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The Relationship Between Social Science Majors' Quantitative-Course Experience and Their Quantitative Anxiety

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THE RELATIONSHIP BETWEEN SOCIAL SCIENCE MAJORS' QUANTITATIVE-COURSE EXPERIENCE AND THEIR QUANTITATIVE ANXIETY

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Abstract

This study examined the relationship between quantitative anxiety, specifically mathematics anxiety and statistics anxiety, and quantitative-course experience with gender. Social science majors from two universities were offered the opportunity to complete an online survey. Twenty-one undergraduates responded. The survey contained demographic questions, 25 items from the Revised-Mathematics Anxiety Rating Scale, and 24 items from the Statistical Anxiety Scale. Data from the surveys were analyzed using linear regression and multiple regression. Data showed all students had some level of mathematics test anxiety and statistics class test anxiety. There were some students with no anxiety in the other anxiety subscales. Data from this study was not found to be statistically significant.

Key words: quantitative experience, quantitative anxiety, mathematics anxiety, statistics anxiety, gender

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Chapter 1

Introduction

As an adjunct statistics professor I have seen many undergraduate social science students not complete the required statistics class, or take it two, three, and sometimes even four times before successfully completing the course. Many students wait until their last term to take the course. I rarely had a freshman or sophomore take the class. Why was this happening? Before the course even started, students were telling me they were not good at math and therefore believed they would not be good at statistics. Where was this coming from?

Parents play an important role in supporting their children's education, serving as role models and influencing educational values. Parents influence their children with their own attitudes and anxiety - including attitudes and anxiety toward math (Luttenberger, Wimmer & Paechter, 2018). Parental influence can lessen the amount of anxiety (Scarpello, 2007) or create it (Foley et al., 2017), potentially putting their children at risk for developing mathematics anxiety (Ramirez, Shaw & Maloney, 2018). Casad, Hale, and Wachs (2015) report that, parents' math anxiety plays a role in their children's math anxiety with same-gender parent-child dyads showing a more significant relationship.

When math-anxious parents help their children with math homework, it gives parents many opportunities to share their beliefs about math. A study by Maloney, Ramirez, Gunderson, Levine, and Beilock (2015) found parent's math anxiety is negatively related to their children's math learning. The homework assistance that math-anxious parents provide may be playing a role in early mathematics anxiety. When parents express their beliefs with statements such as, "I am not good at math" this normalizes a fear of math. These statements could likely reduce the

amount of effort children invest in math, which may reduce the amount of math learned. As a result of less math learned, children may become more math anxious (Maloney et al., 2015).

Parental influence is not the only factor in mathematics anxiety for children. The first formal interaction with math, and a majority of math knowledge, comes from the classroom (Ramirez et al., 2018). How students interpret the experiences within the classroom may also play a part in the development of mathematics anxiety. Beilock, Gunderson, Ramirez and Levine (2010) found children are more likely to mimic behavior and attitudes of same-gender adults as opposed to opposite-gender adults. This affects girls more than boys if the girls believe in the traditional gender beliefs that boys are better in math (Beilock et al., 2010). In early elementary school, where the teachers are mostly female, teachers' math anxiety can affect girls' math achievement by influencing beliefs about who is good at math (Beilock et al., 2010). Mathematics anxiety "can often be related to past classroom experiences, parental influences, remembering poor past performance, the attitudes of teachers, inadequate curriculum, and/or faulty pedagogy" (Tarasi, Wilson & Puri, 2013, p. 39). In the classroom, math anxiety begins around the fourth grade and peaks in middle school (Scarpello, 2007). Its effects can continue through high school and into the university experience (Tarasi et al., 2013).

In high school, students who experience mathematics anxiety take fewer mathematics courses (Ashcraft, 2002; Hembree, 1990); by the 10th grade many students have stopped taking math (Scarpello, 2007). The amount of math that is taken at the high school level can determine the options available for students in selecting career paths (Scarpello, 2007). "When otherwise capable students avoid the study of mathematics, their options regarding careers are reduced" (Hembree, 1990, p. 34). Mathematics anxiety can have detrimental effects on learners' vocational choices leading to a decrease of professionals in math-related fields (Moreno-Garcia,

Garcia-Santillan, Molchanova & Larracilla-Salazar, 2017), and limiting the number of qualified individuals for careers in science, technology, engineering and math (STEM) (Andrews & Brown, 2015; Blazer, 2011).

Deficits in basic numerical skills, beginning as early as elementary school, leading to repeated experiences in mathematics failure may lead to mathematics anxiety. Anxiety disorders in general, are one of the major mental health issues throughout the world (Luttenberger et al., 2018; Papousek et al., 2012). In recent years, several situation-specific forms of anxiety have been defined, such as test and performance anxiety (Papousek et al., 2012). The most prevalent of these situation-specific forms of anxiety is mathematics anxiety, which is a global concern (Luttenberger et al., 2018). Luttenberger et al. (2018) reports that in the United States, 93% of adults indicate they have some level of mathematics anxiety. Mathematics deficits leading to mathematics anxiety may then impact the development of higher-level mathematics skills (Dowker, Sarkar & Yen Looi, 2016).

Fewer mathematics skills are typically required for some social science majors in fields, such as psychology and education (Huang, 2018). As part of their degree program, most undergraduate and graduate students are required to take one or more statistics courses (Huang, 2018). Students with an insufficient background in mathematics may worry about completing statistics courses (Ciftci, Karadag & Akdal, 2014). The limited background in statistics and mathematics makes statistics comprehension difficult and learning statistics a challenge (Huang, 2018), leading to problems such as postponing examinations and delaying assignments (Macher, Paechter, Papousek & Ruggeri, 2012). A study by Onwuegbuzie and Wilson (2003) found up to 80% of students report some form of statistics anxiety. Several studies show a significant

relationship between mathematics anxiety and statistics anxiety (Chew & Dillon, 2014; Onwuegbuzie & Wilson, 2003; Paechter, Macher, Martskvishvili, Wimmer & Papousek, 2017).

Studies on mathematics anxiety and statistics anxiety often use college students for their data. A study by Baloglu (2003) using both undergraduate and graduate students found previous math experience significantly affected statistics anxiety levels. Cui, Zhang, Guan, Zhao and Si (2019) support this, finding a direct and mediated (e.g. by self-efficacy) correlation between mathematics experience and statistics anxiety, while Faber and Drexler (2019) found prior statistics experience was not significant to predicting statistics anxiety. Few studies look at the levels of mathematics anxiety and statistics anxiety between undergraduate and graduate students to determine if prior experience (number of mathematics and/or statistics type classes taken) makes a difference in anxiety levels. “Little is discussed in the differences between undergraduate and graduate students in statistics which could lead to bias in statistics education since these students are very different, in regard to their backgrounds” (Huang, 2018, p. 157).

Gender differences may also play a role in anxiety levels. Research in quantitative anxiety has looked at the relationship between gender and mathematics anxiety as well as gender and statistics anxiety and found conflicting results. In a study by Ramirez et al. (2018), females reported more mathematics anxiety than males. Stereotyped beliefs rather than actual ability, may explain some of this difference. Dowker et al. (2016) agree that some stereotyping occurs when assessing mathematics anxiety. They found fewer gender differences in mathematics performance in countries that provide educational opportunities for boys and girls, yet girls still rate themselves lower in mathematics and experience higher mathematics anxiety. However, Baloglu (2003) found no significant difference in statistics anxiety by gender while Chew and Dillon (2014) found negligible differences.

There is conflicting data on the relationship between quantitative anxiety (mathematics anxiety and statistics anxiety), gender and quantitative-course experience (number of mathematics and statistics courses taken). Mathematics anxiety has been shown to begin at a young age, possibly affecting mathematics skills, reducing the number of quantitative courses taken, and impacting career choices.

Rationale

In the educational setting, students show more anxiety in mathematics than in any other subject. (Dowker et al., 2016). College majors are often chosen by students based on the math requirements connected to each major (Macher, Papousek, Ruggeri & Paechter, 2015), leading many math-anxious students to the social science fields (Paechter et al., 2017). The statistics courses within these fields require some mathematics knowledge (Huang, 2018); these courses are often viewed as a negative experience for students (Chew & Dillon, 2014) often leading to statistics anxiety (Koh & Zawi, 2014). Research implies that earlier mathematics experience could affect statistics anxiety (Cui et al., 2019), with a direct and mediated correlation between mathematics experience and statistics anxiety. If mathematics experience does impact statistics anxiety, then increasing math exposure throughout a students' academic career may decrease their statistics anxiety. With statistics courses perceived as one of the most demanding and rigorous courses required for college students (Chew & Dillon, 2014; Huang, 2018; Macher et al., 2012), decreasing statistics anxiety could improve student achievement.

