always there to help you, and that it’s not like you have to wait until you get to class to have your questions answered. There’s…You put your cup up, and there’s somebody right up on you wanting to know if you need help, so I like

> that. Don't be afraid to ask questions. Even if it's just the simplest question, people are there to help you. They don't look at you as being dumb because you don't know how to multiply two times two. I mean, there's people that have all different levels of math, and they are there to help you no matter what your math level is. (personal communication, February 8, 2018)

DeShawn also believed asking questions helped not just with the concept, but also helped overcome being self-conscious in asking questions. She suggested to definitely ask questions because "the professors here are trained in math, and they know what they're doing and they know how to explain it to people" (DeShawn, personal communication, February 8, 2018).

During the interview, Rachel indicated she would rather work with a person instead of the computer since computers do not talk back. She indicated her experience thus far had been not to procrastinate getting help. She shared she learned that particular lesson just last semester when she did not follow that advice and ended up failing the developmental mathematics course. Her last statement in the interview was "If you don't know how to do something, just get help and don't procrastinate because that will get you nowhere" (Rachel, personal communication, February 19, 2018).

Earlier, Emilie expressed she did not like the computer since it could not tell her what she was doing wrong. With that in mind, Emilie did state,

> I think learning in the mathematics emporium is a good opportunity for people who want to be able to ask for help from people. That kind of solves the problem of the computer not being able to re-word it. Because if you're not understanding what the computer says, you can always put your cup on your computer and someone can come over and explain it to you. (personal communication, February 13, 2018)

Emilie further expressed what had helped her was not to be afraid to ask questions. She stated, “not getting overly-frustrated and overly-overwhelmed is good. Because you need to have a clear mind so you can evaluate what you’re doing wrong, and what you’re doing right” (Emilie, personal communication, February 13, 2018).

Raeanne stated in the interview, “I guess in the past I was always afraid to ask for help because I felt like people would think I was dumb, or they’d be really frustrated with me if I didn’t get a problem” (personal communication, February 19, 2018). She indicated she had learned from her experiences and now took advantage of asking questions when she did not know something. Raeanne stated,

> if you really don’t get it the first time or the second time, that there’s somebody that might be able to explain it a little bit clearer and walk you through the problem, and help you realize where you’re going wrong with the problem. (personal communication, February 19, 2018)

Jalen expressed, in his interview, in fact emphatically expressed, the emphasis to ask questions. His passion for the mathematics emporium structure was evident and he attributed his success up to that point through his college mathematics courses to his availability to seek help in the mathematics emporium. When asked about his thoughts of learning in the mathematics emporium, Jalen stated,

> Love it. I can't get enough of it. Whenever I have a problem, whenever I have an issue, I just put my little pink cup up on my computer stand and somebody way smarter than me comes and rubs my back and says, "It's going to be okay." I'm about to break the computer and somebody comes and says, "Oh, this is what you've done." I learn a lot better by having somebody show me and kind of explain it. It's like having your own

> personal tutor. I love it. I want to take every math that I have to take, I want to use the math emporium for. (personal communication, February 14, 2018)

Summary

This chapter contained the insights into the lived experiences of 12 developmental mathematics students enrolled in a Central Virginia university who have high mathematics anxiety and high computer anxiety. Each participant was given a pseudonym along with a rich description or portrait. The responses and findings of the AMAS, the CARS, and the demographics survey were given. Using the responses along with repeated readings of the interview transcripts helped me to identify significant statements and themes from the stories shared by the participants. Using the thick and rich descriptions of the experiences of the 12 participants, six common themes emerged. The themes are direct responses to the investigated research questions. The research questions along with the common themes are given:

- What experiences do students enrolled in computer-based developmental mathematics face when completing mathematics work? *Self-assessment* and *self-efficacy*
- What experiences do students enrolled in computer-based developmental mathematics face when using the computer? *Computer perception* and *self-efficacy*
- What factors do students enrolled in computer-based developmental mathematics classes identify as assisting them in coping with their mathematics anxiety and computer anxiety? *Working ahead* and *Asking questions*

The next chapter, Chapter Five, will include the overview, summary of findings, discussion, implications, delimitations and limitations, and recommendations for further research based on the findings in this study.

CHAPTER FIVE: CONCLUSION

Overview

The purpose of this transcendental phenomenological study is to describe the experiences of students taking developmental mathematics who self-report both mathematics anxiety and computer anxiety. There are no qualitative studies up to this point providing a voice for the lived experiences of developmental mathematics students concerning this phenomenon. Chapter Five includes the following sections: (a) a summary of the findings, (b) a discussion of the findings and the implications in light of the relevant literature and theory, (c) an implications section, (d) an outline of the study delimitations and limitations, and (e) recommendations for future research.

Summary of Findings

The overarching research question to this study was: What are the experiences of students enrolled in computer-based developmental mathematics courses who self-report both mathematics anxiety and computer anxiety? Specifically, the research sub-questions the study focused on were:

SQ1: What experiences do students enrolled in computer-based developmental mathematics face when completing mathematics work?

SQ2: What experiences do students enrolled in computer-based developmental mathematics face when using the computer?

SQ3: What factors do students enrolled in computer-based developmental mathematics classes identify as assisting them in coping with their mathematics anxiety and computer anxiety?

In order to answer the research questions, developmental mathematics students enrolled in a Central Virginia university agreeing to participate in the study and signing an informed consent letter completed a demographics survey, the AMAS, and the CARS. Participants scoring high anxiety levels in both the AMAS and CARS were contacted through email and asked to participate further in a one-on-one audio-recorded interview. The transcripts to the interviews were read and reread until common statements and eventually themes emerged. The themes were self-assessment, low self-efficacy for mathematics and computers, computer perception, working ahead, and asking questions. The themes emerging were direct responses to the research questions of the study.

Research Sub-Question 1

Research SQ1 asked, "What experiences do students enrolled in computer-based developmental mathematics face when completing mathematics work?" The data analysis of the 12 participants in this study uncovered two major themes from their combined experiences of completing mathematics work, which are self-assessment and self-efficacy.

