THE RELATIONSHIP BETWEEN DOCTORAL STUDENTS' SELF-REPORTED TYPE OF STATISTICS ANXIETY AND FINAL GRADES IN AN ONLINE STATISTICS COURSE

by

Kirsten Lynn Hoegh

Liberty University

A Dissertation Presented in Partial Fulfillment

Of the Requirements for the Degree

Doctor of Philosophy

Liberty University

2020

THE RELATIONSHIP BETWEEN DOCTORAL STUDENTS' SELF-REPORTED TYPE OF STATISTICS ANXIETY AND FINAL GRADES IN AN ONLINE STATISTICS COURSE

by Kirsten Lynn Hoegh

A Dissertation Presented in Partial Fulfillment

Of the Requirements for the Degree

Doctor of Philosophy

Liberty University, Lynchburg, VA

2020

APPROVED BY:

Michelle J. Barthlow, Ed.D., Committee Chair

Kurt Y. Michael, Ph.D., Committee Member

ABSTRACT

Statistics anxiety is an issue for many students, particularly those in degree programs in the social sciences. These students may have very limited mathematics or statistics backgrounds and may experience negative attitudes or feelings of anxiety when faced with taking a statistics course. Enrollment in online doctoral programs in the social sciences is growing, and these programs typically require at least one statistics or quantitative methods course. Many online doctoral students experience some form of statistics anxiety, which could result in poor course performance. The purpose of the current study was to determine if there was a predictive relationship between self-reported types of statistics anxiety and doctoral students' final course grades in an online statistics course. A predictive correlational study was conducted in order to determine if the self-reported types of statistics anxiety could predict the final course grades for doctoral education students taking a fully online statistics course at a large faith-based university in the Southeast United States. Data were collected using a quantitative content analysis of discussion board assignments completed by students in a Doctor of Education or Doctor of Philosophy in education program who took a required 8-week, fully online statistics course during the 2019-2020 academic year. A multiple linear regression showed no significant predictive relationship between type of self-reported statistics anxiety and final course grades.

Keywords: statistics anxiety, attitude toward statistics, online doctoral programs, academic performance

Dedication

This manuscript is dedicated to my family, who have always encouraged me to pursue higher education. To my mother and father, who have taught me throughout my life to value education and who have cheered me on as I went for each degree. To my grandmother, who has always encouraged me throughout my studies. To my siblings, who have always been there for me. To my husband and children, who have been so supportive throughout my doctoral program and who have been my motivation for achieving this degree.

Acknowledgments

Thank you to Dr. Michelle Barthlow and Dr. Kurt Michael for the time and effort you have invested in supporting and guiding me through the research process.

Table of Contents

List of Tables

List of Figures

List of Abbreviations

Institutional Review Board (IRB)

Mathematics Anxiety Rating Scale (MARS)

Statistics Anxiety Rating Scale (STARS)

Statistical Package for the Social Sciences (SPSS)

CHAPTER ONE: INTRODUCTION

Overview

Statistics anxiety has been a concern for at least the past three decades. Cruise et al. (1985) established that there are six specific dimensions of statistics anxiety that can affect students: (a) worth of statistics, (b) interpretation anxiety, (c) test and class anxiety, (d) computational self-concept, (e) fear of asking for help, and (f) fear of statistics teachers. Despite the existing research on statistics anxiety, one area that has not been closely examined is how the six dimensions of statistics anxiety as identified by Cruise et al. (1985) affect student performance. This study was an examination of how students' self-reported six dimensions of statistics anxiety affect student performance in an online doctoral statistics course. Chapter One contains background information on statistics anxiety, the problem statement, the purpose statement, the significance of the study, the research question, and definitions of key terms.

Background

Over the last few years, enrollment in graduate and doctoral programs for the social and behavioral sciences has seen a steady increase (Okahana & Zhou, 2017). Much of this increased enrollment at the graduate and doctoral level is found in online programs (Lederman, 2018; Seaman et al., 2018). While many doctoral programs have evolved over the years to fit increasingly popular online formats, one aspect that has remained consistent is the requirement of a culminating dissertation or scholarly project (Breitenbach, 2019). Once online doctoral students enter the candidacy phase of their programs, they are expected to demonstrate mastery of course content and research concepts through the dissertation or scholarly project (Breitenbach, 2019). It is in the dissertation phase of the program that many candidates struggle and may decide to drop out (Kelley & Salisbury-Glennon, 2016). With increasing enrollment and historically high attrition rates in online doctoral programs, higher education administrators

should consider whether changes need to be made in the research methodology and statistics courses in order to better support students in the final stages of their programs.

Before entering the dissertation phase of their program, studies have shown that doctoral candidates experience most problems during their research methods and statistics courses (Elliott et al., 2013; Perepiczka et al., 2011). Different graduate schools require a different number of research and statistics courses to be taken as part of their programs (Elliott et al., 2013; Leech & Haug, 2015; Perepiczka et al., 2011). Various programs have differing requirements as to how many statistics courses students must take, however, many students in the social sciences have little, if any mathematical or statistics background before taking these courses in a doctoral program (Ferguson et al., 2017; Keeley et al., 2008; Onwuegbuzie, 2000). In fact, statistics courses have historically been considered to be "barrier" or "weed-out" courses, which are courses that are notoriously difficult and often affect students' abilities to persist to program completion (Bronstein, 2008; Gainen, 1995). This is problematic because in doctoral programs in the social sciences, it is important that students have an understanding of quantitative research methods (Onwuegbuzie, 2000). Unfortunately, many online doctoral candidates shy away from quantitative methods of research due to statistics anxiety (Huang, 2018; Thompson et al., 2019). Online students may be particularly hesitant when it comes to statistics, as students need to make an extra effort to connect with their instructors in order to feel adequately supported (DeVaney, 2010; Mills & Raju, 2011; Thompson et al., 2019). Additionally, graduate students in the social sciences often have little mathematics and statistics background, making this population more susceptible to statistics anxiety (Keeley et al., 2008; Onwuegbuzie, 2000; Tutkun, 2019). Because of this anxiety, some doctoral students struggle in statistics courses, which can affect their overall student experience as well as future research endeavors.

Statistics anxiety is rooted in mathematics anxiety and test anxiety. Mathematics anxiety manifests itself in negative physiological, cognitive, and behavioral reactions when a person is presented with mathematical content or problems (Hopko et al., 2003). Test anxiety is similar to mathematics anxiety in that there are negative physiological, cognitive, and behavioral reactions that prevent individuals from being able to focus on test questions and accurately recall material (Onwuegbuzie, 2000). Statistics anxiety has been defined as any anxiety a student experiences when they encounter statistics in any form and at any level of complexity (Onwuegbuzie et al., 1997). It typically causes the individual to feel confused and unable to understand concepts when presented with statistics material.

To help understand statistics anxiety better, Cruise et al. (1985) identified six specific aspects of statistics anxiety. These dimensions are, (1) Worth of statistics, which relates to how students view statistics in regard to its relevance to their field of study; (2) interpretation anxiety, which relates to how a student feels when he or he must interpret statistical data or make an informed decision based on this interpretation; (3) test and class anxiety, which relates to students' concerns with their performance in a class or when taking a test; (4) computational self-concept, which relates to students' self-perception of mathematics abilities; (5) fear of asking for help, which relates to the anxiety of asking for help with any aspect of the statistics course materials, and; (6) fear of statistics teachers relates to any anxiety the student may experience related to the statistics course instructor (Cruise et al., 1985; Onwuegbuzie, 2000).

Studies have shown that statistics anxiety may cause students to struggle in their statistics courses and as a result negatively impact their performance (Keeley et al., 2008; Macher et al., 2011; Onwuegbuzie, 2003; Onwuegbuzie, 1997, 2000). Students who experienced high levels of statistics anxiety earned lower grades than those exhibiting lower levels of statistics anxiety (Keeley et al., 2008; Macher et al., 2011; Onwuegbuzie, 2003). In addition to affecting academic

performance, Onwuegbuzie (2000) notes that a student's experience in a statistics course may "cement their attitudes toward" statistics in the future (p. 323). This could mean that a student who struggles in their statistics methods course may avoid conducting quantitative research of their own. Further, students who do not perform well in statistics courses may potentially lack an understanding of statistical data in research articles when reviewing other studies for their own research (Jordan & Haines, 2003; Onwuegbuzie, 2000). Ultimately, this may affect a student's ability to successfully make the transition from student to scholar.

Problem Statement

There has been a steady increase in online program enrollment since about 2006, especially in online graduate and doctoral programs (Okahana & Zhou, 2017). Due to this growth, many administrators are concerned with retention and student experience. Courses such as statistics may pose a problem as doctoral students experience some level of statistics anxiety that could affect academic performance (Onwuegbuzie, 2000). This is further compounded by the challenges of learning difficult material in an online setting (Mills & Raju, 2011). The problem is that there is currently limited research that looks at how the specific type of statistics anxiety affects students' performance in an online statistics course (Thompson, 2019). More specifically, the six dimensions of statistics anxiety, identified by (Cruise et al., 1985; Onwuegbuzie, 2000) may add insight into the problem warranting further investigation.

Purpose Statement

The purpose of this predictive correlational study was to determine what type of statistics anxiety best predicts final grades for doctoral students in an online statistics course at a large faith-based university in the southeast United States. The students whose records were used for this study were enrolled in online doctoral education programs that required an advanced

educational statistics course as part of the degree completion requirements. All students in this study completed the same statistics course in the 2019-2020 academic year.

The predictor variables in this study consisted of six dimensions of statistics anxiety, based on a study by Cruise et al. (1985), in which the authors sought to validate an instrument for measuring statistical anxiety. The six dimensions of statistics anxiety are *worth of statistics*, *interpretation anxiety*, *test and class anxiety*, *computational self-concept*, *fear of asking for help*, and *fear of statistics teacher* (Cruise et al., 1985). Worth of statistics relates to how students view statistics in regard to its relevance to their field of study; interpretation anxiety relates to how a student feels when he or he must interpret statistical data or make an informed decision based on this interpretation; test and class anxiety relates to students' concerns with their performance in a class or on when taking a test; computational self-concept relates to students' self-perception of mathematics abilities; fear of asking for help relates to the anxiety of asking for help with any aspect of the statistics course materials, and; fear of statistics teachers relates to any anxiety the student may experience related to the statistics course instructor (Cruise et al., 1985; Onwuegbuzie, 2000).

The criterion variable was the students' final course grades from the online statistics course. The final grade was based on a 1010-point scale derived from scores on weekly assignments consisting of discussion boards, worksheets, and quizzes.

Archival data were used for this study. The students' records were retrieved from the learning management system (LMS), Blackboard. The LMS contained a discussion board where the students identify their self-reported specific statistics anxiety based on Cruise's et al. (1985) six dimensions and the students' corresponding final grade.

Significance of the Study

As online doctoral program enrollment grows, specifically in the social sciences, many more students are being exposed to what might be the only statistics courses they have ever been required to take (Keeley et al., 2008; Okahana & Zhou, 2017; Onwuegbuzie, 2000). Onwuegbuzie (2000) notes that students' experiences in statistics courses may not only affect academic performance, but could also impact their abilities to fully understand research articles when conducting their own studies. Additionally, with growing numbers of online doctoral program enrollment, it is important for administrators to determine best practices for adequately supporting students in courses that have traditionally been problematic to student success (Bronstein, 2008; Gainen, 1995).

Studies have shown that research methods and statistics courses have historically been problematic for doctoral students, especially in online programs, as many of these students do not feel adequately prepared in research methods in order to persist to completion of the dissertation or scholarly project (Bronstein, 2008; Kelley & Salisbury-Glennon, 2016). Studies have shown that statistics anxiety could be a significant factor in student performance in statistics courses (Onwuegbuzie et al., 1997; Onwuegbuzie, 2000; Thompson et al., 2019). Cruise et al. (1985) identified six different aspects, or dimensions, of statistics anxiety: (1) worth of statistics, (2) interpretation anxiety, (3) test and class anxiety, (4) computational self-concept, (5) fear of asking for help, and (6) fear of statistics teachers. Each of these dimensions could have a unique impact on student performance in statistics courses. There are few current studies that look specifically at how the six dimensions of statistics anxiety might affect online student performance in a doctoral statistics course. Research in this area could provide important information that would enable instructors and administrators to determine ways to better support doctoral students in online statistics courses.

Research Question

RQ: What type of self-reported statistics anxiety best predicts final grades for doctoral students in an online statistics course?

Definitions

1. *Computational self-concept* - students' self-perception of mathematics abilities (Cruise et al., 1985; Onwuegbuzie, 2000).
2. *Fear of asking for help* - Anxiety related to asking for help with any aspect of the statistics course materials (Cruise et al., 1985; Onwuegbuzie, 2000).
3. *Fear of statistics teachers* - Any anxiety the student may experience related to the statistics course instructor (Cruise et al., 1985; Onwuegbuzie, 2000).
4. *Interpretation anxiety* – The way a student feels when he or he must interpret statistical data or make an informed decision based on this interpretation (Cruise et al., 1985; Onwuegbuzie, 2000).
5. *Statistics anxiety* - Any anxiety a student experiences when they encounter statistics in any form and at any level of complexity (Onwuegbuzie et al., 1997).
6. *Test and class anxiety* – Students' concerns with their performance in a class or on when taking a test (Cruise et al., 1985; Onwuegbuzie, 2000).
7. *Worth of statistics* – The way students view statistics in regard to its relevance to their field of study (Cruise et al., 1985; Onwuegbuzie, 2000).

CHAPTER TWO: LITERATURE REVIEW

Overview

Chapter Two contains a discussion of the theoretical framework that guided the study. Statistics anxiety is defined and addressed in detail after exploring its antecedent, mathematics anxiety. Existing research is explored and discussed in the areas of statistics anxiety, online statistics course delivery, and online doctoral student support. The chapter concludes with a discussion of how the current study adds to the literature regarding supporting online doctoral students in their research methods and statistics courses.

Theoretical Framework

Statistics anxiety is a construct that helps explain the various mental, emotional, and physiological processes students experience when they encounter anxiety related specifically to statistics. To better understand statistics anxiety and how it affects online doctoral student performance, self-efficacy theory and cognitive-attentional theory provided a theoretical framework for this study.

Self-Efficacy Theory

Self-efficacy theory stems from Bandura's (1977a, 1977b) social cognitive theory, which asserts that people learn from their own experiences as well as from observing others and the results of others' experiences. Whether through direct experience or through vicarious experience, people learn behaviors and develop thoughts about a task, which can influence their ability to learn and their ability to perform a task. Self-efficacy theory is founded on the idea that people's expectations of how well they will perform a task directly affects their performance. Onwuegbuzie (2003) summarizes self-efficacy theory as how "an individual's belief system influences behavior choices, effort invested, persistence, and task success" (p. 1022). When people have low expectations of their abilities, they may experience emotional or physiological

arousal that affects the level of effort or persistence they exert to complete a task, or may result in avoidance of the task altogether (Bandura & Adams, 1977). Self-efficacy is a concept that has been well-researched in the field of education, and studies have shown that self-efficacy often has a positive correlation to academic performance (Hoegler & Nelson, 2018; Honicke & Broadbent, 2015).

A person's sense of self-efficacy is typically influenced by one of four main factors: personal experiences performing a task, vicarious experiences watching others performing a task, verbal persuasion from others regarding one's ability to perform a task, and physiological responses to a situation (Bandura & Adams, 1977). These four factors are discussed throughout the literature, specifically in the literature regarding academic self-efficacy and its effect on academic achievement.

According to Bandura and Adams (1977), personal experiences with performing and attempting to master a task have a great influence on a person's sense of self-efficacy regarding that task. Prior positive learning experiences can lead to increased self-efficacy (Elias & MacDonald, 2007; Putwain et al., 2012). In a study conducted by Putwain et al. (2012), the researchers found that students who had greater success in their academic performance in the first semester of an academic year had more positive learning-related emotions in the second semester, which, in turn, predicted better performance in the second semester. Depending on whether a previous experience had a positive or negative result can greatly influence a person's development of positive or negative self-efficacy beliefs regarding a specific task.

Another factor that can influence self-efficacy is vicarious experience (Bandura & Adams, 1977; Kozar et al., 2015). Vicarious experiences occur when people observe others engaging in an activity or task (Kozar et al., 2015). According to Kozar et al. (2015), one of the major differences in online learning for doctoral students is that they are not able to observe their

instructors and peers in the same way they could in a residential course. For some students, this may result in feeling a lack of preparedness when it comes to the demands of a doctoral program or certain courses in particular (Bartsch et al., 2012; Kozar et al., 2015). On the other hand, some students find they are able to be successful in online programs and do not view the lack of faculty and peer interaction as a hindrance (Kozar et al., 2015). Kozar et al. (2015) suggest that these students may be seeking out interaction with peers (and therefore having vicarious experiences) at local research centers or conferences. Alternatively, structured interactive assignments within the online course may provide enough of a vicarious experience for some students (Kozar et al., 2015).