If experience in mathematics decreased mathematics anxiety and statistics anxiety, then perhaps exposing students to mathematics terms in non-mathematics courses earlier in their academic career could provide that experience. Perhaps more students would successfully complete their statistics course the first time if they are exposed to statistics terms in earlier

classes. Chamberlain, Hillier, and Signoretta (2015) support this notion when they state, “a key priority for quantitative methods [teachers] is . . . to also seek active support of their non-quantitative method teaching colleagues if they are to positively challenge students’ preconceptions while also building their self-confidence and reducing their statistical anxiety” (p. 64). Since mathematics anxiety and statistics anxiety are highly correlated (Paechter et al., 2017), using statistics terms in other non-mathematics and non-statistics courses may provide the experience students need to decrease statistics anxiety.

Purpose

The purpose of this study was to examine the differences in quantitative anxiety (mathematics anxiety and statistics anxiety) in relation to gender and quantitative-course experience (number of mathematics and statistics courses taken). Students from two universities who were majoring in a social science field and enrolled in a statistics course required by their degree program were sampled. Participating students completed an online survey that included some demographic questions. Data from the survey provided the mathematics anxiety and statistics anxiety scores. Data collected from the demographic questions was used to examine quantitative-course experience, the number of mathematics and statistics type courses taken, and gender.

Research Questions

1) To what extent does quantitative-course experience predict mathematics anxiety in college-level social science majors?
2) To what extent does quantitative-course experience predict statistics anxiety in college-level social science majors?

3) To what extent does quantitative-course experience interact with gender to predict quantitative anxiety in college-level social science majors?

Hypotheses

1) College-level social science majors' mathematics anxiety scores will decrease as their quantitative-course experience increases.
2) College-level social science majors' statistics anxiety scores will decrease as their quantitative-course experience increases.
3) College-level social science majors' gender will moderate the influence of quantitative-course experience on their:
    a. Mathematics anxiety scores.
    b. Statistics anxiety scores.

Limitations

A major limitation of this study was the self-reporting on the anxiety scales. There is the possibility that some participants may not have a definitive reflection of themselves in order to answer questions accurately. It has been reported that females tend to be more critical of themselves when self-reporting (Eden, Heine & Jacobs, 2013), which may have had an impact on the assessments results.

Another limitation was the lack of the researcher's physical presence and availability to the participants for providing clarifying information, or to answer questions regarding the study during the solicitation phase. When a professor was asked a question, and was unable to answer, it took time for the researcher to communicate back a response. Another limitation was the lack of control over how the participating instructors administered or communicated the instructions for the survey, and thus, fidelity of instrument administration.

Two more limitations include the choice of assessments. Both the Revised Mathematics Anxiety Rating Scale (R-MARS) and The Statistical Anxiety Scale (SAS) were chosen for their shortened versions. The R-MARS is a shortened version of the MARS (Mathematics Anxiety Rating Scale). The total number of items is reduced from 98 to 25 with the R-MARS having similar internal consistency reliability (Spearman-Brown coefficient = 0.95) and concurrent validity (0.70) as the MARS (Baloglu & Zelhart, 2007). The SAS is the shortened version of the STARS (Statistical Anxiety Rating Scale). This scale was reduced from 51 items to 24 items with similar internal consistency reliability (alpha coefficient = 0.91) and validity (r = 0.34) as the STARS (Vigil-Colet, Lorenzo-Seva & Condon, 2008). The researcher felt more students would be willing to participate if there were fewer questions to answer. With the shortened forms, however, the data may not provide as complete an assessment as the original.

A final limitation is in the memory of the participants. One question asked on the demographic questionnaire concerns when the participant last took a mathematics and/or statistics course. For some participants, likely nontraditional students, their last mathematics or statistics course may have been many years ago, making it difficult to accurately recall the correct time.

Delimitations

One delimitation of this study is the self-selection of the two universities from which the participants were sampled. The universities were chosen for convenience as the researcher has connections to both schools. They are both small, private universities from two different geographic locations. Both universities have graduate and undergraduate social science programs that require statistics courses for degree completion.

Another delimitation is the definition chosen for quantitative-course experience, the number of high school and college-level mathematics and statistics type courses taken from the math department. There are many ways this could have been defined, such as the number of courses taken since high school that utilize mathematics or statistics. That definition would require participants to think back over all their courses since high school and remember what classes were taken and if there was math or statistics involved. Those classes could have included some science or social studies classes. The researcher chose a less complex definition to maintain more consistency with the type of classes remembered by participants.

Definition of Terms

Mathematics anxiety is defined as a "feeling of tension and anxiety that interferes with the manipulation of numbers and solving of mathematical problems in a wide variety of life and academic situations" (Richardson and Suinn, 1972, p. 551).

Quantitative anxiety includes all forms of anxiety stemming from any type of quantitative subject matter (Tarasi et al., 2013), such as mathematics and statistics.

Quantitative-course experience is defined as the number of high school and college-level mathematics and statistics type courses taken from the math department.

Statistics anxiety is defined as "a feeling of anxiety when taking a statistics course or doing statistical analysis; that is gathering, processing, and interpreting data" (Williams, 2013, p. 48).

Contributions

The results from this research were to provide more data into the relationship between quantitative anxiety, quantitative-course experience and gender. With experience in mathematics significantly affecting mathematics anxiety, professors in non-mathematics courses should introduce general mathematics concepts and terminology to help students gain mathematics

experience without taking a math course. With experience in statistics significantly affecting statistics anxiety, professors in non-statistics courses should introduce statistical concepts and terminology to help students gain statistics experience without enrolling in a statistics course. This should provide students more experience in both mathematics and statistics prior to taking the required statistics courses, and thus, decrease mathematics anxiety and statistics anxiety and increase student achievement in the statistics courses.

Summary

Some students who believe they are not good at math, may experience mathematics failure (Caray, Hill, Devine & Szucs, 2016; Eden et al., 2013; Wigfield & Eccles, 2000). The experience of failure may develop into mathematics anxiety (Dowker et al., 2016). Mathematics anxiety can begin at a young age, learned from parents or teachers and is more prevalent in females (Eden et al., 2013, Scarpello, 2007; Tarasi et al., 2013). Students anxious about mathematics tend to avoid math-related courses (Foley et al., 2017; Meece, Wigfield & Eccles, 1990). At the college level, there are minimal math requirements for social science majors (Huang, 2018). With a limited background in mathematics, the required statistics courses could be more challenging (Huang, 2018). Perceiving difficulty in statistics, many college students procrastinate on taking those courses (Chew & Dillon, 2014; Cui et al., 2019; Macher et al., 2012; Onwuegbuzie, 2004). This procrastination may prolong the time it takes to complete a degree program (Kinkead, Miller & Hammett, 2016). Baloglu (2003) found previous mathematics experience significantly affected statistics anxiety levels.

Chapter 2

Literature Review

This literature review will describe quantitative anxiety. It will then discuss each aspect of quantitative anxiety for this study, mathematics anxiety and statistics anxiety, explaining the impact on students. In the mathematics anxiety section, you will find a visual diagram to show three different models used by researchers to explain mathematics anxiety. Similarities and differences between mathematics anxiety and statistics anxiety are also discussed, looking at the relationship between the two anxieties. Since this study is examining the relationship between quantitative anxiety and quantitative-course experience, there is a section discussing what quantitative-course experience entails. This literature review ends with a discussion on covariates such as gender and age to share what has been found in prior studies.

Literature for this paper was found using EBSCOhost search engine. Key words used were ‘anxiety’, ‘mathematics anxiety’, ‘statistics anxiety’, ‘quantitative anxiety’, ‘quantitative experience’ and ‘gender’. Many references came from the reference list of reviewed articles. All articles used were peer-reviewed.

Quantitative Anxiety

The feeling of anxiety, anticipating a threat that is unknown, is often accompanied by fear (Rachman, 2013). The person who experiences this anxiety has a difficult time specifying what that threat or fear is. Because this person does not know the specifics, they avoid situations they believe may cause potential harm (Rachman, 2013). In recent years, situation-specific forms of anxiety have been defined (Papousek et al., 2012). Within the academic setting, test anxiety and mathematics anxiety appear to be most common (Hembree, 1990) along with, in university

students, statistics anxiety (Papousek et al., 2012). These forms of quantitative anxiety can have a negative effect on academic performance (Tarasi et al., 2013).