According to Boud and Falchikov (1989), students performing a self-assessment are merely making a self-judgement about his or her own learning experiences or achievements. The participants, when assessing their learning experiences, described when they did mathematical problems their learning experiences had been frustrating, overwhelming, and very stressful. These three subthemes revealed specific aspects of the combined experiences. Participants commented on the extra time that was spent on learning, along with their perceived learning pace was always behind their peers, and regularly not understanding the material. The collective views of these 12 participants with high anxiety levels in mathematics and computers indicated the learning experiences while doing mathematics problems were associated with these negative emotions.

The 12 participants also experienced a low self-efficacy in mathematics. Bandura (1986) defined self-efficacy as the personal belief or perception in one's self in ability and performance. Self-efficacy, when compared to self-assessments, has more of an emphasis on past performance when related to mastery of the concept (Bong & Clark, 1999). Several of the participants stated they often felt something was wrong with them, and they were not good in math while others were.

Research Sub-Question 2

Research SQ2 asked, "What experiences do students enrolled in computer-based developmental mathematics face when using the computer?" The participants' responses to the CARS and the interviews were analyzed and two major themes emerged, computer perception and self-efficacy.

The computer perceptions of the 12 participants included feeling left behind in the technology field, having a fear of making a mistake and losing data, having a fear of the computer crashing, or having frustration toward the computer for not directly answering questions like a professor could. The participants commented on the anxiety and frustration often felt when the participants were using a computer, despite the academic subject or task that was assigned. The participants indicated a fear or intimidation of using a computer, which in return caused the anxiety and frustration when given a task to complete on a computer.

The second major theme was the low self-efficacy participants had when using a computer. The frustration, confusion, and stress were all expressed by the participants when using a computer. The participants did not feel assured of what was being asked of them and commented on not feeling comfortable in using a computer. The combined experiences of the participants expressed their intimidation in using a computer since the use of computers, from their perception, was too hard to grasp or fully understand.

Research Sub-Question 3

Research SQ3 asked, "What factors do students enrolled in computer-based developmental mathematics classes identify as assisting them in coping with their mathematics anxiety and computer anxiety?" Although the 12 participants struggled with both mathematics anxiety and computer anxiety, each one of them has been successful up to this point in their prior experiences of dealing with their anxieties. The participants' firsthand experiences and proven techniques can give valuable insight for students who may be struggling with these anxieties. The emerging themes from this question were working ahead and asking questions.

The first major common theme the participants identified in assisting them was to work ahead. The participants indicated working ahead could alleviate some of the stress and anxiety of meeting the deadline. When working ahead, the participants expressed feeling less anxious about the assignment, which allowed them to concentrate on the concept, and provided a better learning experience. As one participant stated about working ahead, "that way I don't have to stress out about it, and that way I have time to learn" (Bailee, personal communication, February 6, 2018). To help achieve this, further advice was given to work more frequently in smaller time increments throughout the week. In addition, participants advised coming to class early or staying after class a few minutes since those extra few minutes each class period could make a difference in the learning experience.

The second major theme identified in coping with the anxiety was asking questions. The participants emphasized the importance of asking questions was needed to assist them in the learning experience. Participants stated they had fear in asking questions since they felt they may be dumb or frustrating to the person. Not asking questions, the participants stated, did not get them anywhere. Learning from experiences and asking questions had been a positive experience for the participants. This initial fear of asking question needs to be overcome, which leads to realizing learning can start by asking questions. One of the participants summarized it by stating, "I learn a lot better by having somebody show me and kind of explain it. It's like having your own personal tutor. I love it" (Jalen, personal communication, February 14, 2018).

Discussion

The purpose of this qualitative phenomenological study was to describe the experiences of college students enrolled in developmental mathematics classes who self-report both mathematics anxiety and computer anxiety. Previous research has dealt individually with mathematics anxiety and computer anxiety, but no qualitative research has been conducted that has dealt with students experiencing both types of anxiety. Some college campuses employ the use of computers in learning mathematics, and so the problem exists for those students attempting to complete a mathematics course while using a computer if the student struggles with both mathematics anxiety and computer anxiety. This qualitative study involved 12 participants who are enrolled in a developmental mathematics class and who all have high levels of anxiety toward both mathematics and toward the use of computers. The results of this study, along with the combined experiences of the participants, confirm previous research discussed in Chapter Two dealing with each individual anxiety along with giving new insight into students struggling with both types of anxieties. This discussion addresses the relationship between this study's findings and the empirical and theoretical research.

Theoretical

During the study, I was guided by the social cognitive theory by Bandura (1977). The theory is the view of individuals having self-beliefs about "what people think, believe, and feel affects how they behave" (Bandura, 1986, p. 25). The self-belief, fears, perceptions, and avoidance behaviors were recognized in this study through the personal experiences of the 12 participants. Bandura (1986) further defined self-efficacy as the personal belief in one's self in ability and performance. Prior research demonstrates there is a correlation between self-efficacy beliefs and performance both in the realm of mathematics and computers (Bandalos et al., 1995; Eden et al., 2013; Hsi-Chi et al., 2010; Jain & Dowson, 2009). Students who struggle in an area tend to develop a mindset of failure in that area, and not everyone is capable of success (Howard & Whitaker, 2011). Students having a low confidence level because of prior experiences will tend to have a low self-efficacy and higher anxiety in the same area (Bandura, 1977). This aligns with prior research dealing with mathematics anxiety and computer anxiety (Andrews & Brown, 2015; Akin & Kurbanoglu, 2011; Hsi-Chi et al., 2010; Jameson & Fusco, 2014; Maloney & Beilock, 2012; Peker, 2016; Wigfield & Eccles, 2000), along with the findings of this study. The findings of this study further support Bandura's social cognitive theory (1977, 1986, 1997, 2001) since the participants commented on their past negative experiences of mathematics and computers have affected their performance in the developmental mathematics class. With that in mind, the participants, even though they have high anxiety levels toward mathematics and computers, are trying to overcome or work through the anxieties to become successful in their pursuit of a degree.

Empirical

The discussion on empirical research is categorized by themes based on each research question.