Self-efficacy can also be impacted by verbal persuasion. Verbal persuasion is defined as providing comments or feedback with the intention of influencing someone to successfully complete a task (Hodges, 2008). Bandura (1997) is careful to note that verbal persuasion is more than simply kind words of encouragement, but rather it is intentional feedback regarding a person's performance, as the former may result in unrealistic expectations and could lead to decreased self-efficacy in the event of a failure in performance. Verbal persuasion may not always be as effective as vicarious experience in influencing someone, as verbal persuasion requires that the persuader is considered to be credible (Hodges, 2008; Zimmerman, 2000). However, verbal persuasion seems to be effective in cases where the person attempting a task is just within reach of being able to accomplish it (Hodges, 2008).

The physiological or affective state of a person can affect his or her performance when attempting to complete a task. Physiological responses to a situation are related to the emotions experienced when attempting to complete a task, and can manifest in ways such as fatigue, feelings of stress, or altered mood (Hodges, 2008; Zimmerman, 2000). Students may assess their physiological reactions to a task as a measure of their ability to successfully perform the task

(Hodges, 2008; Zimmerman, 2000). The level of physiological arousal can either negatively or positively affect performance. In some cases, physiological arousal may result in increased awareness and ability to perform a task (Hodges, 2008). In other cases, the physiological arousal may result in disrupting a person's ability to focus on and complete the task successfully (Bandura & Adams, 1977).

Of the four factors related to self-efficacy, past experiences, or enactive experiences, are often considered to have the most influence on a person's performance of a task (Zimmerman, 2000). The outcomes of these experiences influence one's confidence to perform a task in either a positive or a negative way, which, in turn, affects one's behaviors toward the task. For example, students who have struggled in math or statistics courses in the past may have low self-efficacy in regards to taking future statistics courses. This may result in students avoiding taking these courses or in poor academic performance once they do take these courses (Onwuegbuzie, 2004). Studies have shown that students who have had negative experiences in math or statistics courses in the past often struggle with performance in current math or statistics classes (Cui et al., 2019; Lalayants, 2012; Onwuegbuzie, 2004). In the case of negative past experiences, students' expectations may be that they will not perform well, which influences behaviors such as study habits or ability to focus during a test (Onwuegbuzie, 2004).

In the current study, self-efficacy helps give understanding to how and why statistics anxiety might affect online doctoral students. When considering the six dimensions of statistics anxiety (worth of statistics, interpretation anxiety, test and class anxiety, computational self-concept, fear of asking for help, and fear of statistics teacher) presented by Cruise et al. (1985), it is clear that some aspects of statistics anxiety relate to a student's self-perceived abilities when it comes to learning statistics and conducting statistical analysis. Interpretation anxiety, test and class anxiety, and computational self-concept all directly relate to the student's abilities and

sense of self-efficacy (Onwuegbuzie, 2000). Worth of statistics, fear of asking for help, and fear of statistics teacher may also be areas of statistics anxiety that are related to self-efficacy, as some students may have perfectionist tendencies, and therefore may either try to dismiss statistics as unimportant to them or avoid asking for help in order to avoid embarrassment (Onwuegbuzie, 2004; Onwuegbuzie & Daley, 1999).

Cognitive-Attentional Theory

While self-efficacy theory helps explain how students' experiences and sense of confidence impact their performance, Wine's (1980) cognitive-attentional theory provides a framework for further understanding how anxiety disrupts mental processes while performing a task. In this theory, Wine (1980) focuses primarily on test anxiety and exploring the cognitive processes that may detract a student's attention while taking a test. Cognitive-attentional theory describes how students may have distracting or negative thoughts or emotions that make it difficult for them to concentrate fully on the task or to recall information pertinent to completing the task. Wine (1980) suggests that the working memory is compromised when these distracting or negative thoughts or emotions are present. Highly anxious students may find themselves preoccupied and directing their attention to other thoughts or emotions that ultimately distract them from the task on which they should be focusing or from the information that they should be learning (Wine, 1980; Onwuegbuzie, 2003).

In the context of statistics anxiety, cognitive-attentional theory may help explain why students struggle to understand statistical concepts or to perform well during statistical analyses. According to Onwuegbuzie (2003), "Wine's theory predicts that anxiety interferes with performance by impeding students' ability to receive, to concentrate on, and to encode statistical terminology, language, formulas, and concepts" (p. 1033). Onwuegbuzie and Wilson (2000) noted that in some ways the process of learning statistics is similar to learning a foreign

language, which can result in high levels of anxiety due to the unfamiliarity of certain terms and concepts. Additionally, Onwuegbuzie (2004) notes that many students who struggle with statistics anxiety experience emotional reactions that can range from mild discomfort to feelings of panic. When students are focused on anxious thoughts or feelings of panic, they may have difficulty remembering key information and fully processing important concepts.

Cognitive-attentional theory provides a framework to help explain why students in online programs may struggle in their statistics courses. Cognitive-attentional theory seems to relate most to three of the six dimensions of statistics anxiety: (a) interpretation anxiety, (b) test and class anxiety, and (c) computational self-concept. Regarding interpretation anxiety and test and class anxiety, it stands to reason that if a student's working memory is interrupted due to anxious thoughts or physiological reactions of anxiety, then he or she may struggle to interpret data, recall information during a test, or may believe he or she is simply not capable of understanding statistics. This could be even more of an issue for students in fully online programs who may experience increased anxiety due to the independent nature of online courses compared with face-to-face courses (Tonsing, 2018).

Computational self-concept refers to how a student perceives his or her abilities to understand and perform mathematics-related tasks (Cruise et al., 1985; Onwuegbuzie, 2000). Cognitive-attentional theory relates to this dimension of statistics anxiety in that a negative computational self-concept could lead to negative and distracting thoughts that disrupt students' working memory or hinder their learning, and therefore could result in poor course performance. Students who are highly statistics anxious and struggle with computational self-concept may benefit from additional support from the statistics instructor in order to gain a sense of confidence in their abilities (Tonsing, 2018). In an online course environment, a statistics

instructor may need to take extra steps to reach out and to provide support to students who may be struggling with low computational self-concept (Thompson et al., 2019).

Related Literature

Statistics anxiety can be a significant hindrance to academic performance and comprehension of research methods course material for many graduate students (Onwuegbuzie, 2004; Onwuegbuzie, 2000). Studies have shown statistics anxiety has its roots in math anxiety (Benson, 1989; Hopko et al., 2003; Onwuegbuzie, 2000). In order to fully understand statistics anxiety, it is important to examine its similarities to math anxiety, as well as the factors that make it its own unique type of anxiety. Additionally, with the rise of online graduate programs, statistics anxiety may be even more prevalent as it is compounded with the challenges of online learning environments.

Mathematics Anxiety

Mathematics anxiety refers to feelings of fear or uncertainty regarding one's ability to successfully understand and complete math-related tasks (Paechter et al., 2017; Ramirez et al., 2018; Richardson & Suinn, 1972). Those who experience math anxiety typically have negative thoughts about math and about their ability to complete mathematical tasks, which can interfere with their ability to focus on solving a mathematical problem (Ramirez et al., 2018). Researchers have pinpointed mathematics anxiety as a unique construct, even though it shares some of the same characteristics as other forms of anxiety, such as test anxiety (Ashcraft & Faust, 1994). Math anxiety can induce physiological reactions in people such as increased heart rate and elevated cortisol levels when they are dealing specifically with situations that require the use of mathematics (Ramirez et al., 2018). The psychological and physiological stress of math anxiety can make it difficult for students to focus on the concepts they need to learn and may interfere with working memory when trying to recall information in order to perform mathematical tasks

(Paechter et al., 2017). To better understand math anxiety, it is important to look at theories related to mathematics anxiety, assessment of math anxiety, the relationship between attitudes toward mathematics and mathematics anxiety, mathematics anxiety and academic performance, and factors that affect mathematics anxiety.

Related Theories and Models

There are several prominent theories and models that have been investigated in the research surrounding the causes of mathematics anxiety and how they might affect math achievement. There is conflicting evidence among various mathematics anxiety studies as to whether mathematics anxiety causes poor performance, or whether poor performance (or a mathematics-learning deficit) causes mathematics anxiety (Carey et al., 2016; Ramirez; 2018). Despite some variation in regards to the origin of mathematics anxiety, it is worth looking at some of the prominent ideas in this area in order to better understand how mathematics anxiety may develop in some individuals and what impact it may have on their abilities to perform mathematics-related tasks. Among these theories and models are the disruption account, reduced competency account, and the reciprocal theory.

Disruption Account. Ramirez et al. (2018) note that a prevalent theory related to mathematics anxiety is the disruption account, which proposes that some students are predisposed to have math anxiety, and that it causes a disruption to one's working memory and ability to recall information due to negative or distracting thoughts about failing at the mathematics task. Studies have shown that the brain functions differently for low- and high-anxious students (Pletzer et al., 2015). For example, Pletzer et al. (2015) conducted a study in which neuroimaging was used to study how the brain functions while students of varying levels of mathematics anxiety completed mathematical tasks. The results of the study indicated that the brain activity in students with higher mathematics anxiety was such that they seemed to be

unable to inhibit distracting thoughts brought on by an emotional response while completing the mathematics task, thus reducing the efficiency of their working memory (Pletzer et al., 2015). The disruption account affirms elements of Wine's (1980) cognitive-attentional theory, which asserts that students' attention is redirected when they are faced with a situation that causes anxiety. For example, a student may be thinking about the possible consequences of performing poorly on a math exam, which could hinder his or her ability to quickly recall pertinent information needed to correctly solve equations (Ramirez et al. 2018).

Reduced Competency Account. Another theory used to help explain mathematics anxiety is the reduced competency account. Rather than mathematics anxiety causing poor mathematics abilities, the reduced competency account suggests that lower mathematics abilities leads to poor performance, which, in turn, causes mathematics anxiety (Ramirez et al., 2018). Additionally, students with lower math abilities may not take opportunities to improve their mathematics skills by avoiding taking mathematics courses or procrastinating on assignments (Ashcraft, 2002; Paechter et al., 2017; Ramirez et al., 2018). Reduced numerical processing abilities can be an issue for some students, leading to negative experiences with mathematics and possibly resulting in the development of mathematics anxiety (Ramirez et al., 2018). The development of mathematics anxiety can then continue a cycle of poor performance in mathematics or avoidance of mathematics (Ramirez et al., 2018). For example, a student may struggle to understand concepts and perform well in a math class due to a numerical processing difficulty. The negative experiences in the class may cause the student to develop mathematics anxiety, which, in turn, causes the student to avoid mathematics courses or activities that would provide opportunities to improve their abilities (Ramirez et al., 2018).

Reciprocal Theory. Another theory related to mathematics anxiety looks at the two possible causal directions of mathematics anxiety and performance. Carey et al. (2016) posit that

there are two main ideas regarding the causal direction of mathematics anxiety and performance that are in opposition to one another. The first idea is related to the deficit theory, which suggests that poor performance leads to negative memories that induce mathematics anxiety (Carey et al., 2016). The second idea is related to the debilitating anxiety model, which suggests that anxiety inhibits cognitive abilities when trying to complete a mathematics-related task (Carey et al., 2016). In the first case, poor performance causes anxiety and in the second case anxiety causes poor performance.

Carey et al. (2016) suggest that given the mixed results of some studies that report data supporting the deficit theory and some studies that report data supporting the debilitating anxiety model, the causal direction of mathematics anxiety and performance might be better explained by the reciprocal theory. The reciprocal theory suggests that mathematics anxiety and performance can influence one another in a cyclical manner, where, for example, poor performance induces mathematics anxiety, and that mathematics anxiety contributes to future poor performance (Carey et al., 2016). Carey et al. (2016) note that it may not be possible for one study to show both causal directions due to methodological constraints, and so this theory would need to be tested further using varied data collection methods, possibly over longer periods of time.

Assessment of Math Anxiety

Mathematics anxiety is a concept that first began gaining recognition in the 1950s as researchers sought to understand why some students seemed to be proficient in all other academic subjects but struggled with math (Ashcraft & Faust, 1994; Ashcraft & Moore, 2009). One of the most commonly used scales of mathematics anxiety is the Mathematics Anxiety Rating Scale (MARS).

Mathematics Anxiety Rating Scale (MARS). Richardson and Suinn (1972) developed the Mathematics Anxiety Rating Scale (MARS) in order to be able to measure math anxiety in students. Their scale was based on the theory that mathematics anxiety is a unique construct and that developing a specific instrument to measure anxiety in this one area would prove more useful to address mathematics anxiety rather than using a more general anxiety scale. The MARS consists of 98 items describing various situations involving mathematics that might induce anxiety in a person. A person completing the MARS would select a response on a scale of 1 to 5, with 1 indicating no anxiety related to the situation and 5 indicating a high level of anxiety related to the situation. Though the MARS has provided a valid and reliable measure to determine a person's level of mathematics anxiety, there is still more for researchers to investigate related to the exact way that the level of anxiety affects performance in mathematics (Ashcraft & Faust, 1994; Ramirez et al., 2018).

Data from studies using the MARS show that those who are highly math anxious tend to perform lower on math-related tasks than those who are low math anxious; however, it is uncertain how this anxiety translates into specific actions that affect performance (Ashcraft & Faust, 1994; Ramirez et al., 2018; Richardson & Suinn, 1972). For example, those who are highly math anxious may have distracting thoughts that prevent them from recalling information, they may be those who have less math training and experience, or they may simply second-guess their work and spend too much time changing answers on a test (Ashcraft & Faust, 1994). Understanding how math anxiety specifically affects the execution of a math problem is necessary in order to know how to help people overcome math anxiety.

Assessing and properly treating mathematics anxiety can be difficult, as there are many different personal and environmental factors that can impact someone's mathematics experiences (Luttenberger et al., 2018; Ramirez et al., 2018). While it is difficult to know exactly what causes

math anxiety in a person, researchers seem to generally believe it has to do with one or a combination of three things: "(a) poor math skills, (b) genetic predispositions, or (c) socioenvironmental factors" (Ramirez et al., 2018, p. 148). Pinpointing exactly what variables are interacting to cause math anxiety in a person is a topic of ongoing research (Luttenberger et al., 2018).

Attitude Towards Mathematics

Attitude towards mathematics refers to how a person perceives the usefulness or enjoyment of mathematics and can affect the level to which he or she is motivated to successfully learn and implement mathematical knowledge and skills (Hodges & Kim, 2013). There is a distinct difference between math anxiety and attitudes toward math, as anxiety refers to an emotional response whereas attitude is a cognitive response that refers to perceived usefulness or enjoyment of something (Dowker et al., 2016). Research has shown a negative relationship between attitudes toward math and mathematics anxiety (Dowker et al., 2016). For example, in their study Mazana et al. (2019) found a significant positive correlation between students' attitudes toward mathematics and their grades in the mathematics course for students among various grade levels in Tanzania. Data from Mazana et al.'s (2019) study indicated that attitude factors such as perceived usefulness, confidence, enjoyment, and motivation were the most highly positively correlated to student achievement in a mathematics course. Thus, positive attitudes toward mathematics may indicate the presence of student qualities or perceptions that result in less mathematics anxiety, and therefore better performance in math-related tasks (Hodges & Kim, 2013; Mazana et al., 2019).

Mathematics Anxiety and Academic Performance

Some studies have shown that high levels of mathematics anxiety have a negative relationship to student performance in a mathematics class (Ashcraft & Moore, 2009; Karimi &

Venkatesan, 2009). According to Ashcraft and Moore (2009), math anxiety can result in poor mathematics performance, especially under timed conditions. Ashcraft and Moore (2009) also suggest that math anxiety is not necessarily the result of a lack of ability, but rather they support the idea that anxiety causes a disruption in working memory, causing students to struggle when completing mathematics tasks. A study by Skagerlund et al. (2019) looked specifically at the relationship between mathematics anxiety and working memory and found that mathematics anxiety seemed to significantly affect participants' mathematics performance by affecting their working memory ability.

Gender and Mathematics Anxiety

Studies have also indicated that female students tend to have higher levels of math anxiety than their male counterparts (Ashcraft & Faust, 1994; Karimi & Venkatesan, 2009; Paechter et al., 2017; Ramirez et al., 2018). A study conducted by Karimi and Venkatesan (2009) of high school students in South India indicated that female students experienced mathematics anxiety more frequently than male students, however, female students seemed to actually perform just as well as the male students in their mathematics course.