Quantitative anxiety manifests as fear of quantitative problems and may begin in the early years of schooling, continuing through high school and into college (Geist, 2010). Tarasi et al. (2013) define quantitative anxiety as “a general fear or tension or timidity associated with anxiety provoking situations that involve interactions with quantitative issues” (p. 39). Physiological symptoms may include sweaty palms, fast heart rate, or an upset stomach. Feeling panic, nervous before a quantitative class, or helpless when completing quantitative homework could be psychological signs of quantitative anxiety. Factors that may contribute to quantitative anxiety include mathematics and statistics phobia, not making a connection between quantitative concepts and daily life, the pace of instruction, and the instructor’s attitude (Pan & Tang, 2005). All of which can inhibit a student’s ability to learn or be able to apply what they know (Freiberg, 2005).

Tarasi et al. (2013) indicate several possible causes for quantitative anxiety symptoms. Some include past classroom experiences and/or poor performance, parental influences, teacher attitudes, and inadequate curriculum. Many students who lack confidence in their mathematics ability may start missing math classes or stop taking math classes and/or leave school (Farrell, 2006). When classes are missed, these gaps in education hold students back from learning more complicated concepts. This can have a “snowball effect” in which students are afraid to ask questions about concepts they feel they should already know. This can cause a student to fall further behind, creating a vicious circle, and increasing anxiety (Farrell, 2006). Quantitative anxiety can lead to avoidance of quantitative-courses and careers that use quantitative skills (Ashcraft, 2002).

Mathematics Anxiety

Mathematics anxiety has been defined as involving "feelings of tension and anxiety that interfere with the manipulation of numbers and the solving of mathematical problems in a wide variety of ordinary life and academic settings" (Richardson & Suinn, 1972, p. 551). The concept was first investigated in 1957 when Dreger and Aiken made three assumptions about "Number Anxiety" (mathematics anxiety) and its associations with related constructs. First, mathematics anxiety is a unique construct, despite a relationship with general anxiety. Second, mathematics anxiety does not seem to be related to general ability, such as intelligence. Third, a negative linear correlation exists between mathematics performance and mathematics anxiety, meaning that as mathematics anxiety increases, academic performance in math decreases. Since then, all three of these hypotheses have been confirmed by many researchers (Ashcraft & Moore, 2009; Dowker et al., 2016; Foley et al., 2017; Hembree, 1990).

Blazer (2011) shares three factors involved with the development of mathematics anxiety, personality, intellect, and environment. Personality factors include low self-esteem, inability to handle frustration, shyness, and intimidation. The intellectual factor that Blazer (2011) believes most strongly contributes to mathematics anxiety is the inability to understand mathematics concepts. Environmental factors include overly demanding parents or negative classroom experiences, such as unintelligible textbooks, an emphasis on drill without understanding concepts, or a poor (ineffective) math teacher. Paechter et al. (2017) would argue that personal, is a fourth factor involved in the development of mathematics anxiety to include prior knowledge or gender. A study by Dupuis et al. (2012) found that prior knowledge in higher level mathematics courses may have attributed to a more positive attitude about, and less anxiety toward mathematics.

Mathematics anxiety is prominent among all ages in the educational setting across the globe (Luttenberger et al., 2018), and distinct from other subjects (Paechter et al., 2017). It is a "pervasive issue in education that requires attention from both educators and researchers to help students reach their full potential" (Ramirez et al., 2018, p. 145). Mathematics anxiety may be felt on a cognitive level, compromising the functioning of mathematics skills (Macher et al., 2012) which may lead to poor mathematics performance. However, it remains unclear whether mathematics anxiety leads to poor mathematics performance, if poor mathematics performance leads to mathematics anxiety, or if there is a bidirectional relationship. Knowing the direction of the mathematics anxiety-mathematics performance relationship has implications for education research. For example, if poor mathematics performance increases mathematics anxiety, computer-based interventions may be offered to target the learner's performance so that they have repeated chances to master the material before failure and anxiety set it. On the other hand, if mathematics anxiety reduces mathematics performance, methods to reduce mathematics anxiety could be utilized in the classroom such as the use of humor and instructor immediacy. (Carey, Hill, Devine & Szucs, 2016; Ramirez et al., 2018).

One direction in the mathematics anxiety-mathematics performance relationship is called the Deficit Theory (Tobias, 1983). The Deficit Theory claims that poor performance leads to higher anxiety. When it comes to mathematics, proponents of this theory believe prior mathematics performance deficits lead to memories of poor mathematics performance, which then generates the mathematics anxiety. Some researchers suggest that mathematics anxiety in adults may result from basic numerical processing deficits that compromises the development of higher-level mathematics skills (Carey et al., 2016). However, it could be possible that these adults have avoided mathematics tasks throughout their education and into adulthood due to their

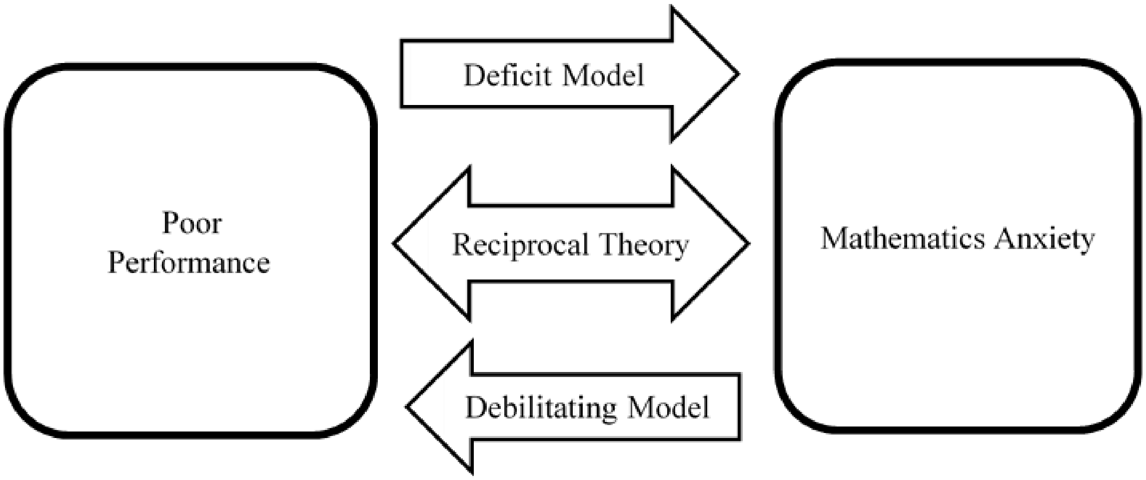
high levels of mathematics anxiety. This leads to a second direction known as the Debilitating Anxiety Model (Wine, 1971).

The Debilitating Anxiety Model claims that mathematics anxiety impacts mathematics performance at the stages of pre-processing, processing and retrieval of math knowledge (Carey et al., 2016). At the pre-processing stage, mathematics anxiety may influence learning by individuals' avoidance of mathematics situations. At the processing and recall stages, mathematics anxiety may influence mathematics performance by cognitive interference. For example, mathematics anxiety may tax working memory resources with attempts to control anxiety rather than manipulate the mathematics task. Working memory resources are vital for the processing and retrieval of mathematics facts and methods (Kelly, Rice, Wyatt, Ducking & Denton, 2015). Mathematics anxiety is likely to reduce learning opportunities due to avoidance of mathematics tasks and situations thereby reducing mathematics performance.

The evidence is conflicting; some studies provide data that support the Deficit Model while other studies provide data that fit the Debilitating Anxiety Model. Perhaps the Reciprocal Theory (Carey et al., 2016; Morsanyi et al., 2016) provides the best explanation for the mathematics anxiety-mathematics performance relationship. The Reciprocal Theory states that poor performance triggers mathematics anxiety and mathematics anxiety leads to poor performance in math-related situations. In the Reciprocal Theory the causal link between mathematics anxiety and mathematics performance is bidirectional (Morsanyi et al., 2016). Whichever direction the anxiety/performance relationship is going, lower levels of mathematics skills are being acquired (Luttenberger et al., 2018). This further impacts the development of mathematics knowledge acquisition (Ashcraft & Moore, 2009). Figure 1 was created by the researcher as a visual explanation of the models.

Figure 1

Mathematics Anxiety Model



Statistics Anxiety

Statistics is the gathering, processing and interpreting of data (Hanna, Shevlin & Dempster, 2008). It provides experience for critical thinking, analyzing data and discussing research (Huang, 2018; Onwuegbuzie & Wilson, 2003). Media uses statistics to describe trends in society such as population growth and educational achievement. Government decisions are often based on statistical polls distributed to the population. Chew and Dillon (2014) believe, the "knowledge of statistics is a prerequisite for individuals to play their part as well-informed citizens of a democracy" (p. 196).