Self-assessment & self-efficacy. The first research question dealt with the experiences of students who struggle with mathematics and computer anxieties when completing mathematics work, and the themes self-assessment and self-efficacy emerged. Prior research has indicated students having high mathematics anxiety tend to worry about learning the material, passing tests, and have avoidance tendencies (Andrews & Brown, 2015; Ashcroft & Krause, 2007; Beilock & Willingham, 2014; Eden et al., 2013; Hembree, 1990; Jameson & Fusco, 2014; Maloney & Beilock, 2012; Perry, 2004; Sprute & Beilock, 2016). Prior research has also shown a student's self-efficacy toward mathematics along with mathematics anxiety had the biggest impact to a student's performance (Lee, 2009). Furthermore, anxiety can produce certain emotions experienced by the students such as frustration, confusion, and anger (Saade & Kira, 2009). The results of this study have confirmed the prior research. Participants in this study reported being frustrated, overwhelmed, and stressed out on a regular basis when completing mathematics work. Specifically, some of the participants stated tears were shed on a regular basis, along with parental or teacher relationships were difficult at times because of the mathematical struggles. Some of the participants also shared when they felt lost or behind they just wanted to give up.

Computer-perception & self-efficacy. The second sub-question dealt with the experiences of students who struggle with mathematics and computer anxieties when using the computer. As reported, anxiety can produce negative emotions such as frustration, confusion, and anger (Saade & Kira, 2009). The findings of this study confirmed this when the combined collective experiences of the participants were statements of confusion, stress, frustration, not knowing what to do, and intimidation. Furthermore, prior research shows students with high computer anxiety also have a lower self-efficacy toward computers (Hsi-Chi et al., 2010). Even more so, Beckers et al. (2007) stated fears associated with students having computer anxiety leads to students evaluating themselves of their own self-worth. When students feel anxious toward the use of a computer, there is a tendency to delay the assigned academic assignment (Rahardjo & Juneman, 2013). The fears of the participants of using a computer were evident with statements such as “I hesitate to use a computer,” or “it scares me to think that I could cause the computer to destroy large amount of data by hitting the wrong key.” The results of this study from the voices of the participants reinforce such research with participants indicating they simply could not get it or could not fully understand it.

Working ahead & asking questions. The third sub-question focused on collecting the combined factors that have assisted the participants in coping with mathematics anxiety and computer anxiety. Each of the participants struggled with high anxiety levels in both mathematics and computers. Despite the anxieties, the participants are enrolled in college and have been successful in dealing with their anxieties. Their input and collective voices can be of great value for others struggling with these anxieties or for others working with them. Participants repeatedly stated asking questions was a key factor of their success. Although some of the participants admitted to not asking questions in prior classes was their mistake and reason for not being successful in the course, their commitment and attitude was persuasive that the lesson had been learned. These statements confirm prior research showing extra tutoring or receiving extra assistance results in a higher success rate of passing the course (Ashcraft & Krause, 2007; Daughtery et al., 2013; Finlayson, 2014).

The second emerging theme from the 12 participants was working ahead. Prior research shows the higher level of anxiety the more likely the student will procrastinate on the task (Rahardjo & Juneman, 2013). Furthermore, prior research discusses the anxiety of meeting deadlines does exist, and students that tend to procrastinate not only perform academically lower but also create a lower self-image of themselves (Akpur, 2017; Ozer, O'Callaghan, Bokszczanin, Ederer, & Essau, 2014; Rahardjo & Juneman, 2013). The results of this study reinforce the prior research from the voices of the participants emphasizing the importance of working ahead to relieve the stress associated with the deadlines. A powerful piece that emerged from the voices of the participants, though, takes the prior research a step further. The prior research emphasized procrastination and meeting deadlines because of the anxiety it creates along with the negative academic consequences. The participants in this study proclaimed the importance of not just meeting the deadlines, but actually working ahead being a key component of feeling less stress in the course.

Implications

The results of this qualitative phenomenological study produced findings that have theoretical, empirical, and practical applications for the educational community, specifically those dealing with learning mathematics with the use of a computer. There are no other studies giving a voice to students in developmental mathematics classes struggling with mathematics anxiety and computer anxiety. The purpose of this section is to address the implications of this study and provide recommendations for students and educators.

Theoretical

The theoretical framework for this study is based on Bandura's (1977, 1986, 1997, 2001) social cognitive theory. The social cognitive theory entails individuals having self-beliefs concerning what people think, believe, and feel affects the behavior of the individual (Bandura, 1986). In this study, participants took the AMAS and CARS to determine the level of anxiety in mathematics and computers. The 12 participants in this study showed results of high anxiety levels in both mathematics and computers. Math anxiety is defined as negative thoughts and avoidance behaviors when solving mathematics problems (Andrews & Brown, 2015). Moreover, computer anxiety is defined as emotional fear or apprehension when using a computer (Chua et al., 1999). The participants in this study shared their thoughts, emotions, and self-beliefs concerning mathematics and computers. Bandura (1977, 1986, 1997, 2001) stated avoidance behaviors will be present if the person's belief is that failure is inevitable. Furthermore, prior research states high anxiety levels toward a certain subject or event triggers unpleasant emotions (Andrews & Brown, 2015; Chien, 2008; Chua et al., 1999; Hismanoglu, 2011; Rahardjo & Juneman, 2013; Saade & Kira, 2009). The statements of the student participants provided validation for the social cognitive theory since they stated their anxieties toward mathematics and computers give them unpleasant feelings, higher stress levels, and fears. As such, the theoretical implication of the social cognitive theory provides meaning to the phenomenon of students experiencing both mathematics anxiety and computer anxiety.