While there is no exact answer as to why studies have shown that females tend to experience higher levels of mathematics anxiety, there has been some speculation. Ashcraft (2002) suggests that females may be more likely to admit to experiencing math anxiety than males. Goetz et al. (2013) found that social conditioning may be more to blame for the higher levels of reported math anxiety by females when compared to males. In their study, Goetz et al. (2013) found that female students were more likely to self-report higher levels of mathematics anxiety, however, when assessed for math anxiety directly before and after completing a mathematics task, the female students did not seem to have higher levels of math anxiety than the male students. Goetz et al.'s (2013) findings suggest that perhaps there is an expectation in

society that females will experience more mathematics anxiety, and therefore more female students expect this to be a problem for them.

Age and Mathematics Anxiety

Age may also be a factor that affects the level of mathematics anxiety experienced by students. Students may begin experiencing mathematics anxiety as early as in elementary school, and it may continue to increase for some students through high school (Ramirez et al., 2018). Ramirez et al.'s (2018) review of literature surrounding the development of mathematics anxiety revealed mixed results regarding patterns in mathematics anxiety levels in students from middle school and high school. According to this review, some students tended to have the highest level of math anxiety in the ninth grade, which then leveled off in subsequent years. Other studies reviewed by Ramirez et al. (2018) showed high levels of math anxiety around seventh grade, which then declined in subsequent grades. For students in early elementary school, some studies indicated that students experienced a decrease in math anxiety over the course of the school year and as they advanced from the first to the third grade (Ramirez et al., 2018).

Other research has looked specifically at how mathematics anxiety affects adult learners. Jameson (2020) conducted a mixed-methods study of female adult learners to identify causes of mathematics anxiety. Jameson (2020) specifically focused on female adult learners, who may experience even more mathematics anxiety than their traditional student counterparts. Jameson's (2020) study revealed that adult learners may struggle in mathematics courses due to the amount of time that has elapsed since they last took formal mathematics courses, which may make it difficult to recall information, therefore resulting in increased anxiety. Additionally, adult learners typically need to be able to apply their real-world experience to the material they are learning in order to feel a sense of mastery of the subject (Jameson, 2020). Some mathematics

courses may not focus enough on incorporating real-world experiences in the curriculum to aid in subject mastery for adult learners.

Statistics Anxiety

Statistics anxiety has been defined as any anxiety a person experiences when they encounter statistics in any form and at any level of complexity (Onwuegbuzie et al., 1997; Paechter et al., 2017). Statistics anxiety typically causes the individual to feel confused and unable to understand concepts or perform statistical analysis when presented with statistics material. Statistics anxiety shares similarities with mathematics anxiety; however, statistics anxiety has been identified as a unique construct that includes elements specific to situations involving statistics (Baloğlu, 2004; Paechter et al., 2017). In order to better understand statistics anxiety, it is important to look at related theories, relationship between mathematics anxiety and statistics anxiety, assessment of statistics anxiety, relationship between attitudes toward statistics and statistics anxiety, statistics anxiety and academic performance, and factors that influence statistics anxiety (i.e, gender, age).

Related Theories

When it comes to providing a framework for understanding the construct of statistics anxiety, there are a couple of prominent theories. Some researchers have used Wine's (1980) cognitive attentional theory as a framework to explain poor performance in statistics courses (Benson, 1989; Musch & Bröder, 1999; Onwuegbuzie, 2003; Onwuegbuzie & Wilson, 2000). First developed as a way to better understand test anxiety, cognitive-attentional theory is a cognitive interference model that has helped explain how working memory may be disrupted as the mind focuses on negative thoughts or feelings related to statistics. Distracting thoughts make it difficult for students to recall information necessary to perform statistics-related tasks, and ultimately impacts understanding of statistics as well as academic performance.

Another model that is prominent in the literature regarding statistics anxiety is the deficit model (Carey et al., 2016; Hoegler & Nelson, 2018; Onwuegbuzie, 2004). This model suggests that there could be deficits in certain knowledge and skills that leads to poor performance. Research suggests that the deficit in learning statistics can be caused by statistics anxiety, which has the potential to result in students avoiding studying course material and preparing for coursework and exams (Hoegler & Nelson, 2018; Onwuegbuzie, 2004; Paechter et al., 2017). Ultimately, the deficit theory helps elucidate how statistics anxiety can lead students to be ill prepared to complete certain statistics-related tasks, such as taking an exam, which can result in poor performance.

Relationship to Mathematics Anxiety

Statistics anxiety has been found to be related to various aspects of a person's mathematics experience, preparation, and self-concept (Onwuegbuzie, 2004; Paechter et al., 2017). Researchers have found that students who have taken less mathematics coursework experience greater levels of statistics anxiety when compared to students who have taken more mathematics courses (Benson, 1989; Onwuegbuzie & Wilson, 2000). Additionally, students who were identified as being less oriented toward logical-mathematical intelligence had higher levels of anxiety related to computational self-concept in statistics (Daley & Onwuegbuzie, 1997).

Research has shown that anxiety related to statistics is more than simply an extension of mathematics anxiety (Baloğlu, 2004; Paechter et al., 2017). Cruise et al. (1985) were among the first researchers to assert that mathematics anxiety did not fully account for all of the factors related to statistics anxiety. Statistics anxiety occurs specifically in situations involving statistical analysis, which incorporates elements of verbal reasoning and uses different logical and inductive reasoning skills than simple mathematics would require (Baloğlu, 2004; Chew & Dillon, 2014; Paechter et al., 2017). While statistics anxiety shares similar qualities with

mathematics and test anxiety, statistics requires the use of different mental processes and requires verbal reasoning and data interpretation skills that go beyond simply manipulating numbers and symbols (Chew & Dillon, 2014; Cui et al., 2019).

Studies have supported the distinction between mathematics anxiety and statistics anxiety, showing that mathematics anxiety did not necessarily have a negative correlation to performance in statistics courses, while statistics anxiety did appear to have a negative correlation to performance in statistics courses (Paechter et al., 2017; Zeidner, 1991). In some cases, there was a positive correlation between mathematics anxiety and statistics course performance (Chew & Dillon, 2014). Paechter et al. (2017) found that some students with higher levels of mathematics anxiety also experienced higher levels of statistics anxiety, but overall, these students had better grades in their statistics coursework than students with lower levels of mathematics and statistics anxiety. The authors posit that this could be because students expect to have difficulty in the statistics course based on their previous mathematics experiences, and therefore they may put forth greater effort to try to do well in the statistics course (Paechter et al., 2017).

Assessment of Statistics Anxiety

Cruise et al. (1985) were among the first researchers to assert that statistics anxiety was a unique construct and not simply a form of mathematics anxiety. Statistics anxiety requires different mental processes and goes beyond understanding mathematical concepts to being able to analyze and interpret data (Cruise et al., 1985; Baloğlu, 2004). Cruise et al. (1985**)** developed the Statistics Anxiety Rating Scale (STARS), which identified six areas that may cause feelings of anxiety related to statistics.

Six Dimensions of Statistics Anxiety. Cruise et al. (1985) identified six specific dimensions of statistics anxiety: (a) Worth of statistics, which relates to how students view

statistics in regard to its relevance to their field of study; (b) interpretation anxiety, which relates to how a student feels when he or he must interpret statistical data or make an informed decision based on this interpretation; (c) test and class anxiety, which relates to students' concerns with their performance in a class or when taking a test; (d) computational self-concept, which relates to students' self-perception of mathematics abilities; (e) fear of asking for help, which relates to the anxiety of asking for help with any aspect of the statistics course materials, and; (f) fear of statistics teachers relates to any anxiety the student may experience related to the statistics course instructor (Cruise et al., 1985; Onwuegbuzie, 2010).

Onwuegbuzie et al. (1997) built upon the work of Cruise et al. (1985) and identified four primary components that help to better explain the nature of the various dimensions of statistics anxiety: (a) instrument anxiety, (b) content anxiety, (c) interpersonal anxiety, and (d) failure anxiety. These four components provide a way to categorize and further understand the six dimensions of statistics anxiety presented by Cruise et al. (1985). According to their qualitative study regarding statistics anxiety in graduate students, Onwuegbuzie et al. (1997) found that instrument anxiety consisted of issues such as computational self-concept and statistical computing anxiety. The researchers also found that some students dealt specifically with content anxiety, which could consist of issues such as understanding statistical language the perceived worth of statistics. Interpersonal anxiety was a theme that arose from students expressing a fear of asking for help or a fear of the statistics teacher. Finally, failure anxiety appeared to be an issue for many of the students who expressed serious concerns with their grades and their attempts to study and understand the material (Onwuegbuzie et al., 1997).

It is also important to note that the six dimensions of statistics anxiety are really made up of two subscales measuring two different things: statistics anxiety and attitude toward statistics. Chew and Dillon (2014) have pointed out that the STARS is often used to measure just statistics

anxiety, however, three of the six dimensions are actually measures of attitude. The authors note that test and class anxiety, interpretation anxiety, and fear of asking for help are the only three dimensions that measure anxiety. Worth of statistics, computational self-concept, and fear of the statistics teacher measure attitude toward statistics.

Attitude Toward Statistics

In order to understand how attitudes toward statistics affects statistics anxiety, it is important to first define attitude in this context. Attitudes toward statistics have been described as a construct made up of four components: *affect*, *cognitive competence*, *value*, and *difficulty* (Lavidas et al., 2020; Schau, 2003). The *affect* component refers to students' feelings regarding statistics. The *cognitive competence* component refers to students' attitudes about their personal level of knowledge and abilities in statistics. The *value* component refers to students' perceptions of the usefulness and importance of statistics in their personal and professional lives. The *difficulty* component refers to students' perceptions of the level of difficulty of statistics as a subject of study (Lavidas et al., 2020).

Attitudes toward statistics have been shown to impact students' levels of statistics anxiety, which in turn can affect their ability to understand statistical concepts and to be successful in statistics courses (Chiesi & Primi, 2018; Chew & Dillon, 2014; Dempster & McCorry, 2009; Onwuegbuzie, 2000; Onwuegbuzie, 2003; Rosli & Maat, 2017). Chiesi and Primi (2018) found that psychology students who developed more positive attitudes toward statistics during a statistics course earned higher grades on the midterm exam than students whose attitudes became more negative. The researchers suggest that increased positive attitudes may result in reduced statistics anxiety, allowing students to perform better in the course (Chiesi & Primi, 2018).

Studies have shown that students' attitudes toward statistics are predictive of students' performance in statistics courses (Emmioğlu & Capa-Aydin, 2012; Lavidas et al., 2020). When considered individually, there are varying levels of correlation between each of the four components of attitudes toward statistics (*affect*, *cognitive competence*, *value*, and *difficulty*) and students' performance in statistics courses (Emmioğlu & Capa-Aydin, 2012; Lavidas et al., 2020). Studies tend to show a moderate correlation between *affect* and student performance and *cognitive competence* and student performance, and low correlations between *value* of statistics and student performance and *difficulty* of statistics and student performance (Emmioğlu & Capa-Aydin, 2012; Lavidas et al., 2020). The overall findings, however, indicate that more positive attitudes toward statistics are correlated to better performance in statistics courses (Emmioğlu & Capa-Aydin, 2012).

Some researchers have begun to look more carefully at differentiating between the effect of statistics anxiety and the effect of attitude toward statistics on student achievement (Chew & Dillon, 2014; Devaney, 2016; Macher et al., 2015). Chew and Dillon (2014) have indicated that many researchers may be using measures such as the Statistics Anxiety Rating Scale (STARS) incorrectly by failing to differentiate between anxiety and attitude scores. Chew and Dillon (2014) noted that many researchers use the composite score of both subscales (consisting of the six dimensions of statistics anxiety) in the STARS to assess statistics anxiety, when, in fact, only three dimensions measure anxiety and the other three measure attitudes. Chew and Dillon (2014) also note that statistics anxiety sometimes leads to better course performance for students, whereas negative attitudes toward statistics often results in poor course performance; therefore, it is important to differentiate between the scores of the two subscales in order to accurately assess whether anxiety or attitude affects statistics performance.

Despite the importance of statistics in the social sciences, many students in social science degree programs are surprised to learn that there are required courses in statistics and may have negative attitudes regarding their statistical abilities or the usefulness of such courses (Dempster & McCorry, 2009; Mandap, 2016; Onwuegbuzie, 2004). The social sciences consist of fields such as psychology, sociology, and education. These fields rely on statistical methods and analyses for furthering important research (Azar & Mahmoudi, 2014). Negative attitudes toward statistics could induce anxiety when it is time for the student to take statistics courses (Dempster & McCorry, 2009; Onwuegbuzie, 2004)

Gender and Statistics Anxiety

Studies have shown that gender may be a predictor in students' levels of statistics anxiety, however, findings in this area are inconsistent (Eduljee & LeBourdais, 2015). One study found that males experience higher levels of statistics anxiety than females (Mandap, 2016). Another study indicated that female undergraduate students had higher levels of anxiety related to test and class anxiety on the STARS than male students and that female students' worth of statistics scores and computational self-concept scores on the STARS seemed to be negatively correlated with course grades (Eduljee & LeBourdais, 2015). Rodarte-Luna and Sherry (2008) found that women scored higher than men on the subscales of interpretation anxiety, test and class anxiety, computational self-concept, and fear of asking for help on the STARS. Mandap (2016) also found that female students scored higher on the fear of asking for help category of the STARS. Some studies found no significant differences between males and female students' levels of statistics anxiety (Alizamar et al., 2019; Baloğlu, 2002).

Age and Statistics Anxiety

Studies regarding the effect of age on statistics anxiety have varying results as well. With the rise of online education, the number of nontraditional college students (those over 25 years of

age) is increasing, resulting in a wide range of ages of college students around the world (Heretick & Tanguma, 2020). Heretick and Tanguma (2020) looked at the difference between younger nontraditional and older nontraditional students' levels of statistics anxiety, finding that younger nontraditional students reported higher levels of statistics anxiety. Conversely, Baloğlu (2002) looked at the statistics anxiety levels in both traditional and nontraditional undergraduate and graduate students and found that the older students reported higher levels of statistics anxiety than their younger counterparts did.

Statistics Anxiety and Academic Performance

Statistics is a field of study that has gained in prominence over the last several decades, in part due to the rise of advanced computer applications and the need for more advanced data analysis for research and reporting purposes in various aspects of society (Azar & Mahmoudi, 2014; Chew & Dillon, 2014; Mokhele, 2018). The social sciences in particular rely heavily on statistical analysis for the extensive research conducted by students and practitioners in these fields. Students and practitioners in the social sciences often have varying levels of mathematics or statistical backgrounds and may exhibit negative attitudes or have high levels of anxiety about statistics when they begin their degree programs (Azar & Mahmoudi, 2014; Dempster & McCorry, 2009). Most doctoral programs in the social science fields require at least one statistics or quantitative methods course (Azar & Mahmoudi, 2014; Dempster & McCorry, 2009; Onwuegbuzie, 2003). Students who experience statistics anxiety may procrastinate in taking required statistics courses and negative experiences in these types of courses may deter students from pursuing quantitative studies of their own (Chew & Dillon, 2014; Onwuegbuzie, 2000, 2004; Thompson et al., 2019).

Studies have shown mixed results as to the effect of statistics anxiety on academic performance. Research has shown that statistics anxiety and negative attitudes toward statistics

can be detrimental to students' academic performance (Keeley et al., 2008; Macher et al., 2011; Najmi et al., 2018; Ogbonnaya et al., 2019; Onwuegbuzie, 2003; Paechter et al., 2017). One study by Hoegler and Nelson (2018), examined whether self-efficacy and statistics anxiety could predict statistics course performance for undergraduate psychology students. The findings of their study indicated that statistics anxiety alone did not predict course performance, however, statistics anxiety had a negative effect on self-efficacy, which resulted in lower course performance. Overall, existing research indicates that statistics anxiety and negative attitudes toward statistics is common among students, and can result in poor course performance. Conversely, one study by Paechter et al. (2017), found that some students with higher levels of mathematics anxiety also experienced higher levels of statistics anxiety, but overall, these students had better grades in their statistics coursework than students with lower levels of mathematics and statistics anxiety. The authors posit that this could be because students expect to have difficulty in the statistics course based on their previous mathematics experiences, and therefore they may put forth greater effort to try to do well in the statistics course (Paechter et al., 2017).