Statistics anxiety can result from encountering statistics in any form and at any time (Onwuegbuzie, DaRos & Ryan, 1997), such as the language used in statistics. Statistical formulas, symbols and terminology should be conceived as a foreign language (Malik, 2015). Forte (1995) suggests that statistics education should be approached like teaching a different language and should include extensive practice in "speaking statistics". Lindner (2012) concurs the need for practice when stating, "Like the acquisition of any foreign language, the key to helping students develop fluency in quantitative analysis is to plan many small but frequent

opportunities to encounter and interpret data" (p. 57). The difficulties of statistical language and the abstract statistics concepts tend to make statistics learning even more challenging (Huang, 2018).

Statistics is a very difficult subject for many students, particularly those whose majors are not related to statistics or mathematics. Yet, basic statistics knowledge is essential in allowing students to answer research questions in their courses of study (Koh & Zawi, 2014). Statistics anxiety describes the apprehension that occurs when an individual is exposed to statistics content, or to problems and instructional situations, or to evaluative contexts that deal with statistics (Macher et al., 2012). This may lead to problems over the course of a study with students experiencing learning difficulties, postponing taking statistics courses or statistics examinations, delaying assignments, or showing lower academic achievement (Macher et al., 2012).

Statistics anxiety is typically seen at the collegiate level, where students are formally assessed for their knowledge and understanding of statistics and required to apply that knowledge (Onwuegbuzie & Wilson, 2003). Researchers have identified three types of antecedents of statistics anxiety: situational antecedents (i.e., prior knowledge, course grade, satisfaction with the statistics course), dispositional antecedents (i.e., perceived self-concept, level of self-esteem, perfectionism, academic procrastination), and personal characteristics (i.e., gender, ethnicity, age) (Macher et al., 2013; Onwuegbuzie & Wilson, 2003). All may play a role in the acquisition of statistics knowledge; several researchers have documented a negative relationship between statistics anxiety and course performance (Chiesi, Primi & Carmona, 2011; Devaney, 2016; Macher et al., 2012; Onwuegbuzie & Wilson, 2003).

Eccles and colleagues developed a theory in 1983, the Expectancy-Value Theory, that posits that students are more likely to successfully perform statistics tasks in class if they value those tasks (Baloglu, Abbassi & Kesici, 2017; Ramirez, Schau & Emmioglu, 2012). In the Expectancy-Value Theory, students rely on information from their past to link achievement behavior to expectancies for their success, creating a value for the task (Meece et al., 1990). According to the assumption of the Expectancy-Value Theory, students' perception of their statistics skills can have a direct impact on their statistics anxiety (Faber & Drexler, 2019). Baloglu et al. (2017) says this positive task value in statistics is negatively related to statistics anxiety.

Statistics anxiety is a "debilitating phenomenon" (p. 200) that may prevent students from completing their degree (Onwuegbuzie & Wilson, 2003). It may be considered a top concern of students (Huang, 2018; Macher et al., 2012), and therefore must be addressed.

Similarities and Differences

Statistics anxiety is a situation-specific form of anxiety which may be grouped with performance anxieties such as mathematics anxiety (Macher et al., 2013). Students tend to associate statistics with mathematics and expect to focus on numbers, computations, formulas, and correct answers (Hannigan, Hegarty & McGrath, 2014). To a certain degree this is accurate, however, gathering, processing, and interpreting data are also involved in statistics (Frey-Clark, Natesan & O'Bryant, 2019).

Mathematics anxiety and statistics anxiety are positively, significantly correlated with higher mathematics anxiety related to higher statistics anxiety (Paechter et al., 2017). However, it is not yet clear whether statistics anxiety is only an after-effect of mathematics anxiety. Statistics anxiety might replace mathematics anxiety when a student is no longer required to take

courses in mathematics but encounters statistics tasks that seem to look like mathematics tasks (Paechter et al., 2017).

Quantitative-course Experience

Students with limited prior mathematics or statistics backgrounds might experience more difficulties in statistics courses (Malik, 2015). A direct and mediated correlation between mathematics experience and statistics anxiety is reported by Cui et al. (2019). Baloglu (2003) found that students' previous math experience and age significantly affected their statistics anxiety levels with older students experiencing higher levels of anxiety. Students with previous quantitative-course experience in statistics and/or mathematics reported more positive attitudes and higher levels of achievement (Ramirez et al., 2012). While some studies show a relationship between mathematics experience and statistics anxiety, Faber and Drexler (2019) did not find prior statistics experience to be an effective predictor for statistics anxiety. Chamberlain et al. (2015) indicated that students may avoid quantitative tasks and become anxious about learning quantitative skills because they feel they possess poor quantitative knowledge.

Covariates

Women and girls are reported to experience greater mathematics anxiety than men and boys, regardless of their actual math ability. This anxiety begins as early as first and second grade and increases as children get older (Casad et al., 2015). Dew, Galassi and Galassi (1983) also believe that gender differences in mathematics anxiety may exist, but feel they are probably much smaller than has been suggested previously. One possible explanation for greater mathematics anxiety in females than males is stereotype threat; this occurs in situations where people feel at risk of confirming a negative stereotype about a group to which they belong. With mathematics anxiety this usually refers to females being reminded of the stereotype that males

are better at mathematics than females (Dowker et al., 2016). Beilock et al., (2010) report girls who believe in traditional gender ability roles performed worse than girls who did not and worse than boys more generally. Ashcraft and Rudig (2012) found that only those mathematics tasks that required working memory were affected by stereotype threat. Carey et al. (2016) also found that mathematics stereotype threat appears to be mediated by working memory impairment, supporting the idea that mathematics anxiety influences performance by taxing working memory resources. Chew and Dillon (2014) have revealed mixed results in their findings on gender differences. Baloglu (2003) found no significant differences in gender.

Age has been looked at in relation to quantitative anxiety with mixed results. While mathematics anxiety has been found to affect individuals of all ages (Luttenberger et al., 2018), Ramirez et al. (2018) found no clear trend across different age groups in their cross-sectional study. A study by Welch et al. (2015) found no significant correlation between age and statistics anxiety.

Researchers have not been consistent in finding significance in quantitative anxiety by quantitative-course experience or gender. Many theories have been developed to answer those questions, yet those too are conflicting. This study provides one more piece of data to help bring some consensus to the relationship between quantitative anxiety, quantitative-course experience and gender.

Chapter 3

Methodology

Introduction

This study looked at three research questions:

1) To what extent does quantitative-course experience predict mathematics anxiety in college-level social science majors?
2) To what extent does quantitative-course experience predict statistics anxiety in college-level social science majors?
3) To what extent does quantitative-course experience interact with gender to predict quantitative anxiety in college-level social science majors?

There are valid and reliable instruments available to gather data in order to examine the research questions. This study used two different instruments to provide data, one for mathematics anxiety and one for statistics anxiety. The methodology chapter will discuss the design of the study and the participants. The two instruments are then described with reasons why they were chosen. The items for each instrument are included along with a table of the analytical procedures. Ethical concerns are also addressed.

Design

This study was a non-experimental quantitative between-subjects research design, analyzing data from two anxiety scales. The two dependent variables were scores from the Revised-Mathematics Anxiety Rating Scale (R-MARS) to measure mathematics anxiety and scores from the Statistical Anxiety Scale (SAS) to measure statistics anxiety. The independent variables were gender and quantitative-course experience of the participant. A demographic survey was created to provide data on gender, age, graduate level (undergraduate or graduate),

student's major course of study, type of statistics course instruction (online or face-to-face), number of high school and college level courses taken from the math department, and number of months since last mathematics and statistics course was taken.

Participants and Sampling

Undergraduate and graduate social science majors from two Region-West universities statistics courses were invited to participate in this study. Both universities were private institutions with undergraduate enrollments between 1100 and 2700 and total enrollments between 1600 and 4000. Both universities had undergraduate, master's, and at least one doctoral program. The statistics courses available for this study were from the introductory and advanced required program courses. Statistics course instructors were chosen through the director/dean of the social science departments at each of the universities. Instructor names and contact information were provided to the researcher. An email was then sent to the instructors with information about the study and requesting the instructor's participation. With instructor participation, all students within their class(es) were given the opportunity to participate. Since this study was looking at non-mathematics majors (and minors) to assess mathematics anxiety and statistics anxiety, any participant that indicated they were not in a social science field on the demographic questionnaire was eliminated from the study. This was a convenience sample since the classes were already formed. Random assignment was not used.

Instrumentation and Administration

The Revised-Mathematics Anxiety Rating Scale (R-MARS) was developed by Livingston Alexander and Carl Martray (1989). It is an instrument revised from the Mathematics Anxiety Rating Scale (MARS), developed by Frank Richardson and Richard Suinn (1972). This revised version has 25 items, as compared to the original 98 items, and measures three subscales,

mathematics test anxiety, numerical task anxiety, and mathematics course anxiety. R-MARS makes scoring easier and lessens the amount of time it takes to administer, making it more efficient (Bowd & Brady, 2002). The 15 items measuring *mathematics test anxiety* refer to the anxiety involved around taking a math test. The five items measuring *numerical task anxiety* refer to the anxiety involved around completing number calculations. The five items measuring *mathematics course anxiety* refer to the anxiety involved with taking a math course. R-MARS is shown to be reliable and valid with reliability coefficients around 0.95 and concurrent validity at 0.70 (Baloglu & Zelhart, 2007). Bowd and Brady (2002) found the R-MARS to have high internal consistency with Cronbach alpha = 0.97 which is consistent with what the developers reported. See Table 1 for the items from the R-MARS.