Empirical

College students having mathematics anxiety or college students having computer anxiety is not a new topic. However, a qualitative study of college students having both mathematics anxiety and computer anxiety sheds new insight in the gap of literature along with providing a voice for the lived experiences of students. Prior research comparing mathematics anxiety and computer anxiety in Gressard and Loyd's (1987) research showed students with more positive attitudes toward the use of the computer had lower anxiety toward mathematics

(Beckers & Schmidt, 2001; Gressard & Loyd, 1987; Lee & Huang, 2014). Similar to the prior research, several participants in this study stated they felt more comfortable now using a computer in doing their mathematics work since someone had shown them how to use it. Moreover, this study provided insight from the experiences of the participants, which suggested both mathematics and computer anxieties in an individual may be difficult to overcome, but learning from the experiences, asking questions, and working ahead are suggestions to be considered. The implications of such findings point to the importance of not only determination from the student in seeking help, but also for educators reaching out to struggling students.

Practical

The evidence and experience provided by the insights of the participants of this study confirmed that students do have both mathematics anxiety and computer anxiety. Colleges that offer a mathematics course with a computer need to be aware some students may struggle if the student has either mathematics anxiety or computer anxiety, but specifically if a student struggles with both types of anxieties.

The result of this study also suggests participants struggling with both types of anxieties will need to be monitored more closely to help them be successful in the course. Specifically, an implication for college educators would be if students are suspected of having mathematics anxiety or computer anxiety, then giving personal attention in helping these students could be a great benefit to the students. As reported by the voices of the participants in this study, some of the participants were afraid to ask questions for fear of what others may think, or did not want to be a bother to others. In addition, some of the participants noted they were not sure what to do on the mathematics lesson or with the use of a computer until a tutor or professor was able to help them.

Lastly, an implication for college educators overseeing the mathematics emporium is to consider adjusting the required weekly time for students to be in the emporium. Several of the participants commented that they understood the reasoning for the required time, but expressed an adjustment be considered for those students who are working ahead or have a certain achieved grade in the course.

Delimitations and Limitations

The study focused on student perceptions and experiences of struggling with mathematics anxiety and computer anxiety. The delimitations to this study were found with the type of study chosen and the selection of participants. First, I wanted to examine the phenomenon of developmental mathematics students struggling with both mathematics anxiety and computer anxiety, so a qualitative phenomenological study was given. Secondly, I purposefully used a Central Virginia university for the selection of the participants for the study. Thirdly, I excluded developmental mathematics students who did not have high anxiety levels in both mathematics and computers. In addition, since my focus was on the developmental mathematics students' experiences, I excluded non-developmental mathematics students, faculty, and administration from my study.

Potential limitations of the study exist that could affect the validity and reliability in this qualitative phenomenological study. One such potential limitation stems from the participants chosen were from one university located in one region of one state. Moreover, another limitation to the study was although there were 46 developmental mathematics students scoring high levels of anxiety on both the AMAS and CARS, only 12 participants volunteered further for the interviews. Furthermore, there are many types of anxieties, testing conditions, even health issues the day of the test that could have influenced the results of the study. In that regard, another possible limitation to the study was this study only tested anxiety levels for mathematics and computers.

Recommendations for Future Research

As computers are being utilized more in the academic setting and the math emporium model is becoming more popular on college campuses, there is still a need for more qualitative studies investigating the phenomenon of students experiencing both mathematics anxiety and computer anxiety. Additional insight across other regions, and different populations could provide a different perspective or add to the findings of this study.

Other recommendations would be to not only for qualitative studies testing for mathematics anxiety and computer anxiety, but also testing for other types of anxieties or considering constructs such as age, gender, and ethnicity. Moreover, this study was conducted during the first week of the spring semester and conducting this study in the fall semester or during a different part of the semester would be another recommendation. Furthermore, conducting this study using online developmental mathematics course may also provide valuable insight. I also recommend that not only qualitative studies be conducted, but also quantitative studies while considering larger populations.

Summary

The purpose of this qualitative phenomenological study was to describe the experiences of students taking developmental mathematics who self-report both mathematics anxiety and computer anxiety. This study was necessary in filling the gap in literature since there has been no study prior to this one investigating the phenomenon. The study was conducted at a Central Virginia university with developmental mathematics students using a math emporium setting. The students participating in the study completed the AMAS and the CARS. The participants scoring high anxiety on both the AMAS and CARS were contacted to participate in an interview. The rich descriptions of 12 participants were analyzed to gather the essence of the participants' common experiences. Results from this study provided implications that provide insight for educators into helping students struggling with mathematics anxiety and computer anxiety. To summarize, this study offers two take-aways from its findings.

The first take-away is for students struggling with mathematics anxiety and computer anxiety to seek help by asking questions despite the fear and apprehension. The common statement by the participants overwhelmingly was to ask questions when needed. During the personal communication, the participants conveyed that they have learned this piece of advice, unfortunately, by struggling many times, but have learned it is an essential part of the learning process.

The second take-away is for college educators. If developmental mathematics students are suspected of having mathematics anxiety or computer anxiety, and especially both anxieties, then giving personal attention in helping these students could be a great benefit to the students. The participants reported they felt intimidated or afraid to ask questions concerning math or the use of the computer. The participants also reported they were not sure of what to do until the tutor or professor showed them how to do it. To summarize it from a participant's point of view, he stated, "I learn a lot better by having somebody show me and kind of explain it. It's like having your own personal tutor. I love it. I want to take every math that I have to take, I want to use the math emporium for" (Jalen, personal communication, February 14, 2018).

As a final point, this study not only confirms previous research concerning mathematics anxiety and computer anxiety, but also begins to fill the literature gap on students who struggle with both types of anxieties. Colleges implementing math courses with computers will need to consider how educators can better assist students who struggle with both mathematics anxiety and computer anxiety. Even though this study did provide insight into the experiences of these struggling students, more qualitative and quantitative studies will need to be conducted in order to understand the whole picture of the education of developmental mathematics students. Although the problem of the high percentage of developmental mathematics students failing still exists, this research makes a significant contribution to the literature, specifically to educators in post-secondary education, while laying the foundation for further research in helping students who struggle with both mathematics anxiety and computer anxiety. As educators, we need to hear the voices of our students, and make the changes that will make a difference.

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APPENDIX A: Interview Protocol & Questions

Before the interview, all participants will:

- Sign a consent letter.
- Be reminded the interview will be audio-recorded.
- Will be assured of confidentiality in the study.
- Will be informed that they can discontinue the interview at any time.