In order to be successful in social sciences degree programs, it is critical for students to understand the importance of statistics and to be able to develop a proficiency in statistical concepts and analysis (Azar & Mahmoudi, 2014; Onwuegbuzie, 2000). Students who experience high levels of statistics anxiety may put off taking courses and could encounter greater difficulties related to comprehension and academic performance in these courses (Chew & Dillon, 2014; Onwuegbuzie, 2004; Thompson et al., 2019). In addition to affecting academic performance, Onwuegbuzie (2000) notes that a student's experience in a statistics course may "cement their attitudes toward" statistics in the future (p. 323). This could mean that a student who struggles in their statistics methods course may avoid conducting quantitative research of

their own. Further, students who do not perform well in statistics courses may potentially lack an understanding of statistical data in research articles when reviewing other studies for their research (Jordan & Haines, 2003; Onwuegbuzie, 2000). For doctoral students, this could affect their ability to successfully transition from student to scholar as they undertake research for their doctoral dissertation or scholarly project.

Challenges in Online Doctoral Programs

Online learning has increased in popularity, providing a convenient way for many students to pursue a higher education degree. The drawback to this type of learning, at least for some students, is that historically challenging courses such as research methods courses can be more difficult in an asynchronous, online format (Ewing et al., 2012; Ni, 2013). Students in online statistics courses may even experience higher levels of statistics anxiety than students in traditional, on-campus courses (Devaney, 2010). Many online doctoral students face feelings of isolation or lack of connectedness to the university, which can lead to difficulties in learning and academic performance (Maul et al., 2018). Given the complex nature of statistics, teaching this subject in an online setting can present even more challenges than traditional face-to-face courses (Yang, 2017).

Some of the current research concerning online doctoral programs in general highlights the issue of students experiencing feelings of isolation or lack of connectedness to their institutions and therefore not feeling adequately supported (Ames et al., 2018; Hwang et al., 2015). Students in online programs may feel as though they are not supported in their learning in the same way they would have been in a traditional, residential setting (Ewing et al., 2012; Maul et al., 2018). Tonsing (2018) found that students in a residential statistics course who experienced a greater sense of instructor immediacy experienced lower levels of statistics anxiety than those who reported a lower sense of instructor immediacy. Students in online courses in

particular may not feel a sense of instructor immediacy or that they have effective interactions with their instructors as they seek clarification and support in learning the content, possibly resulting in increased statistics anxiety (Devaney, 2010; Thompson et al., 2019).

While many online doctoral courses may primarily consist of asynchronous learning modules, there are various tools instructors can use to connect with students and to help enhance the student learning experience. Maul et al. (2018) found that incorporating synchronous meeting opportunities for doctoral students and their mentors helped to increase the students' sense of self-efficacy. Similarly, Jiang et al. (2019) found that students seemed to benefit from PowerPoint presentations with embedded lectures and synchronous question and answer sessions with the instructor. Thompson et al. (2019) suggest that discussion boards can provide an effective means of communication and collaboration that fosters learning in an online statistics course.

While many of the best practices in online learning seem to promote the inclusion of some type of synchronous element (Yang, 2017), some students actually seem to prefer the independent learning opportunities afforded by asynchronous, online classes (Lim, Dannels, & Watkins, 2008). Lim, Dannels, and Watkins (2008) found that while some students in online research methods courses did not prefer this setting for doctoral research preparation, other students appreciated the self-directed learning environment. Thompson et al. (2019) found that asynchronous collaboration through discussion board forums can serve as an important learning tool, and even seemed to reduce students' levels of statistics anxiety when used effectively.

Doctoral Research in Online Programs

Most online doctoral programs in the social sciences require a dissertation or doctoral project as part of the degree requirements. Completing these research projects requires at least some knowledge of statistics as it applies to the social sciences. In some cases, students may feel

they have not had adequate training in quantitative methods to be able to conduct quantitative studies of their own (Ferguson et al., 2017). Ferguson et al. (2017) conducted a mixed-methods study on doctoral students' perspectives regarding their quantitative training and their perceived proficiency in quantitative methods. Their findings suggested that there may be too few research methods courses or other opportunities for students to develop proficiency in quantitative research. Some online doctoral candidates may avoid quantitative methods of research altogether due to statistics anxiety (Huang, 2018; Thompson et al., 2019). Additionally, online students may experience higher levels of statistics anxiety compared to students in on-campus programs, therefore it is possible that these students will avoid quantitative methods of research more than traditional students (Devaney, 2010). When students fail to develop an understanding of statistical concepts and quantitative methods, not only are they less likely to contribute to quantitative research with their own studies, but they may not even be able to fully understand other published quantitative studies they read (Onwuegbuzie, 2000).

Online Research Methods Courses. Research methods courses seem to be problematic for many doctoral students, especially in online doctoral programs (Ewing et al., 2012; Lim, Kim et al., 2008; Ni, 2013). There is often a lack of face-to-face learning and mentoring opportunities in online programs, which can result in increased apprehension regarding the complex content in research methods courses (Ewing et al., 2013). Ni (2013) suggests that the content of research methods courses may be uniquely challenging in an online format compared to other courses, and that extra student support may be needed to encourage student success. Lim, Kim et al. (2008) highlighted that students in online research methods courses seemed to perceive a lack of instructor immediacy, even though they were able to receive quick responses via email rather than wait a week to ask a question in class.

Online Statistics Courses

Research methods courses, including courses in statistics, are historically a difficult part of any graduate or doctoral program (Ewing et al., 2012; Fiore et al., 2019). Studies have shown that many students in higher education degree programs in the social sciences often exhibit some level of statistics anxiety (Heretick & Tanguma, 2020; Huang, 2018; Onwuegbuzie, 2000). Because of this anxiety, some doctoral students struggle in statistics courses, which can affect their overall student experience as well as future research endeavors. Administrators of online doctoral programs may need to consider ways that critical courses such as research methods and statistics courses can be offered in an online format that is effective in supporting students with limited statistics background and who may struggle with statistics anxiety.

With the growing number of online graduate programs, many students are now taking their only statistics courses in an online format (Thompson et al., 2019). Online students may be particularly hesitant when it comes to statistics, as students need to make an extra effort to connect with their instructors in order to feel adequately supported (Devaney, 2010; Mills & Raju, 2017; Thompson et al., 2019). Additionally, graduate students in the social sciences often have little mathematics and statistics background, making this population more susceptible to statistics anxiety (Keeley et al., 2008; Onwuegbuzie, 2000; Tutkun, 2019). Studies suggest that creating opportunities within the course for collaboration is one way that statistics anxiety might be reduced (Thompson et al., 2019; Yang, 2017). Additionally, Thompson et al. (2019) note that faculty professional development might also be helpful to ensure that faculty members are able to effectively engage online statistics students in ways that help reduce their anxiety about the course material.

Online doctoral students may experience low self-efficacy in regards to their abilities to learn new subject matter. Statistics self-efficacy has been shown to be a predictor of academic

performance in statistics courses (Hoegler & Nelson, 2018). Hoegler and Nelson (2018) suggest that statistics students may benefit from intentionally reviewing their performance on an exam or assignment in order to determine what they mastered, what they still need to work on, and what methods of preparation were successful or unsuccessful. In this way, students are more consciously aware of how and why they performed a certain way and are able to then objectively assess how they can improve in the future. In online statistics courses, however, this may be a challenge due to the largely self-directed nature of learning remotely. It may be beneficial for online course designers to consider ways that they can incorporate self-assessment measures in statistics courses in order to encourage increased student self-efficacy.

One way to incorporate self-assessment may be through reflective exercises in a course. A study by Denton (2018) looked at the effect of reflective journaling for psychology majors in an introductory statistics course. The results of Denton's (2018) study indicated that reflective journaling seemed to help reduce statistics anxiety and resulted in better course performance. Thompson et al. (2019) found that discussion boards, which provide a space to reflect on information and interact with the faculty member and other students, may have helped to reduce statistics anxiety for doctoral candidates in an online statistics course. This may have been due to the opportunity for the student to reflect on his or her own understanding of the course material as well as the opportunity to observe other students' interpretation of course material.

Statistics can be a challenging subject, and many students in social science fields have not necessarily studied this topic in depth (Onwuegbuzie, 2000). For some of these students, particularly at the graduate and doctoral level, there is a requirement to take at least one research methods course in their program that focuses on statistics (Jiang et al., 2019). Occasionally, students will procrastinate in registering for statistics courses, and when they do, they experience statistics anxiety that can hinder their academic performance (Onwuegbuzie, 2003;

Onwuegbuzie, 2004). While there is ample literature exploring statistics anxiety and its effects on students, little research has been done recently that focuses on statistics anxiety in doctoral students enrolled in fully online programs (Thompson et al., 2019). As online graduate education enrollment continues to grow, there may be an increased need to better support students in challenging courses such as statistics.

Supporting Doctoral Program Completion

In recent years, there has been a steady increase in enrollment in graduate and doctoral programs in the social and behavioral sciences (Okahana & Zhou, 2017). Much of this increased enrollment at the graduate and doctoral level is found in online programs (Lederman, 2018; Seaman et al., 2018). Studies show that 50% of doctoral candidates in traditional programs do not complete the dissertation, with that number being at least 10% higher for doctoral candidates in online programs (Ewing et al., 2012; Fiore et al., 2019; Kennedy et al., 2015; Rigler et al., 2017). Doctoral students are most at risk for dropping out of their programs at the dissertation stage, particularly if they have difficulty in their research methods courses or in navigating the largely self-directed the dissertation process itself (Ewing et al., 2012; Fiore et al., 2019; Rockinson-Szapkiw et al., 2016).

College administrators are concerned with factors such as student satisfaction and student retention (Roberts & Styron, 2010). High levels of attrition from doctoral programs can have negative financial and personal effects on doctoral students and society as a whole (Geven et al., 2018; Gittings et al., 2018). Not only has time and money potentially been wasted in not completing a degree, but the potential future contributions to a specific field or society as a whole could be hindered (Gittings et al., 2018). Many doctoral candidates in online programs fail to persist to completion of their programs, with many dropping out at the dissertation stage (Kelley & Salisbury-Glennon, 2016). Studies have shown that one of the reasons students drop

out of their online doctoral programs at the dissertation stage are that they do not feel adequately prepared to conduct independent research, and become overwhelmed with the dissertation process (Ewing et al., 2012; Ferguson et al., 2017). Additionally, the largely self-directed nature of the dissertation can present a challenge, especially if students do not feel confident in their research skills to begin with.

Doctoral programs are unique in that there is an emphasis on students transitioning from students to scholars, which entails independent research in the form of a dissertation or doctoral project. To prepare for the culminating project, doctoral students typically are required to take certain methods courses related to quantitative or qualitative research and analysis. Studies have shown that these courses tend to be the most difficult for online students, as they involve learning complex concepts in a largely self-guided, asynchronous setting (Fiore et al., 2019; Kennedy et al., 2015). This may be especially true for online statistics courses (Jiang et al., 2019). When students struggle in their research methods courses, this could lead to feelings of dissatisfaction with their program and could potentially lead to drop out (Fiore et al., 2019; Kennedy et al., 2015).

Onwuegbuzie (2000) notes that having an understanding of statistical concepts is foundational to student success in other areas of research. Students who lack basic knowledge of statistical analyses may have difficulty fully understanding articles they read while conducting research. Additionally, students may develop a negative attitude toward quantitative research methods, which could influence the type of methods they choose for their own research, and lead to a lack of quantitative studies (Onwuegbuzie, 2000). In the social sciences, quantitative research provides valuable information to help advance knowledge, so it is important for students to not only have a basic understanding of statistical concepts, but also to develop an appreciation for quantitative research.

Unfortunately, many students in the social sciences have had limited mathematics or statistics course experience and often struggle with low self-efficacy in statistics (Hoegler & Nelson, 2018). This low self-efficacy can lead to feelings of anxiety in one or more of the six dimensions of statistics anxiety, which ultimately can hinder their ability to gain an adequate understanding of the statistical concepts needed to be successful not only in their courses but also in their future professions (Onwuegbuzie, 2004). In order to adequately prepare independent scholars who will successfully contribute to the research in their fields, it is important for online doctoral program administrators to consider how research methods and statistics courses can be developed or revised to better accommodate students who experience statistics anxiety.

Summary

Statistics anxiety is an issue that has been studied for at least the past 30 years, and it is an issue that continues to affect students today. Bandura's (1977a, 1977b) self-efficacy theory and Wine's (1980) cognitive-attentional theory help to provide a framework for how statistics anxiety may affect students who struggle with statistics anxiety. Though it is related to mathematics anxiety, and at one point was considered a form of mathematics anxiety, statistics anxiety has been found to be a unique construct that specifically affects students in situations in which they need to perform statistics-related tasks.

Different graduate schools require a different number of research and statistics courses to be taken as part of their programs, particularly in the social sciences (Elliott et al., 2013; Leech & Haug, 2015; Perepiczka et al., 2011). In many cases, it seems that research methods and statistics course requirements are minimal, and that many students feel underprepared for conducting independent empirical research (Leech & Haug, 2015). Students who experience statistics anxiety may struggle even more than others in their few required statistics courses, and ultimately in successfully transitioning from students to independent scholars (Onwuegbuzie,

2000; Onwuegbuzie et al., 1997). Cruise et al. (1985) established information regarding the various dimensions of statistics anxiety that could be helpful in gaining a deeper understanding of what aspects of statistics anxiety most affect students. As online doctoral program enrollment grows, specifically in the social sciences, many more students are being exposed to what might be the only statistics courses they have ever been required to take (Onwuegbuzie, 2000; Keeley et al., 2008). It is important to consider how students experiencing statistics anxiety can best be supported in online statistics courses.

CHAPTER THREE: METHODS

Overview

The purpose of this predictive correlational study was to determine what type of students' self-reported statistics anxiety best predicts final grades for doctoral students in an online statistics course at a large faith-based university in the southeast United States. This chapter contains an explanation of the design and procedures used to conduct this study as well as information regarding the research questions, hypotheses, participants, setting, and instrumentation. A detailed description of the procedures and data analysis is also provided.

Design

This study was conducted using a predictive correlational design in order to determine whether a predictive relationship exists between the type of statistics anxiety experienced by doctoral students in an online statistics course and their final grades for the course. Predictive correlational designs are appropriate for studies in which researchers want to determine if it is possible to "predict scores on one variable from research participants' scores on other variables" (Gall et al., 2007, p. 337). Correlational studies enable researchers to evaluate information regarding how multiple variables might affect certain outcomes or behaviors, however, correlational designs are limited in that they cannot show cause and effect (Gall et al., 2007). A predictive correlational design was appropriate for this study, which was conducted in order to determine if doctoral students' self-reported type of statistics anxiety predicted their final grades in an online statistics course.

For this study, the six dimensions of statistics anxiety served as the predictor variables, and the final course grade was the criterion variable. According to Gall et al. (2007), it is acceptable to test the predictive validity of self-report measures as predictor variables of the

chosen criterion variable in correlational studies. Gall et al. (2007) also note that the criterion variable should be a consistent score that measures the same thing for all participants.

The predictor variables (the six dimensions of statistics anxiety) were self-reported by each student at the beginning of each course via a discussion board. The six predictor variables are based on a study by Cruise et al. (1985), in which the authors sought to validate an instrument for measuring statistical anxiety. The six dimensions of statistics anxiety are *worth of statistics*, *interpretation anxiety*, *test and class anxiety*, *computational self-concept*, *fear of asking for help*, and *fear of statistics teacher*. (a) Worth of statistics relates to how students view statistics in regard to its relevance to their field of study; (b) interpretation anxiety relates to how a student feels when he or he must interpret statistical data or make an informed decision based on this interpretation; (c) test and class anxiety relates to students' concerns with their performance in a class or on when taking a test; (d) computational self-concept relates to students' self-perception of mathematics abilities; (e) fear of asking for help relates to the anxiety of asking for help with any aspect of the statistics course materials, and; (f) fear of statistics teachers relates to any anxiety the student may experience related to the statistics course instructor (Cruise et al., 1985; Onwuegbuzie, 2000).

In this study, the criterion variable is the final course grade which is a consistent cumulative score for the same assignments for all students who take the course. The course grade is based on a 1010-point scale derived from scores on weekly assignments consisting of discussion boards, worksheets, and quizzes.

Archival data were used for this study. The students' records were retrieved from the learning management system (LMS), Blackboard. The LMS contained a discussion board where the students identify their specific statistics anxiety and the students' corresponding final grade.

Research Question

RQ: What type of statistics anxiety best predicts final grades for doctoral students in an online statistics course?

Null Hypothesis

H_0: There is no statistically significant predictive relationship between the criterion variable (final course grade) and the predictor variables related to the six dimensions of statistics anxiety (worth of statistics, interpretation anxiety, test and class anxiety, computational self-concept, fear of asking for help, and fear of statistics teacher) for doctoral students in an online statistics course.