Table 1

Revised Mathematics Anxiety Rating Scale and Statistical Anxiety Scale Items

Revised Mathematics Anxiety Scale

Mathematics Test Anxiety

1. Studying for a math test
2. Taking math section of a college entrance exam
3. Taking an exam (quiz) in a math course
3. Taking an exam (final) in a math course
5. Picking up math textbook to begin working on a homework assignment
6. Being given homework assignments of many difficult problems that are due the next class meeting
7. Thinking about an upcoming math test 1 week before
8. Thinking about an upcoming math test 1 day before
9. Thinking about an upcoming math test 1 hour before
10. Realizing you have to take a certain number of math classes to fulfill requirements
11. Picking up math textbook to begin a difficult assignment
12. Receiving your final math grade in the mail
13. Opening a math or stats book and seeing a page full of problems
14. Getting ready to study for a math test
15. Being given a “pop” quiz in a math class

Numerical Task Anxiety

1. Reading a cash register receipt after your purchase
2. Being given a set of numerical problems involving addition to solve on paper
3. Being given a set of subtraction problems to solve
4. Being given a set of multiplication problems to solve
5. Being given a set of division problems to solve

Mathematics Course Anxiety

1. Buying a math textbook
2. Watching a teacher work on an algebraic equation on the blackboard
3. Signing up for a math course
4. Listening to another student explain a math formula
5. Walking into a math class

Statistical Anxiety Scale

Statistics Class Test Anxiety

1. Studying for an examination in a statistics course
2. Realizing the day before an exam that I cannot do some problems that I thought were going to be easy
3. Doing the final examination in a statistics course
4. Walking into the classroom to take a statistics test
5. Getting to the day before an exam without having had time to revise the syllabus
6. Waking up in the morning on the day of a statistics test
7. Realizing just before you go into the exam, that I have not prepared a particular exercise
8. Going to a statistics exam without having had enough time to revise

Statistics Interpreting Anxiety

1. Interpreting the meaning of a table in a journal article
2. Reading a journal article that includes some statistical analyses
3. Trying to understand a mathematical demonstration
4. Reading an advertisement for an automobile which includes figures on gas mileage, compliance with population regulations, etc.
5. Copying a mathematical demonstration from the blackboard while the teacher is explaining it
6. Trying to understand the odds in a lottery
7. Seeing a classmate carefully studying the results table of a problem he has solved
8. Trying to understand the statistical analyses described in the abstract of a journal article

Statistics Asking for Help Anxiety

1. Going to ask my statistics teacher for individual help with material I am having difficulty understanding
2. Asking a private teacher to explain a topic that I have not understood at all
3. Asking the teacher how to use a probability table
4. Asking the teacher about how to do an exercise
5. Asking one of your teachers for help in understanding a printout
6. Asking a teacher for help when trying to interpret a results table
7. Going to the teacher’s office to ask questions
8. Asking a private teacher to tell me how to do an exercise

The Statistical Anxiety Scale (SAS) was developed by Andreu Vigil-Colet, Urbano Lorenzo-Seva and Lorena Condon (2008). The instrument was chosen for its short form of 24-items. SAS was designed from the Statistical Anxiety Rating Scale (STARS) developed by Cruise and Wilkens (1980). STARS consists of 51-items which measure statistics anxiety and statistics attitude. SAS measures only statistics anxiety using three subscales, test and class anxiety, interpreting anxiety, and anxiety around asking for help. The eight items measuring *test and class anxiety* refer to the anxiety involved when taking a statistics test or class. The eight items measuring *interpreting anxiety* refer to the anxiety experienced when a person is faced with a decision about statistics or asked to interpret statistical data. The eight items measuring *asking for help anxiety* refer to the anxiety experienced when asking someone for help in understanding statistics. SAS was found to be reliable and valid with internal consistency alpha coefficient = 0.91 and correlation r = 0.34 (Vigil-Colet et al., 2008). Chiesi et al. (2011) report internal consistency using Cronbach's alpha = 0.90. Chew and Dillon (2014) believe the SAS is "a promising instrument that affords researchers a specific measure of statistics anxiety" (p. 199). See Table 1 for the items from the SAS.

With approval from the two Region-West universities, instructors had the opportunity to ask their students who were enrolled in their statistics course to voluntarily complete a survey which included the Revised-Mathematics Anxiety Rating Scale (R-MARS) and the Statistical Anxiety Scale (SAS). Those students who volunteered to participate also completed a demographics portion of the survey to include gender, age, graduate level (undergraduate or graduate), student's major course of study, type of statistics course instruction (online or face-to-face), number of high school and college-level courses taken from the math department, and number of months/years since last mathematics course and statistics course was taken. A student

was considered a participant if they completed the R-MARS, SAS, and demographic survey, as well as indicated whether they were a social science major.

Analytical Procedures

Linear regression and multiple regression were used in this study to analyze the data between quantitative-course experience, quantitative anxiety and gender.

Table 2 describes the variables used in this study with the operationalized definitions, analyses used and assumptions.

Table 2

Analytical Table

RQ	Variable	Operationalized	Assumptions
#1	IV: Quantitative-course Experience	Number of high school and college-level courses taken from the math department	Linear Regression: 1. Continuous dependent variable 2. Continuous independent variable 3. Needs to be a linear relationship between the dependent and independent variables. 4. Independence of residuals 5. No significant outliers 6. Data needs to show homoscedasticity 7. The residuals of the regression line are approximately normally distributed
	DV: Mathematics Anxiety	Score on the Revised-Mathematics Anxiety Rating Scale (R-MARS), a 25-item instrument measuring three subscales of mathematics anxiety	
#2	IV: Quantitative-course Experience	Number of high school and college-level statistics courses taken	
	DV: Statistics Anxiety	Score on the Statistical Anxiety Scale (SAS), 24-item instrument measuring three subscales of statistics anxiety	
#3	IV: Quantitative-course Experience	Number of high school and college-level mathematics and statistics courses taken from the math department	Multiple Regression: 1. Continuous dependent variable 2. Two or more independent variables which can be either continuous or categorical 3. Independence of residuals 4. A linear relationship between the dependent variable and each of the independent variables and the dependent variable and independent variables collectively 5. Data needs to show homoscedasticity 6. Data must not show multicollinearity 7. No significant outliers 8. The residuals are approximately normally distributed
	IV: Gender	Male or Female	
	DV: Quantitative Anxiety	a) Mathematics Anxiety: Score on the Revised-Mathematics Anxiety Rating Scale (R-MARS), a 25-item instrument measuring three subscales of mathematics anxiety b) Statistics Anxiety: Score on the Statistical Anxiety Scale (SAS), 24-item instrument measuring three subscales of statistics anxiety	

Ethical Concerns

Institutional Review Board (IRB) approval through both Region-West universities was received before administering the survey. This was a voluntary study. Participation or non-participation did not affect the student's grade in their statistics course. Participants could withdraw at any time during the study. All ethical standards were followed for participant treatment as set forth by the American Psychological Association (APA), including disclosing

the purpose of the study, obtaining informed consent and maintaining confidentiality. Confidentiality includes no names or identifying information disclosed unless required by law. Data obtained is being kept secure by the primary researcher, in a locked box and will be destroyed after five years. Typical psychological burden may have occurred from completing the assessments. This may have included recurring thoughts on statistics and/or mathematics or the development of stress from the time involved in taking the assessments. To help alleviate some of this stress, participants had an opportunity to receive one of six Amazon gift cards. Participants could enter the drawing to win a gift card if they provided an email address. Contact information was also made available to participants in the informed consent if there were any questions or concerns about the study.

Chapter 4

Results

Introduction

The purpose of this study was to examine differences in quantitative anxiety, gender and quantitative-course experience. A survey was created through Survey Monkey which included demographic questions as well as the Revised-Mathematics Anxiety Rating Scale (R-MARS) and the Statistical Anxiety Scale (SAS) items. Data collected from the surveys are summarized and detailed in this chapter. For analysis purposes, all Likert scale variables (not at all, a little, a fair amount, much, and very much) were transformed into a numerical value of 1 to 5 with 1 being “not at all” and 5 being “very much.” Linear regression and multiple regression were run on the data. Open-ended questions were examined to determine students’ majors. An item of students’ most memorable experience was also reviewed for common themes. It was hypothesized that mathematics anxiety and statistics anxiety scores would decrease as quantitative-course experience increased and that gender would be a moderator between quantitative-course experience and quantitative anxiety.