Interviewer Introduction: The first few questions are going to ask you about your math experiences up to this point of your education.

1. What is your earliest memory of first struggling with math?

   Probe: When did this occur?

   Probe: How did you feel?

   Probe: What was your action or reaction?

2. Were there other experiences of struggling with math since your earliest memory?

   Probe: When did this occur?

   Probe: How did you feel?

   Probe: What was your action or reaction?

3. Were there experiences when you have felt successful in math class or doing math?

   Probe: When did this occur?

   Probe: How did you feel?

   Probe: What was your action or reaction?

Interviewer Introduction: The next few questions are going to ask you about your computer experiences up to this point of your education.

4. What is your earliest memory of first using a computer?

Probe: When did this occur?

Probe: How did you feel?

Probe: What was your action or reaction?

5. Were there negative experiences of using computers since your earliest memory?

   Probe: When did this occur?

   Probe: How did you feel?

   Probe: What was your action or reaction?

6. Were there experiences when you felt successful in using a computer?

   Probe: When did this occur?

   Probe: How did you feel?

   Probe: What was your action or reaction?

Interview Introduction: The next few questions will ask you about your college math course experiences.

7. What feelings did you have when you were placed in a developmental math course?
8. What positive or negative feelings have you had so far in the developmental math course?
9. Tell me about your thoughts of learning in the math emporium.
10. What factors or steps that you would recommend to others to be more successful have you used to help you in a math class in a math emporium setting?

APPENDIX B: Demographics Survey

Please circle or write in the correct response:

1. Name: ___________________________________ E-mail: ______________________

2. What is your gender?

   a. Male

   b. Female

3. What is your age?

   a. 18-20

   b. 21-29

   c. 30-39

   d. 40-49

   e. 50 or older

4. What is your ethnicity?

   a. Asian

   b. Black or African-American

   c. Hispanic

   d. White or Caucasian

   e. Other: _______________________

5. Have you previously taken a class in the math emporium?

   If so, list the course(s) and number of times taken:

   ____

   ____

APPENDIX C: Abbreviated Mathematics Anxiety Scale (AMAS)

Removed due to copyright

Hopko, D. R., Mahadevan, R., Bare, R. L., & Hunt, M. K. (2003). The abbreviated math anxiety scale (AMAS): Construction, validity, and reliability. *Assessment, 10*(2), 178-182.

APPENDIX D: Computer Anxiety Rating Scale (CARS)

Computer Anxiety Rating Scale – CARS (Heinssen, Glass & Knight, 1987)

Instructions:

For each statement, decide whether you disagree or agree with the statement using the following 5 point scale ranging from strongly disagree to strongly agree. In the box to the right of each statement, fill in the number on the 5 point scale that best describes your level of disagreement or agreement.

Strongly Disagree				Strongly Agree
1	2	3	4	5

1.	I feel insecure about my ability to interpret a computer printout.	☐
2.*	I look forward to using a computer in my job.	☐
3.	I do not think I would be able to learn a computer programming language.	☐
4.*	The challenge of learning about computers is exciting.	☐
5.*	I am confident that I can learn computer skills.	☐
6.*	Anyone can learn to use a computer if they are patient and motivated.	☐
7.*	Learning to operate computers is like learning any new skill – the more you practice, the better you become.	☐
8.	I am afraid that if I begin to use computers I will become dependent upon them and lose some of my reasoning skills.	☐
9.*	I am sure that with time and practice I will be as comfortable working with computers as I am in working with a typewriter.	☐
10.*	I feel that I will be able to keep up with the advances happening in the computer field.	☐
11.	I dislike working with machines that are smarter than I am.	☐
12.	I feel apprehensive about using computers.	☐
13.	I have difficulty in understanding the technical aspects of computers.	☐
14.	It scares me to think that I could cause the computer to destroy a large amount of data by hitting the wrong key.	☐
15.	I hesitate to use a computer for fear of making mistakes that I cannot correct.	☐
16.	You have to be a genius to understand all the special keys contained on most computer terminals.	☐
17.*	If given the opportunity, I would like to learn about and use computers.	☐
18.	I have avoided computers because they are unfamiliar and somewhat intimidating to me.	☐
19.*	I feel computers are necessary tools in both educational and work settings.	☐

Note: * indicates items that are reverse-scored. Higher scores indicate higher levels of computer anxiety.

This test may be used for research purposes with proper citation to the authors.

References

Heinssen, R.K., Glass, C.R., & Knight, L.A. (1987). Assessing computer anxiety: Development and validation of the Computer Anxiety Rating Scale. *Computers in Human Behavior*, *3*, 49-59.

APPENDIX E: Recruitment Letter

January 22, 2018

Developmental Mathematics Student
Liberty University
Demoss Hall 2332
1971 University Blvd
Lynchburg, Va. 24515

Dear Student:

As a graduate student in the School of Education at Liberty University, I am interested in conducting research as part of the requirements for a doctorate degree. The purpose of this study is to investigate how college students enrolled in developmental mathematics classes explain the experiences they have had in mathematics and in the use of computers. The overarching question is: What are the experiences of students who are enrolled in computer-based developmental mathematics courses and who self-report both mathematics anxiety and computer anxiety? I am writing to invite you to participate in my study.

If you are 18 years of age or older, are enrolled in a college developmental mathematics course, and are willing to participate, you will be asked to complete a demographics questionnaire, complete the Abbreviated Mathematics Anxiety Scale, and complete the Computer Anxiety Rating Scale. Students who score high on the anxiety scales will be asked to complete a one-on-one interview. It should take approximately 33 minutes for you to complete the procedures listed. Your name and/or other identifying information will be requested as part of your participation, but the information will remain confidential.

If you would like to participate, please complete and return the consent document to the researcher, and you will be provided further instructions on how to access the questionnaire through SurveyMonkey.

A consent document is attached to this letter. The consent document contains additional information about my research. Please sign the consent document and return it to the researcher to participate in this study.