Participants and Setting

Archival data was used for this study. Student records from online Doctor of Education (Ed.D.) and Doctor of Philosophy (Ph.D.) in education programs at a large faith-based university in the southeast United States. The university offers both residential and online programs and is accredited by the Southern Association of Colleges and Schools Commission on Colleges (SACSCOC). The students whose records were used for this study were enrolled in online doctoral education programs that required one advanced educational statistics course as part of the degree completion requirements. All students in this study completed the same statistics course in either the 2019-2020 or 2020-2021 academic year.

The course used in this study was called EDUC 812: Advanced Educational Statistics. The course content focused on descriptive statistics, basic inferential statistical techniques, hypothesis testing, confidence intervals, analysis of variance, correlation techniques and nonparametric statistical methods. The course was offered via the Blackboard learning management system in an eight-week online format with a cap of approximately 15 students per section. The course was taught in an asynchronous format and its primary textbook was *Applied*

Statistics: From Bivariate Through Multivariate Techniques by Rebecca M. Warner (2013). The statistical software used in the course was the Statistical Package for the Social Sciences (SPSS). There were no prerequisite course requirements for EDUC 812, and students could take this course at any point in the program prior to the dissertation methods courses.

A convenience sample of 276 student records were used for this study. According to Warner (2013), the minimum sample required for a medium effect size with statistical power of .80 and an alpha level of .05 is 110 student records. The sample consisted of 72 males and 204 females. The average age of the sample was 41 years old. The sample consisted of 20 White students, 5 African American students, 1 Latino student, 1 Asian student, and 249 students who did not indicate their ethnicity. Students whose information was included in this study were in either a Doctor of Education (Ed.D.) or Doctor of Philosophy (Ph.D.) in education program through the university's School of Education.

Instrumentation

Archival data consisting of student records from an online statistics course were used for this study. The predictor variable consisted of the six dimensions of statistics anxiety (worth of statistics, interpretation anxiety, test and class anxiety, computational self-concept, fear of asking for help, and fear of statistics teacher) and the criterion variable consisted of final course grades. These variables were measured in order to see if a predictive relationship existed between the students' self-reported type of statistics anxiety and their final grades in an online statistics course in an Ed.D. or Ph.D. program.

Predictor Variables (Six Dimensions of Statistics Anxiety)

The predictor variables (the six dimensions of statistics anxiety) were self-reported by each student at the very beginning of each course. The six dimensions of statistics anxiety are defined in Table 1.

Table 1

Six Dimensions of Statistics Anxiety

Dimension	Definition [a]
Worth of statistics	how students view statistics in regard to its relevance to their field of study
Interpretation anxiety	how a student feels when he or he must interpret statistical data or make an informed decision based on this interpretation
Test and class anxiety	students' concerns with their performance in a class or on when taking a test
Computational self-concept	students' self-perception of mathematics abilities
Fear of asking for help	the anxiety of asking for help with any aspect of the statistics course materials
Fear of statistics teacher	any anxiety the student may experience related to the statistics course instructor

[a] (Cruise et al., 1985)

The six dimensions of statistics anxiety are based on a study by Cruise et al. (1985). In their study, Cruise et al. (1985) used a factor analysis to determine the validity of a scale to measure statistics anxiety. The results revealed that (a) worth of statistics, (b) interpretation anxiety, (c) test and class anxiety, (d) computational self-concept, (e) fear of asking for help, and (f) fear of statistics teacher were dimensions that reliably identified.

Students self-reported the dimension(s) of statistics anxiety with which they most identified. This was completed at the beginning of the course in the form of a discussion board assignment. The discussion board prompt was as follows:

> **Thread**: The article *Statistics Anxiety and the Role of Self-Perceptions* addresses the concept of statistics anxiety. The author describes seven dimensions of self-perception and six dimensions of statistic anxiety. After reading the article, please address the discussion prompts below. Please adhere to the required word count (300 words).
>
> The author mentions six general components of statistics anxiety (worth of statistics, interpretation anxiety, test and class anxiety, computational self-concept, fear of asking for help, and fear of statistics teacher). Which of these six statistics anxiety components do you most identify with and why?
>
> The Bible reminds us in Philippians 4:6 (NIV), "Do not be anxious about anything, but in every situation, by prayer and petition, with thanksgiving, present your requests to God." What other verse(s) can you share to help your classmates overcome statistics anxiety?
>
> **Replies:** Choose two peers' posts that resonate the most with you and reply to both of them. Incorporate biblical scripture in your responses. Please adhere to the required word count (200 words). Submit your thread by 11:59 p.m. (ET) on Thursday of Module 1: Week 1, and submit your replies by 11:59 p.m. (ET) on Sunday of the same module: week.

After reading the article, students drafted a 300-word discussion board thread that disclosed the dimension(s) of statistics anxiety with which they most identified. The students posted this initial thread and then replied to two classmates' threads. Additionally, the instructors would typically comment on the discussion board posts for each student.

The researcher downloaded all student discussion board posts and used a quantitative content analysis to identify which dimension(s) the students self-reported as their area of statistics anxiety. In some instances, the students reported more than one dimension. In these cases, the researcher recorded multiple dimensions reported by the student. According to Gall et al. (2007), content analysis in quantitative research is the analysis of documents or other means of communication in which information is coded, categorized, and compared in order to test a hypothesis. In this study, the statistical anxiety dimensions for each student were identified in the content analysis of the discussion board posts and were then noted in a frequency table organized according to statistics anxiety categories. See Table 2 for an example.

Table 2

Example Frequency Table for Content Analysis

Student Code	Section	Professor	Worth of Statistics	Interpretation Anxiety	Test/Class Anxiety	Computational Self-Concept	Fear of Asking for Help	Fear of Statistics Teacher	Final Course Grade
1	202020 B01	Dr. __	0	1	0	1	0	0	986
2	202020 B01	Dr. __	1	1	0	0	0	0	874
3	202020 B01	Dr. __	0	0	0	1	0	0	953
4	202020 B01	Dr. __	1	0	1	0	0	0	742
5	202020 B01	Dr. __	0	0	0	1	1	0	487
6	202020 B01	Dr. __	0	0	0	0	1	1	858

Criterion Variable (Final Course Grade)

The criterion variable was the final course grade earned at the end of the online statistics course. Course grades were a valid measure of student performance for this study, as these grades measured the same thing for all students (Gall et al., 2007). Gall et al. (2007) note the importance of consistency in the criterion variable in order to reduce bias and to ensure a better

chance of accurately detecting a predictive relationship. The final grade was a cumulative score based on a 1010-point scale derived from scores on weekly assignments consisting of two discussion boards, six worksheets, and six quizzes. One discussion board was on the subject of statistics anxiety and the second discussion board was on the subject of identifying a research topic. These assignments were worth 50 points each. The course assignments also consisted of textbook readings with six corresponding quizzes, each worth 50 points. Textbook readings consisted of reviews of basic statistical concepts, one sample t-test, independent samples t-test, ANOVA and post hoc analysis, correlations, and multiple regression. Finally, the students were required to complete six SPSS worksheets, analyzing a different data set for each assignment. These worksheet assignments were worth 100 points each. A 10-point course check-in assignment is also calculated into the final grade. See Table 3 for grading scale for the EDUC 812 course.

Table 3

Grading Scale for EDUC 812

	Letter Grade						
	A	A-	B+	B	B-	C+	C
Numeric Grade	940-1010	920-939	900-919	860-899	840-859	820-839	780-819

Procedures

The purpose of this predictive correlational study was to determine what type of statistics anxiety best predicts final grades for doctoral students in an online statistics course. Permission to conduct this study was granted by the School of Education administration. At that point,

Institutional Review Board (IRB) approval was obtained before requesting access to the course sections used for this study. See Appendix A for IRB approval.

Archival data for this study were obtained from all of the sections of the statistics course, EDUC 812, during the spring and summer semesters of the 2019-2020 school year and fall semester of the 2020-2021 school year. After receiving permission, the researcher accessed each section of the EDUC 812 courses. The researcher collected data for both the predictor variables and the criterion variable in these courses.

According to Gall et al. (2007), content analysis involves analyzing documents and other forms of communication. In this study, the researcher downloaded the discussion board posts for each student and analyzed the text for mention of the specific dimension of anxiety (predictor variable) for each student. To access the discussion board posts, the researcher selected the Discussion Board link in the sidebar of the Blackboard course and clicked on the link for the first forum (Forum 1 [Module 1]). The researcher then marked all posts for download, clicked the "Collect" button, clicked "Print Preview," selected "Save as PDF," and saved the document. The researcher then closed out of the discussion board forum and retrieved the pdf file in order to print the discussion board posts out. The researcher identified the initial discussion thread for each student and also reviewed their replies for confirmation. The researcher then used the data collection chart (see Table 2 in the Instrumentation section). The researcher then read through each post, highlighting each students' self-reported dimension of statistics anxiety based. The dimension of anxiety was then reported in the appropriate column in the chart for each student.

For the criterion variable, the researcher selected the Grade Center dropdown and clicked "Full Grade Center" which contains students' names and corresponding grades for all activity in the course. Using the "Work Offline" function in Blackboard, the researcher chose "Download" and clicked "Submit" in order to process a download of the entire grade center in Excel format.

In Excel, the researcher looked at the "Total" grade column and recorded the final grade for each student in the data collection sheet. Once all data were collected in the data collection sheet, they were entered into Excel, formatted and data-screened, then transferred to SPSS for analysis.

Data Analysis

A multiple linear regression was used to analyze the data using SPSS software. A linear regression analysis was appropriate for this study, as the purpose was to "evaluate the strength of linear association between scores on two quantitative variables" (Warner, 2013, p. 315). A multiple linear regression was used for this study, as there was more than one predictor variable (Warner, 2013). Multiple regression analysis allows the researcher to assess the relationship between each individual predictor variable and the criterion variable, while controlling for all other predictor variables (Warner, 2013). Additionally, Warner (2013) notes that regression analysis is appropriate for non-experimental studies in which "researcher has manipulated none of the variables" (p. 555). This study was non-experimental and none of the predictor variables (dimension of statistics anxiety) and none of the criterion variables (final course grades) were manipulated in any way.

Multiple linear regression requires certain assumptions to be met when the criterion and predictor variables are continuous. In this study, all predictor variables were dichotomous, therefore, the assumptions were not applicable. A multiple linear regression was conducted at the 95% confidence level. The model was tested using an F-statistic and reported. The model's effect size was reported using R and R^2. Coefficients were reported using t-statistics and Pearson's r for strength and direction of the variables.

CHAPTER FOUR: FINDINGS

Overview

The purpose of this study was to determine what type of self-reported statistics anxiety best predicts final grades for doctoral students in an online statistics course at a large faith-based university in the southeast United States. The predictor variables in this study consisted of six dimensions of statistics anxiety (worth of statistics, interpretation anxiety, test and class anxiety, computational self-concept, fear of asking for help, and fear of statistics teacher). The criterion variable was the final course grade for the online statistics course. A multiple regression was used to test the hypothesis. The Findings section includes the research question, null hypothesis, data screening, descriptive statistics, and results.

Research Question

RQ: What type of self-reported statistics anxiety best predicts final grades for doctoral students in an online statistics course?

Null Hypothesis

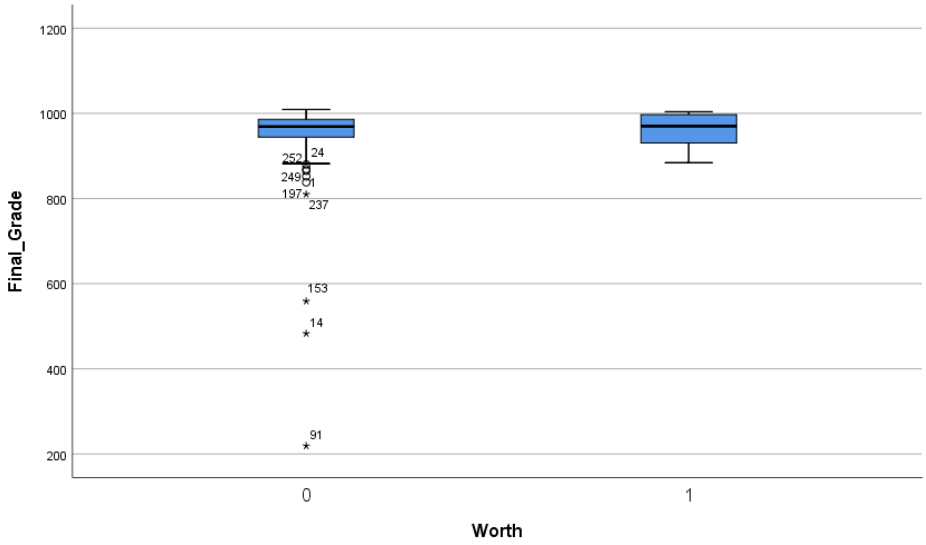
H_0: There is no significant predictive relationship between the criterion variable (final course grade) and the linear combination of predictor variables related to statistics anxiety (worth of statistics, interpretation anxiety, test and class anxiety, computational self-concept, fear of asking for help, and fear of statistics teacher) for doctoral students in an online statistics course.

Data Screening

The researcher sorted the data and scanned for inconsistencies on each variable. No data errors or inconsistencies were identified. Boxplots were used to look for outliers for each of the predictor variables on the criterion variable. Outliers were identified, however, they did not affect the results so the researcher did not remove them in order to maintain sample size. See Figures 1- 6 for boxplots.

Figure 1

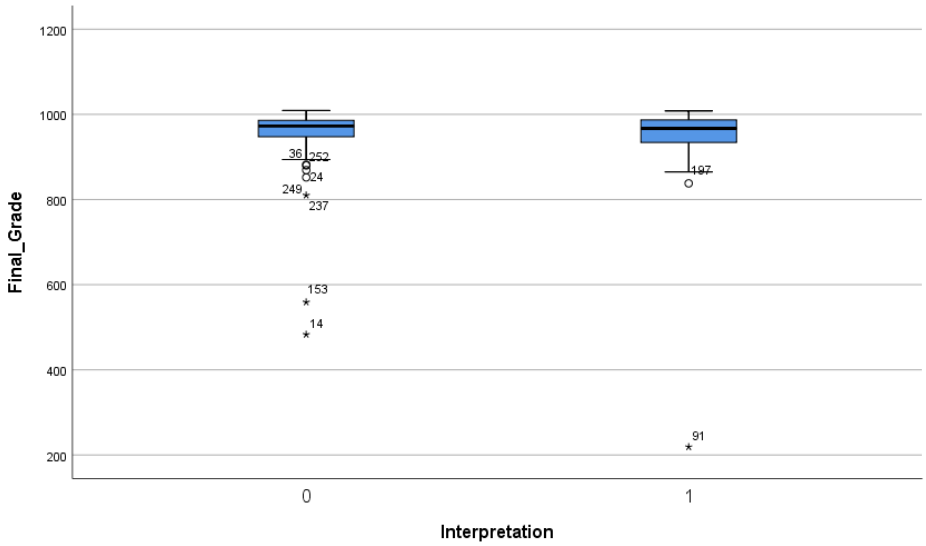
Boxplot for Worth of Statistics Predictor Variable



Note. 0 = student did not indicate this as self-reported type of statistics anxiety; 1 = student did indicate this as self-reported type of statistics anxiety.

Figure 2

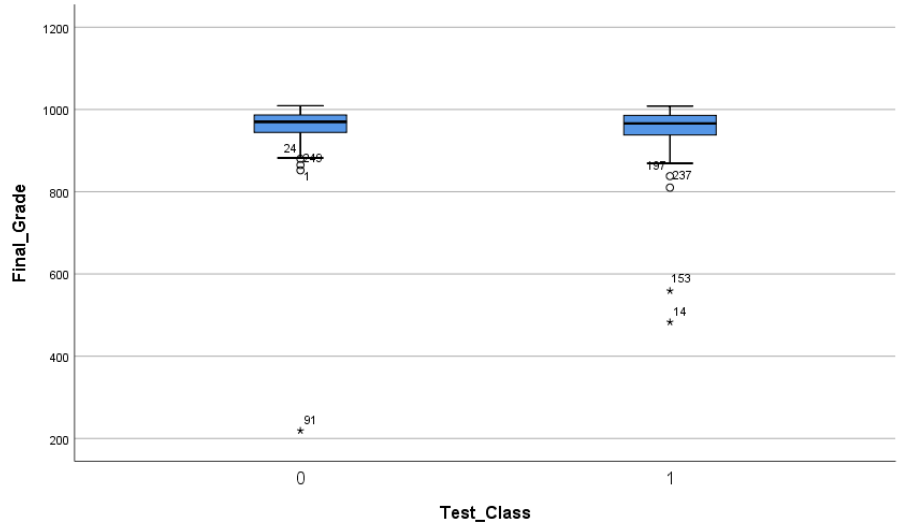
Boxplot for Interpretation Anxiety Predictor Variable



Note. 0 = student did not indicate this as their self-reported type of statistics anxiety; 1 = student did indicate this as self-reported type of statistics anxiety.