The results chapter begins with demographic data and descriptive statistics, including correlations, to get the overall picture of the study. Then, in the survey results section, data from the individual items for each of the instruments are presented. These data show excellent reliability. From this, each of the three research questions are discussed. The assumptions are shown first to confirm they had been met. The chapter ends with a summary of the results.

Demographics

Students from two Region-West Universities were invited to participate in this study. Statistics professors from the universities were asked to provide their students with the

opportunity to participate. The survey link was made available to the professors to pass on to their students. A total of twenty-one students (6 male and 15 female) volunteered to participate, of which all were accepted. The participants were all traditional undergraduate students ranging in age from 18-24 years. The majority were psychology majors (n=13, 61.9%), with three having a double major in Spanish, Political Science, or Exercise Science. There were five Exercise Science-majors, including the double major in psychology (23.8%) and four cognitive science majors (19%) with one double majoring in computer science. Two students reported that their statistics class was both online and face-to-face while the other 19 respondents said their class was face-to-face only.

Descriptive Statistics

In the descriptive statistics data (Table 3), the quantitative-course experience shows the average number of courses taken by students in this study to be about six mathematics and/or statistics courses (Mean=5.62). To analyze the data for this variable, the higher value in the range of numbers provided on the survey was used in the calculation. For example, the number 4 was used in the analysis for the range of 3-4 classes taken. This explains the minimum value of 4 and the maximum value of 8 for quantitative-course experience.

Table 3

Descriptive Statistics

	Scale	Frequency	Min.	Max.	Mean	St. Dev.	Variance
Mathematics Test Anxiety	15-75	21	24	71	49.95	13.891	192.948
Numerical Task Anxiety	5-25	21	5	16	7.57	3.075	9.457
Mathematics Course Anxiety	5-25	21	5	21	10.19	4.557	20.762
Statistics Class Test Anxiety	8-40	21	14	39	30.00	7.740	59.900
Statistics Interpreting Anxiety	8-40	19	8	32	18.26	8.285	68.649
Statistics Asking for Help Anxiety	8-40	21	8	40	22.76	10.927	119.390
Quantitative-course Experience		21	4	8	5.62	1.499	2.248

With a variance of 2.248, students were similar in the number of high school and college level courses taken from the math department. Table 4 provides the data for the number of courses taken by the students.

Table 4

Mathematics and/or Statistics Courses Taken

Number of Courses	Frequency
3-4	8
5-6	9
7-8	4

All students showed some amount of mathematics test anxiety and statistics class test anxiety. If a respondent were to indicate no mathematics test anxiety (not at all), the minimum value would have been 15. Since the data show mathematics test anxiety had a minimum value of 24, all students expressed some form of mathematics test anxiety. If a respondent were to indicate no statistics class test anxiety (not at all), the minimum value for that subscale would have been 8. Since statistics class test anxiety had a minimum value of 14, all students expressed some form of statistics class test anxiety. There were six respondents indicating no anxiety in mathematics course anxiety and thirteen respondents who indicated no anxiety in mathematics numerical task anxiety. There were five respondents who indicated no anxiety in statistics interpreting anxiety, however, there were two respondents who did not complete one question each within the statistics interpreting anxiety subscale (n=19). There were four respondents indicating no anxiety in statistics asking for help anxiety. On the “very much” anxiety level, there were two respondents within the mathematics test anxiety subscale, six within the statistics class test subscale and four within the statistics asking for help subscale. Table 5 shows the

number of respondents at each level of anxiety within the six subscales measured. The scores were averaged for each respondent at each subscale.

There was a large variance in the statistics asking for help anxiety and mathematics test anxiety subscales. This can be seen when looking at Table 5 and noting how spread out the responses were when compared to numerical task anxiety with a smaller variance, where most of the responses converged in the lower two levels.

Table 5

Number of Respondents at Each Anxiety Level

	not at all 1-1.49	a little 1.5-2.49	a fair amount 2.5-3.49	much 3.5-4.49	very much 4.5-5
Mathematics Test Anxiety	0	4	9	6	2
Numerical Task Anxiety	13	7	1	0	0
Mathematics Course Anxiety	6	10	3	2	0
Statistics Class Test Anxiety	0	3	4	8	6
Statistics Interpreting Anxiety	5	8	4	4	0
Statistics Asking for Help Anxiety	4	4	6	3	4

Table 6 shows significant positive correlations between all anxiety subscales at the 0.01 level, except for statistics class test anxiety and numerical task anxiety. The correlation was not found to be significant between statistics class test anxiety and numerical task anxiety. The statistics asking for help had the highest correlation of the subscales, correlating with statistics interpreting anxiety. The highest correlation within the mathematics anxiety subscales was between mathematics test anxiety and mathematics course anxiety. The statistics anxiety subscales correlated more highly among themselves than the mathematics anxiety subscales except for mathematics test anxiety and mathematics course anxiety which was higher than statistics class test anxiety and statistics interpreting anxiety.

Table 6

Correlation Between Dependent Variables

	Mathematics Test Anxiety	Numerical Task Anxiety	Mathematics Course Anxiety	Statistics Class Test Anxiety	Statistics Interpreting Anxiety	Statistics Asking for Help Anxiety
Mathematics Test Anxiety						
Numerical Task Anxiety	.650**					
Mathematics Course Anxiety	.791**	.623**				
Statistics Class Test Anxiety	.736**	.412	.662**			
Statistics Interpreting Anxiety	.727**	.745**	.693**	.744**		
Statistics Asking for Help Anxiety	.774**	.613**	.740**	.797**	.878**	

** Correlation is significant at the 0.01 level (2-tailed)

Table 7 shows correlations between each of the anxiety subscales with the independent variables of quantitative-course experience and gender. All correlations between gender and quantitative-course experience were negative. The correlation between gender and quantitative-course experience within the statistics interpreting anxiety subscale was r = -.296. All other correlations between gender and quantitative-course experience were the same with r = -.309. All correlations between the mathematics anxiety subscales and gender were negative, ranging from r = -.002 to -.161. The statistics anxiety subscales were all positive correlations with gender, ranging from r = .106 to .233.

Table 7

Pearson Correlations

		Mathematics Test Anxiety	Quantitative-course Experience	Gender
Pearson Correlation	Mathematics Test Anxiety	1.00	0.129	-0.002
	Quantitative-course Experience	0.129	1.00	-0.309
	Gender	-0.002	-0.309	1.00
Sig. (1-tailed)	Mathematics Test Anxiety		0.289	0.496
	Quantitative-course Experience	0.289		0.087
	Gender	0.496	0.087	
		Numerical Task Anxiety	Quantitative-course Experience	Gender
Pearson Correlation	Numerical Task Anxiety	1.00	0.310	-0.161
	Quantitative-course Experience	0.310	1.00	-0.309
	Gender	-0.161	-0.309	1.00
Sig. (1-tailed)	Numerical Task Anxiety		0.086	0.243
	Quantitative-course Experience	0.086		0.087
	Gender	0.243	0.087	
		Mathematics Course Anxiety	Quantitative-course Experience	Gender
Pearson Correlation	Mathematics Course Anxiety	1.00	0.333	-0.068
	Quantitative-course Experience	0.333	1.00	-0.309
	Gender	-0.068	-0.309	1.00
Sig. (1-tailed)	Mathematics Course Anxiety		0.070	0.385
	Quantitative-course Experience	0.070		0.087
	Gender	0.385	0.087	
		Statistics Class Test Anxiety	Quantitative-course Experience	Gender
Pearson Correlation	Statistics Class Test Anxiety	1.00	-0.009	0.195
	Quantitative-course Experience	-0.009	1.00	-0.309
	Gender	0.195	-0.309	1.00
Sig. (1-tailed)	Statistics Class Test Anxiety		0.485	0.198
	Quantitative-course Experience	0.485		0.087
	Gender	0.198	0.087	
		Statistics Interpreting Anxiety	Quantitative-course Experience	Gender
Pearson Correlation	Statistics Interpreting Anxiety	1.00	0.217	0.106
	Quantitative-course Experience	0.217	1.00	-0.296
	Gender	0.106	-0.296	1.00
Sig. (1-tailed)	Statistics Interpreting Anxiety		0.186	0.332
	Quantitative-course Experience	0.186		0.109
	Gender	0.332	0.109	
		Statistics Asking for Help Anxiety	Quantitative-course Experience	Gender
Pearson Correlation	Statistics Asking for Help Anxiety	1.00	0.00	0.233
	Quantitative-course Experience	0.00	1.00	-0.309
	Gender	0.233	-0.309	1.00
Sig. (1-tailed)	Statistics Asking for Help Anxiety		0.500	0.155
	Quantitative-course Experience	0.500		0.087
	Gender	0.155	0.087	

All correlations between the mathematics anxiety subscales and quantitative-course experience are positive ranging from r = .129 to .333. The correlations within the statistics subscales and quantitative-course experience were varied. The correlation for statistics class test anxiety was negative with r = -.009, statistics interpreting anxiety was positive with r = .217, and statistics asking for help had r = 0.00 correlation.