Sincerely,

Daniel L. Murphy
Liberty University Doctoral Candidate

APPENDIX F: Informed Consent

A Phenomenological Study of College Students in Developmental Mathematics Classes Experiences with Mathematics and Computer Anxiety
Daniel L. Murphy
Liberty University
School of Education

You are invited to be in a research study of students' experiences with mathematics anxiety and computer anxiety. You were selected as a possible participant because you are 18 years of age and older and because of your enrollment in a computer-based developmental mathematics college course. Since this mathematics course is using computers in the learning process, your input is important. Please read this form and ask any questions you may have before agreeing to be in the study. This study is being conducted by Daniel L. Murphy, a doctoral candidate in the School of Education at Liberty University.

Background Information: The purpose of this study is to investigate how college students enrolled in developmental mathematics classes explain the experiences they have had in mathematics and in the use of computers. The overarching question is What are the experiences of students who are enrolled in computer-based developmental mathematics courses and who self-report both mathematics anxiety and computer anxiety?

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

1. Complete a demographics questionnaire that will request information such as gender, age, ethnicity, and enrolled course. The approximate time for completing this is 3 minutes.
2. Complete the Abbreviated Mathematics Anxiety Scale (AMAS). The approximate time for completing this is 5 minutes.
3. Complete the Computer Anxiety Rating Scale (CARS). The approximate time for completing this is 10 minutes.
4. Participants scoring high or medium on both scales will be asked to participate in an audio-recorded interview. The approximate time for this interview is 15 minutes.

Risks: The risks associated with this study are considered minimal, which means they should be no greater than those experienced in everyday life.
Benefits: This study may provide information to school educators and administrators to help them have a deeper perspective toward the phenomenon of students experiencing both mathematics anxiety and computer anxiety.
Compensation: Participants will not be compensated for participating in this study.
Confidentiality: The records of this study will be kept private. In any sort of report I might publish, I will not include any information that will make it possible to identify a subject. Research records will be stored securely, and only the researcher, Daniel Murphy, will have access to the records. This study is confidential, and your name will not be disclosed in any manner. Data will be stored on a password locked computer, and after three years, all electronic records will be deleted. A number will be assigned to you as a pseudonym for recordings, if applicable.

Voluntary Nature of the Study: 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.

How to Withdraw from the Study: If you choose to withdraw from the study, please contact the researcher at the email address/phone number included in the next paragraph. Should you choose to withdraw, data collected from you will be destroyed immediately and will not be included in this study.

Contacts and Questions: The researcher conducting this study is Daniel L. Murphy. You may ask any questions you have now. If you have questions later, **you are encouraged** to contact him.

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, 1971 University Blvd., Green Hall Ste. 1887, Lynchburg, VA 24515 or email at irb@liberty.edu.

Please notify the researcher if you would like a copy of this information for your records.

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

(NOTE: DO NOT AGREE TO PARTICIPATE UNLESS IRB APPROVAL INFORMATION WITH CURRENT DATES HAS BEEN ADDED TO THIS DOCUMENT.)

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

____

Signature of Participant Date

____

Signature of Investigator Date

APPENDIX G: Math Emporium Letter of Request

November 13, 2017

Dr. Kathy Spradlin
Coordinator of the Math Emporium
Liberty University
Demoss Hall 2332
1971 University Blvd
Lynchburg, Va. 24515

Dear Dr. Spradlin:

As a graduate student in the School of Education at Liberty University, I am interested in conducting research as part of the requirements for a doctorate degree. The title of my research project is A Phenomenological Study of College Students in Developmental Mathematics Classes Experiences with Mathematics and Computer Anxiety. The purpose of my research is to describe the experiences of students taking developmental mathematics who self-report both mathematics anxiety and computer anxiety.

I am writing to request your permission to conduct my research in the math emporium at Liberty University during the first week of the semester. I am asking if students enrolled in developmental mathematics classes in the first week of the semester during their required weekly emporium time can be sent a secure website link to participate in my study. The website link will be directed to Survey Monkey where students will have the opportunity to know about the study and agree to a consent form to the study if they so choose. If the student chooses to participate in the study and agrees to the consent form, then the student will be directed further to take a demographics survey, the Abbreviated Mathematics Anxiety Scale (AMAS), and the Computer Anxiety Rating Scale (CARS). These instruments will allow me to help identify and classify students in the different degrees of anxiety levels. The students enrolled in developmental mathematics classes with higher levels of both mathematics and computer anxieties are the students my study will be focused on. 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 provide a signed statement on official letterhead indicating your approval.

Sincerely,

Dan Murphy
Liberty University Doctoral Candidate

APPENDIX H: Math Emporium Permission

LIBERTY UNIVERSITY | COLLEGE *of* APPLIED STUDIES & ACADEMIC SUCCESS

November 15, 2017

Dear Dan Murphy:

I approve your request to conduct research for your doctorate degree in the Math Emporium. I understand students enrolled in developmental math courses spring semester 2018 will be sent a link to a secure website during their required weekly emporium time the first week of classes. The website link will direct students to Survey Monkey where they will be asked to read about the study and agree to a consent form to the study if they so choose. If the student chooses to participate in the study, then he will complete a demographic survey, the Abbreviated Mathematics Anxiety Scale, and the Computer Anxiety Rating Scale. Students with high levels of both math and computer anxiety will be asked to participate in the study and will be sent consent forms.

Sincerely,

Kathy D. Spradlin
Coordinator of the Math Emporium
Associate Professor of Developmental Math
Liberty University

APPENDIX I: IRB Approval Letter

LIBERTY UNIVERSITY
INSTITUTIONAL REVIEW BOARD

January 11, 2018

Dan Murphy
IRB Approval 3106.011118: A Phenomenological Study of College Students in Developmental Mathematics Classes Experiences with Mathematics Anxiety and Computer Anxiety

Dear Dan Murphy,

We are pleased to inform you that your study has been approved by the Liberty University IRB. This approval is extended to you for one year from the date provided above with your protocol number. If data collection proceeds past one year, or if you make changes in the methodology as it pertains to human subjects, you must submit an appropriate update form to the IRB. The forms for these cases were attached to your approval email.

Thank you for your cooperation with the IRB, and we wish you well with your research project.