Figure 3

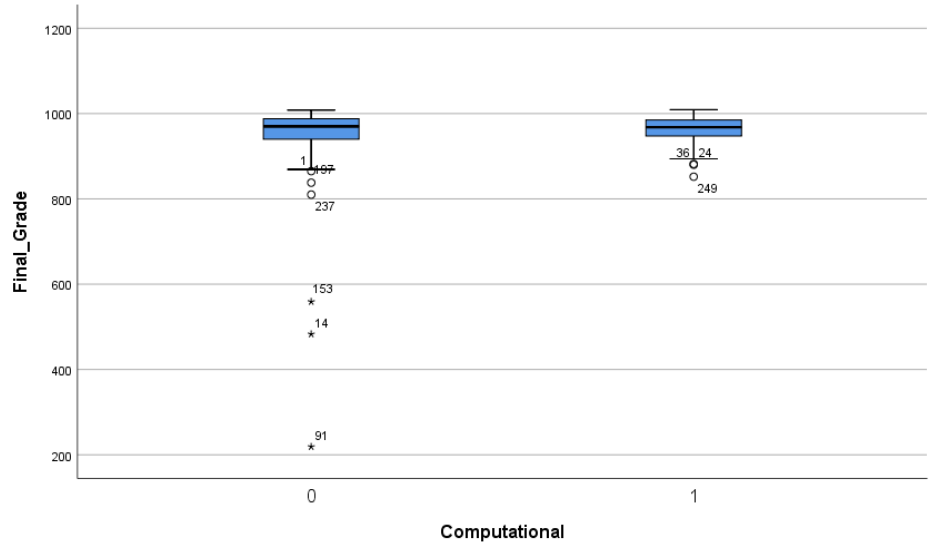
Boxplot for Test/Class Anxiety Predictor Variable



Note. 0 = student did not indicate this as their self-reported type of statistics anxiety; 1 = student did indicate this as self-reported type of statistics anxiety.

Figure 4

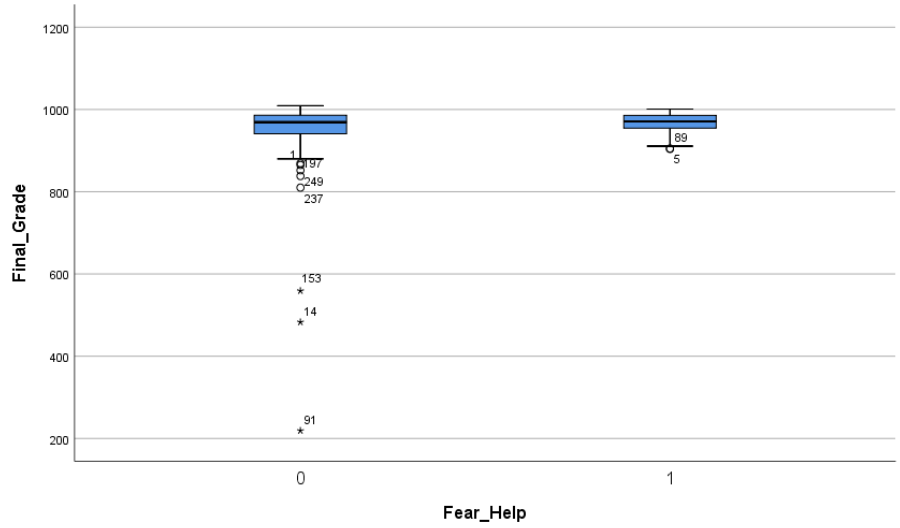
Boxplot for Computational Self-Concept Predictor Variable



Note. 0 = student did not indicate this as their self-reported type of statistics anxiety; 1 = student did indicate this as self-reported type of statistics anxiety.

Figure 5

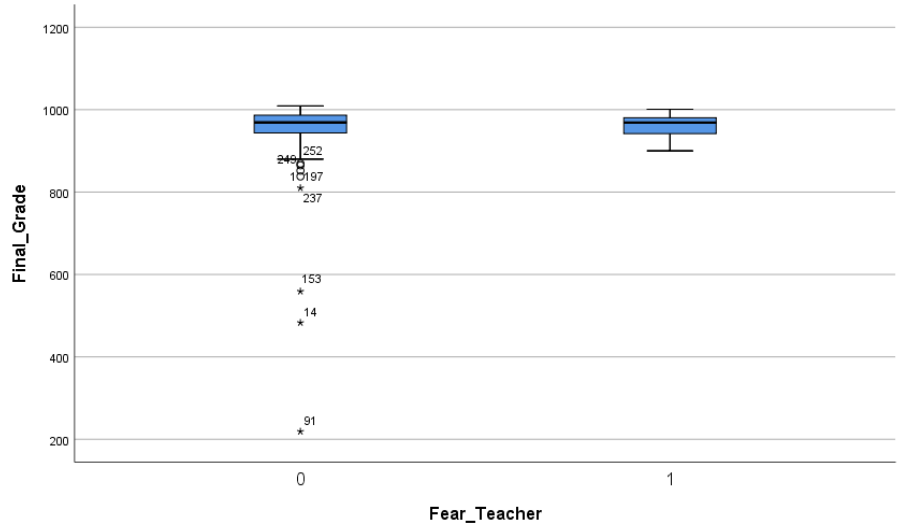
Boxplot for Fear of Asking for Help Predictor Variable



Note. 0 = student did not indicate this as their self-reported type of statistics anxiety; 1 = student did indicate this as self-reported type of statistics anxiety.

Figure 6

Boxplot for Fear of Statistics Teacher Predictor Variable



Note. 0 = student did not indicate this as their self-reported type of statistics anxiety; 1 = student did indicate this as self-reported type of statistics anxiety.

Descriptive Statistics

Descriptive statistics were obtained for each of the variables. The sample consisted of course records for 276 students. For the criterion variable, final course grades in the online statistics course, scores could range from 10 to 1010 points. A high score of 1010 means that the student performed very well in the course and received full credit on all assignments, whereas a low score of 10 means that the student performed poorly or was inactive in the course. See Table 4 for descriptive statistics regarding the final course grades for the sample in this study.

Table 4

Criterion Variable Descriptive Statistics

	N	Minimum	Maximum	Mean	Std. Deviation
Final_Grade	276	219	1009	956.65	66.69
Valid N (listwise)	276				

For the predictor variables, the six dimensions of statistics anxiety, frequency counts were obtained for each of the dimensions reported by students. Out of 276 participants, the majority ranked interpretation anxiety, test and class anxiety, and computational self-concept as the most prevalent form of statistics anxiety they experienced. Worth of statistics, fear of asking for help, and fear of the statistics teacher were noted much less frequently as types of statistics anxiety with which students identified. See Table 5 for frequency counts of the predictor variables.

Table 5

Frequency Counts for Predictor Variables

Type of Statistics Anxiety	Frequency
Worth of Statistics	11
Interpretation Anxiety	112
Test/Class Anxiety	104
Computational Self-Concept	111
Fear of Asking for Help	35
Fear of Statistics Teacher	16

Note. Though there were 276 students whose information was used for this study, there were 389 total responses due to some students choosing more than one type of statistics anxiety.

Results

A multiple regression was conducted to see if there was a predictive relationship between the criterion variable (final course grades) and the linear combination of predictor variables related to statistics anxiety (worth of statistics, interpretation anxiety, test and class anxiety, computational self-concept, fear of asking for help, and fear of statistics teacher) for doctoral students in an online statistics course. The researcher failed to reject the null hypothesis at the 95% confidence level where $F(6, 269) = .54$, $p = .78$. There was no statistically significant relationship between the predictor variables and the criterion variable. See Table 6 for regression model results.

Table 6

Regression Model Results

ANOVA[a]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	14591.51	6	2431.92	.54	.78[b]
	Residual	1208425.40	269	4492.30		
	Total	1223016.901	275			

a. Dependent Variable: Final_Grade
b. Predictors: (Constant), Fear_Teacher, Computational, Worth, Test_Class, Interpretation, Fear_Help

The model's effect size was small, where $R = .109$. Furthermore, $R^2 = .012$, indicating that approximately 1.2 % of the variance of criterion variable could be explained by the linear combination of the predictor variables. See Table 7 for model summary.

Table 7

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.109[a]	.012	-.010	67.03

a. Predictors: (Constant), Fear_Teacher, Computational, Worth, Test_Class, Interpretation, Fear_Help

Because the researcher failed to reject the null, further analysis of the coefficients was not required, however, the information is presented below for reference purposes only. See Table 8 for coefficients.

Table 8

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients		
		B	Std. Error	Beta	t	Sig.
1	(Constant)	953.111	9.051		105.308	.000
	Worth	2.825	20.948	.008	.135	.893
	Interpretation	-2.078	8.840	-.015	-.235	.814
	Test_Class	-4.222	8.804	-.031	-.480	.632
	Computational	10.804	8.907	.080	1.213	.226
	Fear_Help	12.331	13.670	.062	.902	.368
	Fear_Teacher	-.853	18.371	-.003	-.046	.963

a. Dependent Variable: Final_Grade

CHAPTER FIVE: CONCLUSIONS

Overview

The purpose of this study was to determine what type of self-reported statistics anxiety best predicts final grades for doctoral students in an online statistics course at a large faith-based university in the southeast United States. Chapter Five consists of a discussion of the findings of this study, and how they compare to previous studies regarding statistics anxiety. This chapter also includes a discussion of the implications and limitations of this study, followed by recommendations for future research.

Discussion

This study was conducted using a predictive correlational design in order to determine whether a predictive relationship exists between the type of self-reported statistics anxiety experienced by doctoral students and their final grades in an online statistics course. The types of statistics anxiety were based on the six dimensions of statistics anxiety identified by Cruise et al. (1985): (a) worth of statistics, (b) interpretation anxiety, (c) test and class anxiety, (d) computational self-concept, (e) fear of asking for help, and (f) fear of the statistics teacher.

Research has shown that statistics anxiety and negative attitudes toward statistics can be detrimental to students' academic performance (Keeley et al., 2008; Macher et al., 2012; Najmi et al., 2018; Onwuegbuzie, 2003; Paechter et al., 2017). Many students in social science programs have limited, if any, statistics course experience; however, most doctoral programs in these fields of study require at least one statistics or quantitative methods course (Azar & Mahmoudi, 2014; Dempster & McCorry, 2009; Onwuegbuzie, 2003). Students who experience statistics anxiety may procrastinate in taking required statistics courses and their negative experiences in these types of courses may deter them from pursuing quantitative studies of their own (Chew & Dillon, 2014; Onwuegbuzie, 2000, 2004; Thompson et al., 2019). Overall,

existing research indicates that statistics anxiety and negative attitudes toward statistics is common among students and can result in poor course performance.

Online doctoral program enrollment has increased in recent years, and many students are taking their only statistics and quantitative methods courses in a fully online format (Keeley et al., 2008; Okahana & Zhou, 2017; Onwuegbuzie, 2000; Thompson et al., 2019). Some research surrounding online doctoral programs in general highlights the issue of students experiencing feelings of isolation or lack of connectedness to their institutions and therefore not feeling adequately supported (Ames et al., 2018; Hwang et al., 2015; Rockinson-Szapkiw et al., 2016). This can be especially problematic when considering that challenges in research methods courses and the dissertation process itself are often the reason many doctoral students drop out of their programs (Ewing et al., 2012; Fiore et al., 2019; Rockinson-Szapkiw et al., 2016).

The purpose of the current study was to add to the existing literature concerning statistics anxiety and to address the specific need for more research on the effect of statistics anxiety in doctoral students in fully online programs. The current study used a content analysis of archival data from discussion board assignments completed by doctoral students taking an online statistics course. Students whose information was included in the study were doctoral education students taking a required statistics course in an asynchronous, online format. The discussion board assignment prompt asked the students to read an article by Onwuegbuzie (2000) regarding the six dimensions of statistics anxiety, and to share which of the six dimensions best described the anxiety they may have been experiencing about the course. The researcher read each de-identified discussion board post and compiled data regarding the types of statistics anxieties that were self-reported by each student.

Results for the Research Question

The research question for this study addressed whether or not the specific self-reported

type of statistics anxiety experienced by a doctoral student could predict the final course grade earned in an online statistics course. No significant predictive relationship was found between the students' self-reported type of statistics anxiety and their final course grades. The researcher failed to reject the null hypothesis, which indicates that the type of anxiety experienced by students in this online statistics course did not help to predict their final grades for the course.

The findings in the current study do not align with some of the other existing research in the area of statistics anxiety. Some studies have indicated that statistics anxiety can have a negative effect on course performance (Ogbonnaya et al., 2019; Onwuegbuzie, 2003). Findings from a study by Onwuegbuzie (2003) showed that statistics anxiety had a negative relationship with performance on a statistics exam for graduate students. Similarly, Ogbonnaya et al. (2019) found that statistics anxiety had a significant negative relationship with statistical performance for undergraduate psychology students. It is important to note that in their studies, Ogbannaya (2019) and Onwuegbuzie (2003) did not differentiate between the statistics anxiety and attitude toward statistics subscales in the instrument used. This may explain why the findings in the current study do not align with existing research.

Some of the more recent research in the area of statistics anxiety has begun to look more specifically at differentiating between the effect of statistics anxiety and the effect of attitude toward statistics (Chew & Dillon, 2014; Devaney, 2016; Macher et al., 2015). Chew and Dillon (2014) have called into question whether the Statistics Anxiety Rating Scale (STARS) used by many researchers has been used correctly to accurately measure statistics anxiety. Chew and Dillon (2014) noted that many researchers used the composite score of both subscales (consisting of the six dimensions of statistics anxiety) in the STARS to assess statistics anxiety, when, in fact, only three dimensions measure anxiety and the other three measure attitudes. Chew and Dillon (2014) note that statistics anxiety sometimes leads to better course performance for

students, whereas negative attitudes toward statistics often results in poor course performance. In one study by Paechter et al. (2017), the researchers found that some students with higher levels of mathematics anxiety also experienced higher levels of statistics anxiety, but overall, these students had better grades in their statistics coursework than students with lower levels of mathematics and statistics anxiety. The authors posit that this could be because students expect to have difficulty in the statistics course based on their previous mathematics experiences, and therefore they may put forth greater effort to try to do well in the statistics course (Paechter et al., 2017). In the current study, most students performed well in the online statistics course, and the majority selected an anxiety trait as opposed to an attitude trait when considering how they identified with the six dimensions of statistics anxiety. However, the results of the current study still differ from current research about both the effects of statistics anxiety and the effect of attitudes toward statistics on academic performance.

In the current study, all six dimensions of statistics anxiety were included as possible choices for students as they considered their own type of statistics anxiety for the discussion board assignment. However, it can be argued that computational self-concept is a measure of "attitude" and not anxiety. In either case, this study found that neither statistics anxiety subscales nor attitude subscale (computational self-concept) were significant predictors of course grades. It is interesting to note that the three most frequently identified dimensions of statistics anxiety by the students in this study were interpretation anxiety, test and class anxiety, and computational self-concept. Interpretation anxiety and test and class anxiety are part of the anxiety subscale of the STARS, where computational self-concept is part of the attitude subscale. The anxiety dimensions (interpretation anxiety and test and class anxiety) accounted for 216 of the 389 total responses. It is possible that the majority of the students in the online statistics course primarily experienced feelings of anxiety as opposed to negative attitudes toward statistics and were

therefore motivated to invest more time and effort into trying to perform well in the course.

While the majority of students in this study identified with anxiety traits, there were still 173 responses for the attitude traits. Based on recent research, it would not have been unusual for the results of this study to have shown a difference in final course grades between the students who identified with an anxiety trait and the students who identified with an attitude trait. One possible reason for the lack of difference in final course grades between these two groups could be the discussion board assignment completed by the students. A study by Denton (2018) looked at the effect of reflective journaling for psychology majors in an introductory statistics course. The results of Denton's (2018) study indicated that reflective journaling seemed to help reduce statistics anxiety and resulted in better course performance. The discussion board assignment completed by the students in the current study required the students to write out their thoughts on which dimension of statistics anxiety they most identified with and what they would do to cope with this anxiety. The discussion board assignment could have served as a journaling exercise similar to the one described by Denton (2018). Through the reflective exercise required in the discussion board assignment—which was completed during the first week of an eight-week course—it is possible that students experienced reduced statistics anxiety, which, in turn, may have positively affected course performance.