Survey Results

This study had excellent reliability as displayed in Table 8. Mathematics test anxiety, statistics class test anxiety, statistics interpreting anxiety, and statistics asking for help anxiety all have a highly reliable Cronbach alpha score ranging from 0.931 to 0.978.

Table 8

Overall Cronbach's Alpha for Each Anxiety Subscale

	# of Items	Cronbach's Alpha
Mathematics Test Anxiety	15	0.952
Numerical Task Anxiety	5	0.877
Mathematics Course Anxiety	5	0.883
Statistics Class Test Anxiety	8	0.933
Statistics Interpreting Anxiety	8	0.931
Statistics Asking for Help Anxiety	8	0.978

All respondent's scores (n = 21), were used to calculate the mean for each item in mathematics test anxiety. The least mathematics test anxiety expressed was in "picking up math textbook to begin working on a homework assignment," with a mean of 2.10. The greatest mathematics test anxiety was expressed in "taking an exam (final) in a math course" and "thinking about an upcoming math test one hour before," both with means of 4.29. The means from this subscale fell in the range of "a little" to "much" anxiety. Table 9 provides the mean and standard deviation for each mathematics test anxiety subscale item.

Table 9

Mathematics Test Anxiety Scale Item Statistics

	Mean	SD	Frequency
1. Studying for a math test	3.38	1.117	21
2. Taking math section of college entrance exam	3.48	1.250	21
3. Taking an exam (quiz) in a math course	3.52	1.167	21
4. Taking an exam (final) in a math course	4.29	0.902	21
5. Picking up math textbook to begin working on a homework assignment	2.10	1.091	21
6. Being given homework assignments of many difficult problems that are due the next class meeting	3.29	1.146	21
7. Thinking about an upcoming math test 1 week before	2.90	1.338	21
8. Thinking about an upcoming math test 1 day before	3.90	1.136	21
9. Thinking about an upcoming math test 1 hour before	4.29	1.056	21
10. Realizing you have to take a certain number of math classes to fulfill requirements	2.95	1.396	21
11. Picking up math textbook to begin a difficult reading assignment	2.48	1.327	21
12. Receiving your final math grade in the mail	3.90	1.221	21
13. Opening a math or statistics book and seeing a page full of problems	2.67	1.278	21
14. Getting ready to study for a math teat	2.81	1.289	21
15. Being given a “pop” quiz in a math class	4.00	1.183	21

Item-total statistics was calculated to examine the fit of items for the mathematics test anxiety subscale (see Table 10). Fifteen items measuring mathematics test anxiety had an excellent internal consistency, as determined by a Cronbach’s alpha of 0.953. Because the reliability was so high with all the items, deleting any of them would decrease the reliability from 0.953 to between 0.951 and 0.944, depending on which item was deleted. All items on this subscale are extremely reliable.

Table 10

Mathematics Test Anxiety Scale Item-Total Statistics

	Scale Mean if Item Deleted	Scale Variance if Item Deleted	Corrected Item-Total Correlation	Squared Multiple Correlation	Cronbach's Alpha if Item Deleted
1. Studying for a math test	46.57	171.257	0.699	0.901	0.949
2. Taking math section of college entrance exam	46.48	171.562	0.606	0.917	0.951
3. Taking an exam (quiz) in a math course	46.43	170.057	0.707	0.955	0.949
4. Taking an exam (final) in a math course	45.67	174.333	0.747	0.869	0.949
5. Picking up math textbook to begin working on a homework assignment	47.86	171.229	0.719	0.922	0.949
6. Being given homework assignments of many difficult problems that are due the next class meeting	46.67	169.533	0.740	0.834	0.948
7. Thinking about an upcoming math test 1 week before	47.05	160.248	0.912	0.970	0.944
8. Thinking about an upcoming math test 1 day before	46.05	166.748	0.849	0.968	0.946
9. Thinking about an upcoming math test 1 hour before	45.67	172.233	0.707	0.983	0.949
10. Realizing you have to take a certain number of math classes to fulfill requirements	47.00	166.700	0.674	0.963	0.950
11. Picking up math textbook to begin a difficult reading assignment	47.48	170.162	0.607	0.863	0.951
12. Receiving your final math grade in the mail	46.05	168.248	0.733	0.903	0.948
13. Opening a math or statistics book and seeing a page full of problems	47.29	166.014	0.768	0.939	0.948
14. Getting ready to study for a math test	47.14	164.829	0.799	0.891	0.947
15. Being given a "pop" quiz in a math class	45.95	166.748	0.812	0.971	0.947

All respondent's scores (n = 21), were used to calculate the mean for each item in mathematics numerical task anxiety. All the means were in the "not at all" to "a little" range with means ranging between 1.24 and 1.81. Table 11 provides the mean and standard deviation for each numerical task anxiety subscale item.

Table 11

Mathematics Numerical Task Anxiety Scale Item Statistics

	Mean	SD	Frequency
1. Reading a cash register receipt after your purchase	1.24	0.539	21
2. Being given a set of numerical problems involving addition to solve on paper	1.43	0.598	21
3. Being given a set of subtraction problems to solve	1.48	0.814	21
4. Being given a set of multiplication problems to solve	1.62	0.740	21
5. Being given a set of division problems to solve	1.81	0.981	21

Item-total statistics was calculated to examine the fit of items for the numerical task anxiety subscale (see Table 12). Five items measuring numerical task anxiety had very good internal consistency, as determined by a Cronbach's alpha of 0.877. One item in the scale, "reading a cash register receipt after your purchase," would increase Cronbach's alpha, if it were deleted, from 0.877 to 0.914. However, Cronbach's alpha of .877 indicates the scale is highly reliable with the item included.

Table 12

Mathematics Numerical Task Anxiety Scale Item-Total Statistics

	Scale Mean if Item Deleted	Scale Variance if Item Deleted	Corrected Item-Total Correlation	Squared Multiple Correlation	Cronbach's Alpha if Item Deleted
1. Reading a cash register receipt after your purchase	6.33	8.033	0.371	0.248	0.914
2. Being given a set of numerical problems involving addition to solve on paper	6.14	6.829	0.727	0.552	0.853
3. Being given a set of subtraction problems to solve	6.10	5.590	0.833	0.742	0.819
4. Being given a set of multiplication problems to solve	5.95	5.948	0.821	0.788	0.824
5. Being given a set of division problems to solve	5.76	4.790	0.863	0.796	0.816

All respondent's scores (n = 21), were used to calculate the mean for each item in mathematics course anxiety. These means were in "a little" level for anxiety. The least mathematics course anxiety expressed was in "watching a teacher work on an algebraic equation

on the blackboard," with a mean of 1.81. The greatest mathematics course anxiety was expressed in "listening to another student explain a math formula," with a mean of 2.24. Table 13 provides the mean and standard deviation for each mathematics course anxiety subscale item.

Table 13

Mathematics Course Anxiety Scale Item Statistics

	Mean	SD	Frequency
1. Buying a math book	2.10	1.179	21
2. Watching a teacher work on an algebraic equation on the blackboard	1.81	0.928	21
3. Signing up for a math course	2.05	1.071	21
4. Listening to another student explain a math formula	2.24	0.995	21
5. Walking into a math class	2.00	1.304	21

Item-total statistics was calculated to examine the fit of items for the mathematics course anxiety subscale (see Table 14). Five items measuring mathematics course anxiety had very good internal consistency, as determined by a Cronbach's alpha of 0.883. One item in the scale, "buying a math book," would increase Cronbach's alpha, if it were deleted, from 0.883 to 0.907. However, Cronbach's alpha of 0.883 indicates the scale is highly reliable with the item included.