Sincerely,

G. Michele Baker, MA, CIP
Administrative Chair of Institutional Research
The Graduate School

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APPENDIX J: Sample Interview 1

Interviewer: First few questions are going to ask you about your math experiences up to this point of your education. What is your earliest memory of first struggling with math?

Raeanne: My earliest memory was, I would say, early as first grade. Honestly, math has always been my weakest subject.

Interviewer: How did you feel when this happen? If you remember that moment.

Raeanne: I felt kind of anxious and dumb, like why I wasn't getting it compared to other students. I didn't understand how somebody could get the number, like how to count money, and I was just having trouble understanding it. I think because I probably learn differently. So, maybe I'm more hands-on and I can't always understand something when someone's lecturing on a board. Sometimes my mind goes other places. I think that was one of the reasons, and it started making me feel anxious, like I wasn't capable. I never looked forward to doing math, I guess you could say.

Interviewer: Were there other experiences of struggling with math since that earliest memory?

Raeanne: Yeah, all throughout high school. I went to three community colleges, and I've had to take a placement test for each community college, and never placed high enough to get into math level, so I've had to take ... This is my third time taking a prereq math to get into an advanced math, because something ... I don't know. I guess I do really well in the classes, like the prereq classes. Whenever I take a placement test, I guess I don't score high enough, so I don't understand that is, like why I can pass the class with flying colors and it's easy. But then, when I take an actual test, like before I can get into another class, it just, I mess up on it or I don't do well enough on it.

Interviewer: Were there experiences when had you felt successful in math class or doing math?

Raeanne: Yes. One of the community colleges I went to, I had a friend who actually would take the time and we would spend like three hours in the library, and he would go over certain problems with me just so I can understand it. He helped me pass one of my math classes, because he used to take the extra time with me. Just, he would make the do the problem over and over again until he knew I got it. I did really well on my test and did really well in that math class when I was living in Virginia Beach. It was really cool. I was really proud of myself that I passed the class and passed all the tests, that I had a good friend that could help me and he wasn't ... He was really patient with me, so it was really nice.

Interviewer: The next few questions are going to ask you about your computer experiences up to this point of your education. What is your earliest memory of first using a computer?

Raeanne: I would say I think it was the fifth grade. I had to learn how to type, but I think the seventh ... It was either the seventh or eighth grade where I actually learned how to type. That, it was really hard for me at first, like learning the key, like the keyboard. But the classes that I took really helped me to learn how to type, so now I can type really fast. But back then, it was kind of intimidating because it was my first time learning how to type on a computer without looking at the keys and just, you know? I think I would say I was started to learn in the fifth grade, but my earliest experience, like learning how to actually type on a computer, like type, type, was the seventh grade.

Interviewer: How did you feel?

Raeanne: I felt kind of intimidated by it, but eventually, as social media and those things became more popular, I became better at typing, and I became used to the computer. It wasn't as intimating to me anymore because I used it a lot. Yeah.

Interviewer: Were there negative experiences of using a computer since that earliest memory?

Raeanne: Not really. I think the only experience that I had that was a little negative was when I learning how to type. A friend of mine said, "Oh, come on. You can't get this? Why are you taking so long to learn how to type?" But that was the only time that I ever had a negative experience with learning how use a computer. But I don't know. Ever time I've struggle with something, I've always overcome it, so that's pretty good, so not really. I don't think so.

Interviewer: Were there experiences when you felt successful using the computer?

Raeanne: Yeah. I had to take a computer class in community college. I think it was for Microsoft or something like that, and just the basics of the computer, like PowerPoints, data bases and stuff, and that was pretty ... That was easy. It was a easy class. I got a A in it. It just kind of walked you through how to do certain things on a computer, you know, simple things that you're going to use throughout college, like charts, and all kinds of stuff. You know, you just learned how to do it. Once you felt like you were good enough at learning, kind of how you do in the math emporium, then you take a test on the computer, so to make sure you really know what you're doing.

Interviewer: The next few questions will ask you about your college math course experiences. What feelings do you have when you were placed in developmental math course?

Raeanne: Well, recently, I was kind of frustrated because the community college I came from, all of the math I'm taking now, I literally took a semester, two semesters ago. I was really frustrated that I had to take it again. I wasn't really happy with that. I kind of wanted to just move into Math 201, which is for my major, but Liberty, since they made me take a placement test ... And again, like I said, I passed developmental math at my old college. I even was in a college-level math at my previous college, and I passed both of those classes. Liberty said I still had to take the placement test, so I took the placement test. Of course, I didn't score high enough to get into my math level for psychology, so it kind of disappointed me because I felt like I worked really hard in those other classes.

Yeah, to have to take the same math again was kind of frustrating because it feels like you're kind of lagging behind. Because I'm 24, and I'm going to be 25 in December, so I'm trying to graduate. I feel like just taking those extra classes, it's frustrating, but I understand why you have to take it, but I don't know if it's just that I don't practice enough for the placement test that I get placed in developmental classes. I don't know if it's anxiety, if I'm just not confident. Maybe I do really well in classes because I'm always prepared. Like you know, they give you work and your homework problems, and then you take the test, and everything's in your information in your mind.

But sometimes, when you take a placement test, you're not always as prepared. You don't always have a professor walking you through the problems and how to work the problems, even if you practice on your own before you take a placement test. It's a little hard sometimes. I really don't want to be. I tried to get out of developmental class, but they told me I had to take it so, yeah.

Interviewer: What positive or negative feelings have you had so far in the developmental math course?

Raeanne: The positive feelings I've had is that it's easy. I mean, don't get me wrong, there's still some things that I struggle on. It's mostly simple mistakes, like I forgot to put a negative sign here, or I forgot to fully simplify the problem. Those little simple mistakes that can really knock your grade. But, nothing really negative. I think I just figured, "You know what? It's a easy class. I'm just going to try to get through it. At least I don't have a hard class on top of all my other classes this semester." You know, that's the way I try to look at it in a positive way, because I can't really change anything now, so ...

Interviewer: Can you tell me your thoughts about learning in a math emporium?