Implications

This study adds to the existing literature related to statistics anxiety and contributes to fulfilling the need for more research specifically in the area of statistics anxiety in students enrolled in online doctoral programs. This study may be the only recent study to specifically address how self-reported type of statistics anxiety affects final course grades in an online doctoral-level statistics course. Previous studies have assessed the effect of statistics anxiety on course performance for students in traditional, on-campus courses at various academic levels

(Hoegler & Nelson, 2018; Onwuegbuzie, 2003). Other studies have also looked at best practices for alleviating statistics anxiety in students in order to improve course performance (Lalande et al., 2019; Thompson et al., 2019). Some studies have reevaluated traditional rating scales for statistics anxiety or looked more closely at differentiating between statistics anxiety and attitudes toward statistics (Chew & Dillon, 2014; Nielsen & Keiner, 2018; Papousek et al., 2012). While these studies add important information to the body of knowledge surrounding statistics anxiety, the current study helps to address the need for more research specifically dealing with statistics anxiety for students in online doctoral programs.

The implications of the current study are especially relevant when considering the growing numbers in online doctoral program enrollment in the social science fields, as well as the issue of doctoral student attrition (Ewing et al., 2012; Fiore et al., 2019; Rockinson-Szapkiw et al., 2016). Studies have noted the issue of doctoral student attrition, citing that it is worse in online programs (Ewing et al., 2012; Fiore et al., 2019). Additionally, doctoral students are most at risk for dropping out at the dissertation stage, where the difficulty of research methods courses and the dissertation process itself are often the reason for dropping out (Ewing et al., 2012; Fiore et al., 2019; Rockinson-Szapkiw et al., 2016). Doctoral student attrition can have significant negative implications for the students and for society as a whole (Ewing et al., 2012; Hwang et al., 2015; Kelley & Salisbury-Glennon, 2016; Kennedy et al., 2015), and so it is important to consider all aspects of online doctoral programs that could help foster persistence and successful program completion.

Some online doctoral candidates seem to shy away from quantitative methods of research due to statistics anxiety (Huang, 2018; Thompson et al., 2019). Online students may be at an increased risk of experiencing higher levels of statistics anxiety compared to students in on-campus programs, therefore it is possible that these students will avoid quantitative methods of

research more than traditional students (Devaney, 2010). This avoidance could result in procrastination in enrolling in statistics courses or hinder academic performance in these courses (Onwuegbuzie, 2003, 2004). When students fail to develop an understanding of statistical concepts and quantitative methods, not only are they less likely to contribute to quantitative research with their own studies, but they may not even be able to fully understand other published quantitative studies (Onwuegbuzie, 2000).

While the current study did not find a predictive relationship between type of statistics anxiety and final grades in a statistics course, it is important to pursue more studies like this one in order to determine where additional support may be needed for online doctoral students to develop an adequate understanding of statistics. Not only may this help with the issue of online doctoral student attrition, but it could encourage those who persist to the dissertation phase to pursue quantitative studies of their own. Regardless of whether doctoral candidates choose a quantitative or qualitative route for their research, understanding statistics will only help them to understand more fully the research articles they read and to perhaps feel more confident as researchers themselves as they make the transition from student to scholar in the dissertation process.

Limitations

There were several limitations in the current study. One limitation of this study was the threat to external validity, as the results are only generalizable to the population of online doctoral students enrolled at the university at which the study took place. The findings from this study might not be relevant to students at different academic levels (undergraduate or graduate), who attend different colleges or universities, or who take statistics courses in a face-to-face or hybrid format.

The correlational design of the study also has its limitations. While correlational studies can be used to investigate the possibility of a cause-and-effect relationship between variables, it is difficult to draw conclusions from these types of studies (Gall et al., 2007). Even if a significant correlation is found, Gall et al. (2007) suggest that an experimental study should be conducted as a follow up in order to draw any real conclusions about the relationship between variables. While the current study did not find any predictive relationship between the predictor variables and the criterion variable, this particular area of research is still developing, and so additional correlational studies at different settings might still be beneficial for gaining insight into the effect of statistics anxiety on online doctoral students.

Another limitation is that the archival data used for this study consisted of information that was self-reported by students. Self-report measures are generally acceptable, though Gall et al. (2007) note that an important part of obtaining meaningful scores from a self-report measure is to try to ensure that participants see the value in the assessment and take it seriously. The discussion board assignment in the course asked students to confront an issue that many were likely facing as they began the course. It seems likely that students would have had an interest in reading the assigned article and earnestly answering the prompt; however, it is possible that students could have misinterpreted the definitions of the six dimensions of statistics anxiety and may have identified with one that does not truly reflect the type of anxiety they experienced.

Another limitation is that this study did not take into account students' past mathematics or statistics course experiences. A study by Dempster and McCorry (2009) found that previous experiences in math and statistics courses seem to determine whether a student has a more or less favorable attitude toward statistics, which in turn affected course performance. All of the students in the current study were in an education doctoral program, and likely had varying backgrounds for their master's and undergraduate degrees that would have had different, if any,

requirements for mathematics and statistics courses. Further research in this area could shed light on how previous experience in mathematics and statistics courses could impact online doctoral students specifically.

Recommendations for Future Research

There are several ways that research related to statistics anxiety in online doctoral students can be expanded beyond the scope of the current study. Since this study was conducted at one online university, it would be beneficial to extend this study to other colleges and universities. Thompson et al. (2019) noted that there is a need for more recent research regarding statistics anxiety in general. With the growth in online education, there are new aspects to explore in the area of statistics anxiety that have not been fully investigated at this point. Conducting a similar study to this one at different online colleges and universities could shed light on new trends in statistics anxiety in doctoral students.

Another area for furthering this research would be to conduct a study that looks at the differences in course performance between students who most identify with an anxiety trait and students who most identify with an attitude trait related to statistics anxiety. Other research has shown that attitude towards anxiety can have more of a detrimental effect on statistics achievement than statistics anxiety (Chew & Dillon, 2014; Nielsen & Keiner, 2018; Papousek et al., 2012); however, few studies focus specifically on online doctoral students.

In this current study, students participated in a discussion board at the beginning of the course. The discussion board assignment completed by the students taking the course required the students to write out their thoughts on which dimension of statistics anxiety they most identified with and what they would do to cope with this anxiety. In the study by Denton (2018), the author concluded that reflective journaling helped reduce statistics anxiety and resulted in

better course performance. Further investigation regarding the effects of reflective journaling among doctoral students in an online statistics course may be warranted.

Previous studies have also looked at the connection between mathematics anxiety and statistics anxiety (Baloğlu, 2004; Paechter et al., 2017); however, more research could be beneficial in this area as well, specifically as it relates to online doctoral students. With the growing enrollment numbers in online programs in the social sciences, it is possible that greater numbers of doctoral students will have little mathematics or statistics course experience. Assessing how this might affect their performance in statistics courses could help inform program administrators who may want to consider supplementing the curriculum to accommodate for this.

REFERENCES

Alizamar, A., Afdal, A., Ifdill, I., Ardi, Z., Ilyas, A., Zikra, Z., . . .Febriani, R. D. (2019). Are there statistical anxiety differences between male and female students? *Journal of Physics, 1157*(4), 1-5. doi:10.1088/1742-6596/1157/4/042127

Ames, C., Berman, R., & Casteel, A. (2018). A preliminary examination of doctoral student retention factors in private online workspaces. *International Journal of Doctoral Studies*, *13*, 79-107. https://doi.org/10.28945/3958

Ashcraft, M. H. (2002). Math anxiety: Personal, educational, and cognitive consequences. *Current Directions in Psychological Science, 11*(5), 181–185. https://doi.org/10.1111/1467-8721.00196

Ashcraft, M. H., & Faust, M. W. (1994). Mathematics anxiety and mental arithmetic performance: An exploratory investigation. *Cognition and Emotion, 8*(2), 97-125. https://doi.org/10.1080/02699939408408931

Ashcraft, M. H., & Moore, A. M. (2009). Mathematics anxiety and the affective drop in performance. *Journal of Psychoeducational Assessment, 27*(3), 197-205. https://doi.org/10.1177/0734282908330580

Azar, F. S., & Mahmoudi, L. (2014). Relationship between mathematics, self-efficacy and students' performance in statistics: The meditational role of attitude toward mathematics and mathematics anxiety. *Journal of Educational Sciences & Psychology, 4*(1), 32-42. https://www.proquest.com/openview/388adeda47a8e72e8b10b9b0585cc198/1?pq-origsite=gscholar&cbl=786381

Baloğlu, M. (2002). Individual differences in statistics anxiety among college students. *Personality and Individual Differences, 34*, 855-865. https://doi.org/10.1016/S0191-8869(02)00076-4

Baloğlu, M. (2004). Statistics anxiety and mathematics anxiety: Some interesting differences I. *Educational Research Quarterly, 27*(3), 38-48. https://eric.ed.gov /?id=EJ792861

Bandura, A. (1977a). *Social learning theory*. New Jersey: Prentice-Hall.

Bandura, A. (1977b). Self-efficacy: Toward a unifying theory of behavioral change. *Psychological Review, 84*, 191-215. https://doi.org/10.1016/0146-6402(78)90002-4

Bandura, A. (1997). *Self-efficacy: The exercise of control.* New York: Freeman.

Bandura, A., & Adams, N. E. (1977). Analysis of self-efficacy theory of behavioral change. *Cognitive Therapy and Research, 1*(4), 287-310. https://doi.org/10.1007/BF01663995

Bartsch, R. A., Case, K. A., & Meerman, H. (2012). Increasing academic self-efficacy in statistics with a live vicarious experience presentation. *Teaching of Psychology, 39*(2), 133-136. https://doi.org/10.1177/0098628312437699

Benson, J. (1989). Structural components of statistics anxiety in adults: An exploratory model. *The Journal of Experimental Education, 57*(3), 247-261. https://www.jstor.com/stable /20151773

Breitenbach, E. (2019). Evaluating a model to increase doctorate program completion rates: A focus on social connectedness and structure. *International Journal of Doctoral Studies, 14,* 217-236. doi:10.28945/4239

Bronstein, S. B. (2008). Supplemental instruction: Supporting persistence in barrier courses. *Learning Assistance Review, 13*(1), 31-45. https://eric.ed.gov/?id =EJ818225

Carey, E., Hill, F., Devine, A., Szücs, D. (2016). The Chicken or the egg? The direction of the relationship between mathematics anxiety and mathematics performance. *Frontiers in Psychology, 6*, 1-6. https://doi.org/10.3389/fpsyg.2015.01987

Chiesi, F., & Primi, C. (2018, July). What happens when attitudes toward statistics change (increase vs decrease) during the course? In M. A. Sorto, A. White, & L. Guyot (Eds.), *Looking back, looking forward. Proceedings of the Tenth International Conference on Teaching Statistics*, Kyoto, Japan. Voorburg, The Netherlands: International Statistical Institute.

Chew, P. K. H., & Dillon, D. B. (2014). Statistics anxiety update: Refining the construct and recommendation for a new research agenda. *Perspectives on Psychological Science, 9*(2), 196-208. https://doi.org/10.1177/1745691613518077

Cruise, R. J., Cash, R. W., & Bolton, D. L. (1985, August). *Development and validation of an instrument to measure statistical anxiety.* Paper presented at the annual meeting of the Statistical Education Section. Proceedings of the American Statistical Association.

Cruise, R. J., & Wilkins, E. M. (1980). *STARS: Statistical Anxiety Rating Scale*. Unpublished manuscript, Andrews University, Berrien Springs, MI.

Cui, A., Zhang, J., Guan, D., Zhao, X., & Jiwei, S. (2019). Antecedents of statistics anxiety: An integrated account. *Personality and Individual Differences, 144*, 79-87. https://doi.org /10.1016/j.paid.2019.02.036

Daley, C. E., & Onwuegbuzie, A. J. (1997, November 12-14). *The role of multiple intelligences in statistics anxiety*. [Paper presentation]. Annual Meeting of the Mid-South Educational Research Association, Memphis, TN. https://files.eric.ed.gov/fulltext /ED415272.pdf

Dempster, M., & McCorry, N. K. (2009). The role of previous experience and attitudes toward statistics in statistics assessment outcomes among undergraduate psychology students. *Journal of Statistics Education, 17*(2). https://doi.org/10.1080/10691898.2009.11889515

Denton, A. W. (2018). The use of a reflective learning journal in an introductory statistics course. *Psychology Learning & Teaching, 17*(1), 84-93. https://doi.org/10.1177/1475725717728676

Devaney, T. A. (2010). Anxiety and attitude of graduate students in on-campus vs. online statistics courses. *Journal of Statistics Education, 18*(1). doi:10.1080/10691898.2010.11889472

Devaney, T. A. (2016). Confirmatory factor analysis of the statistical anxiety rating scale with online graduate students. *Psychological Reports, 118*(2), 565-586. https://doi.org/10.1177%2F0033294116644093

Dowker, A., Sarkar, A, & Looi, C. Y. (2016). Mathematics anxiety: What have we learned in 60 years? *Frontiers in Psychology, 7*(508), 1-16. https://doi.org/10.3389/fpsyg.2016.00508

Eduljee, N. B., & LeBourdais, P. (2015). Gender differences in statistics anxiety with undergraduate college students. *The International Journal of Indian Psychology, 2*(3), 69-82. https://doi.org/10.25215/0203.028

Elias, S. M., & MacDonald, S. (2007). Using past performance, proxy efficacy, and academic self-efficacy to predict college performance. *Journal of Applied Social Psychology, 37*(11), 2518-2531. https://doi.org/10.1111/j.1559-1816.2007.00268.x

Elliott, W., Choi, E., & Friedline, T. (2013). Online statistics labs in MSW research methods courses: Reducing reluctance toward statistics. *Journal of Social Work Education, 49*(1), 81-95. https://doi.org/10.1080/10437797.2013.755095

Emmioğlu, E., & Capa-Aydin, Y. (2012). Attitudes and achievement in statistics: A meta-analysis study. *Statistics Education Research Journal, 11*(2), 95-102. https://doi.org/10.52041/serj.v11i2.332

Ewing, H., Mathieson, K., Alexander, J. L., & Leafman, J. (2012). Enhancing the acquisition of research skills in online doctoral programs: The Ewing Model.© *MERLOT Journal of Online Learning and Teaching, 8*(1), 34-43. https://jolt.merlot.org/vol8no1 /ewing_0312.pdf

Ferguson, S. L., Hovey, K. A., & Henson, R. K. (2017). Quantitative preparation in doctoral education programs: A mixed-methods study of doctoral student perspectives on their quantitative training. *College of Education Faculty Scholarship, 7*. https://rdw.rowan.edu/education_ facpub/7

Fiore, T. D., Heitner, K. L., & Shaw, M. (2019). Academic Advising and Online Doctoral Student Persistence from Coursework to Independent Research. *Online Journal of Distance Learning Administration, 23*(3). https://www.westga.edu /~distance/ojdla/fall223/fiore_heitner_shaw223.html

Gainen, J. (1995). Barriers to success in quantitative gatekeeper courses. *New Directions for Teaching & Learning, 61*, 5-14. https://doi.org/10.1002/tl.37219956104

Gall, M. D., Gall, J. P., & Borg, W. R. (2007). *Educational research* (8th Ed.). Boston, MA: Pearson.