Raeanne: I like it because you have people that can help you when you don't understand something. I like the way the math system is set up where you can get multiple tries and they can walk you through the problem on the question help spot so you don't always have to ask somebody for help. You can try to figure it out yourself, which I like that. But, I do like that there's help around. Like there's people that if you really don't get it the first time or the second time, that there's somebody that might be able to explain it a little bit clearer and walk you through the problem, and help you realize where you're going wrong with the problem. I like that, and I like my professor. She's really patient, nice. Yeah.

Interviewer: What factors or steps that you would recommend to others to be more successful have you used to help you in a math class in the math emporium setting?

Raeanne: Don't be afraid to ask for help. Don't feel like ... I guess in the past I was always afraid to ask for help because I felt like people would think I was dumb, or they'd be really frustrated with me if I didn't get a problem. Because when I used to go to my dad for help, he would get really frustrated with me because he didn't understand why I couldn't understand certain things. I'm like it made me afraid to ask for help, so I would do really bad in my math classes in high school because I'd never go ask the professor or teacher for help. I would just kind of get frustrated with the homework, not do it. I know that's really bad. Because I was afraid to ask for help, because I didn't have good experience with in the past.

But, I've learned that not everybody's like that. I love my dad. He's a great person, but it's just he was never patient with me when it came to that. I've learned that people, everyone's different, and there are people that are willing, wanting to and willing to help you, and that you should ask for help if you need it, or go for tutoring if you really want to do well in any subject, including math, and not give up. [inaudible 00:10:56] most importantly.

APPENDIX K: Sample Interview 2

Interviewer: The first few questions are going to ask you about your math experiences up to this point of your education. What is your earliest memory of first struggling with math?

Jalen: 10th grade high school.

Interviewer: How did you feel?

Jalen: Like I just completely couldn't understand the material. So, I was frustrated by that. It was algebra.

Interviewer: Okay. Were there other experiences or struggling with math since your earliest memory?

Jalen: Like up until now? Is that what you're asking?

Interviewer: Mm-hmm (affirmative).

Jalen: Yes. Being an adult learner. Being removed from the educational system from the time I was 18 until 30. The process of trying to learn what I think a lot of kids come out of high school with a base knowledge of was very taxing and caused me to fail math last year. So, this semester I'm coming in to it I'm only taking two classes, one of them being math so I can really put a lot of effort into it because it really takes a lot of my focus. For me it's very difficult to ... Math takes one kind of thinking I think. I don't know how to explain it, but the kind of thinking it takes to do math and then I'm a psychology major, the kind of thinking it takes to do some of the softer sciences maybe it's not as easy to correlate as well. So, really hammering on one course or the two classes this semester.

Interviewer: Were there experiences when you have felt successful in math class or doing math?

Jalen: No.

Interviewer: The next few questions are going to ask you about your computer experiences up to this point of your education. When is your earliest memory of first using a computer?

Jalen: I was in elementary school and we had a computer that had a green screen and we had a floppy disk. It was a floppy. It wiggled and you would put it in and a little arm came over and went. That's my earliest memories of that.

Interviewer: How did you feel?

Jalen: I didn't care about it really. It didn't do anything for me. I didn't care about it until I was probably in fourth grade and we got to play Oregon Trail and you could shoot buffaloes. I felt like it was really cool. That was it.

Interviewer: Okay. Were there negative experiences of using a computer since your earliest memory?

Jalen: Sure. There was technology I feel like moves so quickly that if you're not constantly up to date, for example, when I came back to school, I had no idea what a Google doc was or Microsoft Outlook. I knew nothing about that stuff. So, I had to totally learn pretty much everything about the use of the internet. I used it up until now, the internet. No, I take that back. I went three years without the internet at my house or anything. So, I don't know. It's never been a priority. Technology. If you don't stay maintain and get the next upgrade, then I think they call it planned obsolescence. You become obsolete.

Interviewer: Were there experiences when you felt successful using a computer?

Jalen: Sure. Yeah. I can think of completing an assignment and turning it in. That's definitely feeling successful.

Interviewer: The next few questions will ask you about your college math experiences. What feelings did you have when you were placed in developmental math class?

Jalen: I thought that was completely accurate. I didn't have any thoughts or feelings about it. I just knew that I had to continue to do it.

Interviewer: What positive or negative feelings have you had so far in the developmental math course?

Jalen: Well, I had a brain injury that I sustained in combat there and I was told that I wouldn't be able to learn well now that I have a cognitive disability. Going in to it, I was very nervous about that, but I really feel called by God to do what I'm planning on doing. So, when I first got into the math course, I thought, "There's no way I can do this," and bit by bit, I gained some understanding of the material and just getting a toe hold here and a finger hold there. Just kind of getting in to it and I gained that success. So, that was a good feeling knowing that I could learn the material, despite what doctors had told me about having a cognitive disability. So, that was pretty much the only good feeling that's ever come from math for me. It's never a good feeling when I balance my checkbook. I can tell you that.

Interviewer: Can you tell me about your thoughts of learning in the math emporium?

Jalen: Love it. I can't get enough of it. Whenever I have a problem, whenever I have an issue, I just put my little pink cup up on my computer stand and somebody way smarter than me comes and rubs my back and says, "It's going to be okay." I'm about to break the computer and somebody comes and says, "Oh, this is what you've done." I learn a lot better by having somebody show me and kind of explain it. It's like having your own personal tutor. I love it. I want to take every math that I have to take, I want to use the math emporium for.

Interviewer: What factors or steps that you would recommend to others to be more successful have you used to help you in a math class or your math emporium setting?

Jalen: Do math daily. I think it's a skill that is perishable I think is the word and it just the more you practice, the more you hone your skill if you will, the better off you become. I think that doing it that way daily, little chunks is what is really key. I tell people it's like I have this little tank. A picture that's like a little cup of information that I can retain. Then after that, more information can go into that cup, but it'll just overflow and I won't retain that information. So, a little bit every day I can retain a little bit every day. If I continue that and just chugging right along, I can retain the information that I need to hopefully pass this course.

Interviewer: Well, I thank you for your time.