Geven, K., Skopek, J., & Triventi, M. (2018). How to increase PhD Completion Rates? An impact evaluation of two reforms in selective graduate school, 1976-2012. *Research in Higher Education, 59*, 529-552. https://doi.org/10.1007/s11162-017-9481-z

Gittings, G., Bergman, M., Shuck, B., & Rose, K. (2018). The impact of student attributes and program characteristics on doctoral degree completion. *New Horizons in Adult Education & Human Development, 30*(3), 3-22. https://doi.org/10.1002/nha3.20220

Goetz, T., Bieg, M., Ludtke, O., Pekrun, R., Hall, N. C. (2013). Do girls really experience more anxiety in mathematics? Psychological Science, 24(10), 2079-2087. https://doi.org/10.1177/0956797613486989

Heretick, D. M., & Tanguma, J. (2020). Anxiety and attitudes toward statistics and research among younger and older nontraditional adult learners. *The Journal of Continuing Higher Education, 69*(2), 87-99. https://doi.org/10.1080/07377363.2020.1784690

Hodges, C. B. (2008). Self-efficacy in the context of online learning environments: A review of the literature and directions for research. *Performance Improvement Quarterly, 20*(3-4), 7-25. https://doi.org/10.1002/piq.20001

Hodges, C. B., & Kim, C. (2013). Improving college students' attitudes toward mathematics. *TechTrends, 57*(4), 59-66. https://doi.org/10.1007/s11528-013-0679-4

Hoegler, S., & Nelson, M. (2018). The influence of anxiety and self-efficacy on statistics performance: A path analysis. *The International Honor Society in Psychology, 23*(5), 364-375. https://doi.org/10.24839/2325-7342.JN23.5.364

Honicke, T., & Broadbent, J. (2015). The influence of academic self-efficacy on academic performance: A systematic review. *Educational Research Review, 17*, 63-84. https://doi.org/10.1016/j.edurev.2015.11.002

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. doi:10.1177/1073191103010002008

Huang, L. (2018). A mixed method investigation of social science graduate students' statistics anxiety conditions before and after the introductory statistics course. *International Journal of Higher Education, 7*(3), 156-162. https://files.eric.ed.gov/fulltext/EJ1182182.pdf

Hwang, E., Smith, R. N., Byers, V. T., Dickerson, S., McAlister-Shields, L., Onwuegbuzie, A., & Benge, C. (2015). Doctoral students' perceived barriers that slow the progress toward completing a doctoral dissertation: A mixed analysis. *Journal of Educational Issues, 1*(1), 165-190. https://eric.ed.gov/?id=EJ1131694

Jameson, M. M. (2020). Time, time, time: Perceptions of the causes of mathematics anxiety in highly maths anxious female adult learners. *Adult Education Quarterly, 70*(3), 223-239. https://doi.org/10.1177/0741713619896324

Jiang, M., Ballenger, J., & Holt, W. (2019). Educational leadership doctoral students' perceptions of the effectiveness of instructional strategies and course design in a fully online graduate statistics course. *Online Learning Journal, 23*(4). 296-312. https://eric.ed .gov/?id=EJ1237861

Jordan, J. F., & Haines, B. A. (2003). Fostering quantitative literacy: Clarifying goals, assessing student progress. *Peer Review, 5*(4), 16-19. https://eric.ed.gov/?id =EJ676432

Karimi, A., & Venkatesan, A. (2009). Mathematics anxiety, mathematics performance and overall academic performance in high school students. *Management and Labour Studies, 34*(4), 556-562. https://doi.org/10.1177/0258042X0903400406

Keeley, J., Zayac, R., & Correia, C. (2008). Curvilinear relationships between statistics anxiety and performance among undergraduate students: Evidence for optimal anxiety. *Statistics Education Research Journal, 7*(1), 4-15. http://iase-web.org/documents/SERJ/SERJ7(1) _Keeley.pdf

Kelley, M. J., & Salisbury-Glennon, J. D. (2016). The role of self-regulation in doctoral students' status of all but dissertation (ABD). *Innovative Higher Education, 41*(1), 87-100. https://doi.org/10.1007/s10755-015-9336-5

Kennedy, D. H., Terrell, S. R., Lohle, M. (2015). A grounded theory of persistence in a limited-residency doctoral program. *The Qualitative Report, 20*(3), 215-230. https://nsuworks.nova.edu/tqr/vol20/iss3/5/

Kozar, O., Lum, J. F., & Benson, P. (2015). Self-efficacy and vicarious learning in doctoral studies at a distance. *Distance Education, 36*(3), 448-454. https://doi.org/10.1080/01587919.2015.1081739

Lalande, D., Cantinotti, M., Williot, A., Gagnon, J., & Cousineau, D. (2019). Three pathways from achievement goals to academic performance in an undergraduate statistics course. *Statistics Education Research Journal, 18*(1), 94–105. http://www.stat.auckland.ac.nz/serj

Lalayants, M. (2012). Overcoming graduate students' negative perceptions of statistics. *Journal of Teaching in Social Work. 32*, 356–375. https://doi.org/10.1080/08841233.2012.705259.

Lavidas, K., Barkatsas, T., Manesis, D., & Gialamas, V. (2020). A structural equation model investigating the impact of tertiary students' attitudes toward statistics, perceived competence at mathematics, and engagement on statistics performance. *Statistics Education Research Journal, 19*(2), 27-41. https://doi.org/10.52041/serj.v19i2.108

Lederman, D. (2018). Who is studying online (and where). *Inside Higher Ed.* https://www.mtsac.edu/president/cabinet-notes/2017-18/Who_Is_Studying_Online_and_Where.pdf

Leech, N. L., & Haug, C. A. (2015). Investigating graduate level research and statistics courses in schools of education. *International Journal of Doctoral Studies, 10,* 93-110. http://ijds.org/Volume10/IJDSv10p093-110Leech0658.pdf

Lim, J. H., Dannels, S. A., & Watkins, R. (2008). Qualitative investigation of doctoral students' learning experiences in online research methods courses. *The Quarterly Review of Distance Education, 9*(3), 223-236. https://eric.ed.gov/?id=EJ875099

Lim, J., Kim, M., Chen, S. S., & Ryder, C. E. (2008). An empirical investigation of student achievement and satisfaction in different learning environments. *Journal of Instructional Psychology, 35*(2), 113-119. https://www.learntechlib.org/p/101473/

Luttenberger, S., Wimmer, S., & Paechter, M. (2018). Spotlight on math anxiety. *Psychology Research and Behavior Management, 11*, 311-322. http://dx.doi.org/10.2147/PRBM.S141421

Macher, D., Paechter, M., Papousek, I., & Ruggeri, K. (2011). Statistics anxiety, trait anxiety, learning behavior, and academic performance. *European Journal of Psychology of Education, 27*, 483-498. https://link.springer.com/article/10.1007/s10212-011-0090-5

Macher, D., Papousek, I., Ruggeri, K., & Paechter, M. (2015). Statistics anxiety and performance: Blessings in disguise. *Frontiers in Psychology, 6*, 1116. https://doi.org/10.3389/fpsyg.2015.01116.

Mandap, C. M. (2016). Examining gender differences in statistics anxiety among college students. *International Journal of Education and Research, 4*(6), 357-366. https://www.ijern.com/journal/2016/June-2016/31.pdf

Maul, J., Berman, R., & Ames, C. (2018). Exploring the psychological benefits of using an emerging video technology to coach and retain doctoral learners. International Journal of Doctoral Studies, 1349-78. https://doi.org/10.28945/3954

Mazana, M. Y., Montero, C. S., Casmir, R. O. (2019). Investigating students' attitude towards learning mathematics. *International Electronic Journal of Mathematics Education, 14*(1), 207-231. https://doi.org/10.29333/iejme/3997

Mills, J. D., & Raju, D. (2011). Teaching statistics online: A decade's review of the literature about what works. *Journal of Statistics Education, 19*(2), doi:10.1080/10691898.2011.11889613

Mokhele, M. (2018). *The association of statistics anxiety, attitude toward statistics and mathematical self-concept with performance in a business statistics course*. [Master's thesis, University of the Free State]. KovsieScholar.

Musch, J., & Bröder, A. (1999). Test anxiety versus academic skills: A comparison of two alternative models for predicting performance in a statistics exam. *British Journal of Educational Psychology, 69*, 105-116. https://doi.org/10.1348/000709999157608

Najmi, A., Raza, S. A., & Qazi, W. (2018). Does statistics anxiety affect students' performance in higher education? The role of students' commitment, self-concept, and adaptability. *International Journal of Management in Education, 12*(2), 95-113. https://doi.org/10.1504/IJMIE.2018.10009634

Ni, A. Y. (2013). Comparing the effectiveness of classroom and online learning: Teaching research methods. Journal of Public Affairs Education, 19(2), 199-215. https://doi.org/10.1080/15236803.2013.12001730

Ogbonnaya, K. E., Okechi, B. C., & Nwankwo, B. C. (2019). Impact of statistics anxiety and self-efficacy on statistical performance of psychology students. *Nigerian Journal of Social Psychology, 2*(2), 222-238. https://www.nigerianjsp.com/index.php/NJSP/article/view/33

Okahana, H., & Zhou, E. (2017). Graduate enrollment and degrees: 2006 to 2016. *Council of Graduate Schools*. https://cgsnet.org/ckfinder/userfiles/files/CGS_GED16_Report_Final.pdf

Onwuegbuzie, A. J. (2000). Statistics anxiety and the role of self-perceptions. *The Journal of Educational Research, 93*:5, 323-330. doi:10.1080/00220670009598724

Onwuegbuzie, A. J. (2003). Modeling statistics achievement among graduate students. *Educational and Psychological Measurement, 63*(6), 1020-1038. doi:10.1177/0013164402250989

Onwuegbuzie, A. J. (2004). Academic procrastination and statistics anxiety. *Assessment & Evaluation in Higher Education, 29*(1), 3-19. https://doi.org/10.1080/0260293042000160384

Onwuegbuzie, A. J., Da Ros, D., & Ryan, J. M. (1997). The components of statistics anxiety: A phenomenological study. *Focus on Learning Problems in Mathematics, 19*(4), 11-35. https://eric.ed.gov/?id=EJ558838

Onwuegbuzie, A. J., & Daley, C. (1999). Perfectionism and statistics anxiety. *Personality and Individual Differences, 26*(6), 1089–1102. https://doi.org/10.1016/S0191-8869(98)00214-1

Onwuegbuzie, A. J., & Wilson, V. A. (2000). Statistics anxiety: Nature, etiology, antecedents, effects, and treatments: A comprehensive review of the literature. Paper presented at the Annual Meeting of the Mid-South Educational Research Association. https://doi.org/10.1080/1356251032000052447

Paechter, M., Macher, D., Martskvishvili, K., Wimmer, S., & Papousek, I. (2017). Mathematics anxiety and statistics anxiety: Shared but also unshared components and antagonistic contributions to performance in statistics. *Frontiers in Psychology, 8*, 1-13. https://doi.org/10.3389/fpsyg.2017.01196

Perepiczka, M., Chandler, N., & Becerra, M. (2011). Relationship between graduate students' statistics self-efficacy, statistics anxiety, attitude toward statistics, and social support. *The Professional Counselor, 1*(2), 99-108. doi:10.15241/mpa.1.2.99

Perney, J., & Ravid, R. (1990). The relationship between attitudes toward statistics, math self-concept, test anxiety and graduate students' achievement in an introductory statistics course. Paper presented at the Annual Meeting of the American Educational Research Association (Boston, MA, April 16-20, 1990). https://eric.ed.gov/?id=ED318607

Pletzer, B., Kronbichler, M., Nuerk, H.-C., & Kerschbaum, H. H. (2015). Mathematics anxiety reduces default mode network deactivation in response to numerical tasks. Frontiers in Human Neuroscience, 9, 1-12. https://doi.org/10.3389/fnhum.2015.00202

Putwain, D., Sander, P., & Larkin, D. (2012). Academic self-efficacy in study-related skills and behaviours: Relations with learning-related emotions and academic success. *British Journal of Educational Psychology, 83*, 633-650. https://doi.org/10.1111/j.2044-8279.2012.02084.x

Ramirez, G., Shaw, S. T., & Maloney, E. A. (2018). Math anxiety: Past research, promising interventions, and a new interpretation framework. *Educational Psychologist, 53*(3), 145-164. https://doi.org/10.1080/00461520.2018.1447384

Richardson, F. C., & Suinn, R. M. (1972). The mathematics anxiety rating scale: Psychometric data. *Journal of Counseling Psychology, 19*(6), 551-554. https://doi.org/10.1037/h0033456

Rigler, K. L., Bowlin, L. K., Sweat, K., Watts, Stephen, & Throne, R. (2017). *Agency, socialization, and support: A critical review of doctoral student attrition*. [Paper presentation] International Conference on Doctoral Education, Orlando, FL. https://eric.ed.gov/?id=ED580853

Roberts, J., & Styron, R. (2010). Student satisfaction and persistence: Factors vital to student retention. *Research in Higher Education Journal, 6*, 1-18. https://www.aabri.com /rhej.html

Rockinson-Szapkiw, A. J., Spaulding, L. S., & Spaulding, M. T. (2016). Identifying significant integration and institutional factors that predict online doctoral persistence. *Internet & Higher Education, 31*,101-112. https://doi.org/10.1016/j.iheduc.2016.07.003

Rodarte-Luna, B., & Sherry, A. (2008). Sex difference in relation between statistics anxiety and cognitive/learning strategies. *Contemporary Educational Psychology, 33*, 327-344. https://doi.org/10.1016/j.cedpsych.2007.03.002

Rosli, M. K., & Maat, S. M. (2017). *Attitude toward statistics and performance among post-graduate students*. In M. Puteh, N. Z. A. Hamid, & N. H. Adenan (Eds.) Proceedings of the International Conference on Education, Mathematics and Science (ICEMS2016), Perak, Malaysia. https://doi.org/10.1063/1.4983881

Schau, C. (2003). *Students' attitudes: The "other" important outcome in statistics education*. [Paper presentation]. Joint Statistical Meetings, San Francisco, CA. http://statlit.org/pdf /2003SchauASA.pdf

Seaman, J. E., Allen, I. E., & Seaman, J. (2018). Grade increase: Tracking distance education in the United States. *Babson Survey Research Group*. https://onlinelearningsurvey.com /reports/gradeincrease.pdf

Skagerlund, K., Östergren, R., Västfjäll, D., & Träff, U. (2019). How does mathematics anxiety impair mathematics abilities? Investigating the link between math anxiety, working memory, and number processing. *PLoS ONE, 14*(1), 1-17. https://doi.org/10.1371 /journal.pone.0211283

Thompson, C. J., Leonard, L., & Bridier, N. (2019). Online discussion forums: Quality interactions for reducing statistics anxiety in graduate education students. *International Journal of E-Learning & Distance Education, 34*(1). 1-31. https://eric.ed.gov/?id =EJ1227692

Tonsing, K. N. (2018). Instructor immediacy and statistics anxiety in social work undergraduate students. *Social Work Education, 37*(2), 223-233. https://doi.org/10.1080/02615479.2017 .1395009

Tutkun, T. (2019). Statistics anxiety of graduate students. *International Journal of Progressive Education, 15*(5). 32-41. https://doi.org/10.29329/ijpe.2019.212.3

Warner, R. M. (2013) *Applied statistics: From bivariate through multivariate techniques.* Washington, DC: SAGE.

Wine, J. D. (1980). Cognitive-attentional theory of test anxiety. In I. G. Sarason (Ed.), *Test anxiety: Theory, research and applications* (pp. 349-385). Erlbaum.

Yang, D. (2017). Instructional strategies and course design for teaching statistics online: Perspectives from online students. *International Journal of STEM Education, 4*(34), 1-15. https://doi.org/10.1186/s40594-017-0096-x

Zeidner, M. (1991). Statistics and mathematics anxiety in social science students: Some interesting parallels. *British Journal of Educational Psychology, 61*(3), 319–328. https://doi.org/10.1111/j.2044-8279.1991.tb00989.x

Zimmerman, B. J. (2000). Self-efficacy: An essential motive to learn. *Contemporary Educational Psychology, 25*, 82-91. https://doi.org/10.1006/ceps.1999.1016

Appendix A: IRB Approval

LIBERTY UNIVERSITY.
INSTITUTIONAL REVIEW BOARD

2020-10-14

Kirsten Hoegh
Michelle Barthlow

Re: IRB Exemption - IRB-FY20-21-228 THE RELATIONSHIP BETWEEN DOCTORAL STUDENTS' SELF-REPORTED TYPE OF STATISTICS ANXIETY AND FINAL GRADES IN AN ONLINE STATISTICS COURSE

Dear Kirsten Hoegh, Michelle Barthlow:

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

Your study falls under the following exemption category, which identifies specific situations in which human participants research is exempt from the policy set forth in 45 CFR 46: 101(b):

Category 4. Secondary research for which consent is not required: Secondary research uses of identifiable private information or identifiable biospecimens, if at least one of the following criteria is met:

(i) The identifiable private information or identifiable biospecimens are publicly available;

(ii) Information, which may include information about biospecimens, is recorded by the investigator in such a manner that the identity of the human subjects cannot readily be ascertained directly or through identifiers linked to the subjects, the investigator does not contact the subjects, and the investigator will not re-identify subjects;

(iii) The research involves only information collection and analysis involving the investigator's use of identifiable health information when that use is regulated under 45 CFR parts 160 and 164, subparts A and E, for the purposes of "health care operations" or "research" as those terms are defined at 45 CFR 164.501 or for "public health activities and purposes" as described under 45 CFR 164.512(b); or

(iv) The research is conducted by, or on behalf of, a Federal department or agency using government-generated or government-collected information obtained for nonresearch activities, if the research generates identifiable private information that is or will be maintained on information technology that is subject to and in compliance with section 208(b) of the E-Government Act of 2002, 44 U.S.C. 3501 note, if all of the identifiable private information collected, used, or generated as part of the activity will be maintained in systems of records

subject to the Privacy Act of 1974, 5 U.S.C. 552a, and, if applicable, the information used in the research was collected subject to the Paperwork Reduction Act of 1995, 44 U.S.C. 3501 et seq.

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

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

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

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