Table 14

Mathematics Course Anxiety Scale Item-Total Statistics

	Scale Mean if Item Deleted	Scale Variance if Item Deleted	Corrected Item-Total Correlation	Squared Multiple Correlation	Cronbach's Alpha if Item Deleted
1. Buying a math book	8.10	14.690	0.518	0.270	0.907
2. Watching a teacher work on an algebraic equation on the blackboard	8.38	15.148	0.658	0.463	0.873
3. Signing up for a math course	8.14	13.129	0.835	0.767	0.831
4. Listening to another student explain a math formula	7.95	13.948	0.783	0.721	0.846
5. Walking into a math class	8.19	11.462	0.861	0.840	0.823

All respondent's scores (n = 21), were used to calculate the mean for each item in statistics class test anxiety. The least statistics class test anxiety expressed was in "getting to the day before an exam without having had time to revise the syllabus," with a mean of 2.90. This is

considered “a fair amount” of anxiety. The greatest statistics class test anxiety was expressed in “realizing, just before you go into the exam, that I have not prepared a particular exercise,” with a mean of 4.38. These subscale means fell in the range of “a fair amount” to “much” anxiety. Table 15 provides the mean and standard deviation for each statistics class test anxiety subscale item.

Table 15

Statistics Class Test Anxiety Scale Item Statistics

	Mean	SD	Frequency
1. Studying for an examination in a statistics course	3.57	1.165	21
2. Realizing the day before an exam that I cannot do some problems that I thought were going to be easy	4.19	0.981	21
3. Doing the final examination in a statistics course	4.05	1.203	21
4. Walking into the classroom to take a statistics test	3.76	1.221	21
5. Getting to the day before an exam without having had time to revise the syllabus	2.90	1411	21
6. Waking up in the morning on the day of a statistics test	3.57	1.207	21
7. Realizing, just before you go into the exam, that I have not prepared a particular exercise	4.38	0.865	21
8. Going to a statistics exam without having had enough time to revise	3.57	1.248	21

Item-total statistics was calculated to examine the fit of items for the statistics class test anxiety subscale (see Table 16). Eight items measuring statistics class test anxiety had an excellent internal consistency, as determined by a Cronbach’s alpha of 0.933. One item in the scale, “getting to the day before an exam without having had time to revise the syllabus,” would increase Cronbach’s alpha, if it were deleted, from 0.933 to 0.937. Another item, “realizing, just before you go into the exam, that I have not prepared a particular exercise,” would neither increase nor decrease Cronbach’s alpha, but remain the same, if it were deleted. Cronbach’s alpha of 0.933 is an excellent indicator that all items in the scale are extremely reliable.

Table 16

Statistics Class Test Anxiety Scale Item-Total Statistics

	Scale Mean if Item Deleted	Scale Variance if Item Deleted	Corrected Item-Total Correlation	Squared Multiple Correlation	Cronbach's Alpha if Item Deleted
1. Studying for an examination in a statistics course	26.43	47.357	0.698	0.528	0.929
2. Realizing the day before an exam that I cannot do some problems that I thought were going to be easy	25.81	46.962	0.891	0.919	0.917
3. Doing the final examination in a statistics course	25.95	45.048	0.830	0.876	0.919
4. Walking into the classroom to take a statistics test	26.24	43.790	0.905	0.926	0.913
5. Getting to the day before an exam without having had time to revise the syllabus	27.10	45.790	0.635	0.646	0.937
6. Waking up in the morning on the day of a statistics test	26.43	44.757	0.847	0.850	0.918
7. Realizing, just before you go into the exam, that I have not prepared a particular exercise	25.62	51.148	0.647	0.749	0.933
8. Going to a statistics exam, without having had enough time to revise	26.43	45.557	0.759	0.705	0.925

The statistics interpreting anxiety subscale had n=19 respondents calculated into the mean for each of the items in the subscale. Two respondents did not complete one question each within this subscale. The two lowest statistics interpreting anxiety means were "reading an advertisement for an automobile which includes figures on gas mileage, compliance with population regulations, etc." and "trying to understand odds in a lotter," with means of 1.84 and 1.95, respectfully. The greatest statistics interpreting anxiety was expressed in "interpreting the meaning of a table in a journal article" and "trying to understand a mathematics demonstration," both with means of 2.63. Most of the means in this subscale fell in the "a fair amount" level of anxiety. Table 17 provides the mean and standard deviation for each of the statistics interpreting anxiety subscale items.

Table 17

Statistics Interpreting Anxiety Scale Item Statistics

	Mean	SD	Frequency
1. Interpreting the meaning of a table in a journal article	2.63	1.257	19
2. Reading a journal article that includes some statistical analyses	2.32	1.336	19
3. Trying to understand a mathematical demonstration	2.63	1.422	19
4. Reading an advertisement for an automobile which includes figures on gas mileage, compliance with population regulations. Etc.	1.84	0.834	19
5. Copying a mathematical demonstration from the blackboard while the teacher is explaining it	2.11	1.197	19
6. Trying to understand the odds in a lottery	1.95	0.970	19
7. Seeing a classmate carefully studying the results table of a problem he has solved	2.42	1.539	19
8. Trying to understand the statistical analyses described in the abstract of a journal article	2.37	1.383	19

Item-total statistics was calculated to examine the fit of items for the statistics interpreting anxiety subscale (see Table 18). Eight items measuring statistics interpreting anxiety had an excellent internal consistency, as determined by a Cronbach’s alpha of 0.931. One item in the scale, “reading an advertisement for an automobile which includes figures on gas mileage, compliance with population regulations, etc.” would increase Cronbach’s alpha, if it were deleted, from 0.931 to 0.937. However, Cronbach’s alpha of .931 indicates the scale is an excellent indicator that all items in the scale are extremely reliable.

Table 18

Statistics Interpreting Anxiety Scale Item-Total Statistics

	Scale Mean if Item Deleted	Scale Variance if Item Deleted	Corrected Item-Total Correlation	Squared Multiple Correlation	Cronbach's Alpha if Item Deleted
1. Interpreting the meaning of a table in a journal article	15.63	53.912	0.713	0.859	0.925
2. Reading a journal article that includes some statistical analyses	15.95	50.719	0.849	0.867	0.915
3. Trying to understand a mathematical demonstration	15.63	50.801	0.780	0.791	0.921
4. Reading an advertisement for an automobile which includes figures on gas mileage, compliance with population regulations, etc.	16.42	61.035	0.531	0.674	0.937
5. Copying a mathematical demonstration from the blackboard while the teacher is explaining it	16.16	54.029	0.749	0.877	0.923
6. Trying to understand the odds in a lottery	16.32	57.117	0.722	0.753	0.926
7. Seeing a classmate carefully studying the results table of a problem he has solved	15.84	47.918	0.862	0.858	0.914
8. Trying to understand the statistical analyses described in the abstract of a journal article	15.89	49.099	0.910	0.906	0.909

All respondent's scores (n = 21), were used to calculate the mean for each item in statistics asking for help anxiety. All means were very close, ranging from 2.62 to 3.24, falling in the "a fair amount" level of anxiety. Table 19 provides the mean and standard deviation for each of the statistics asking for help anxiety subscale items.

Table 19

Statistics Asking for Help Anxiety Scale Item Statistics

	Mean	SD	Frequency
1. Going to ask my statistics teacher for individual help with material I am having difficulty understanding	3.24	1.480	21
2. Asking a private teacher to explain a topic that I have not understood at all	3.05	1.431	21
3. Asking the teacher how to use a probability table	2.62	1.532	21
4. Asking the teacher about how to do an exercise	2.71	1.189	21
5. Asking one of your teachers for help in understanding a printout	2.67	1.461	21
6. Asking a teacher for help when trying to interpret a results table	2.67	1.592	21
7. Going to the teacher's office to ask questions	3.10	1.411	21
8. Asking a private teacher to tell me how to do an exercise	2.71	1.586	21

Item-total statistics was calculated to examine the fit of items for the statistics asking for help anxiety subscale (see Table 20). Eight items measuring statistics asking for help anxiety had an excellent internal consistency, as determined by a Cronbach's alpha of 0.978. One item in the scale, "asking the teacher how to use a probability table," would increase Cronbach's alpha, if it were deleted, from 0.978 to 0.981. However, Cronbach's alpha of .978 indicates the scale is an excellent indicator that all items in the scale are extremely reliable.

Table 20

Statistics Asking for Help Anxiety Scale Item-Total Statistics

	Scale Mean if Item Deleted	Scale Variance if Item Deleted	Corrected Item-Total Correlation	Squared Multiple Correlation	Cronbach's Alpha if Item Deleted
1. Going to ask my statistics teacher for individual help with material I am having difficulty understanding	19.52	91.362	0.913	0.928	0.975
2. Asking a private teacher to explain a topic that I have not understood at all	19.71	91.414	0.948	0.938	0.974
3. Asking the teacher how to use a probability table	20.14	92.929	0.816	0.913	0.981
4. Asking the teacher about how to do an exercise	20.05	96.348	0.926	0.908	0.976
5. Asking one of your teachers for help in understanding a printout	20.10	91.490	0.922	0.947	0.975
6. Asking a teacher for help when trying to interpret a results table	20.10	88.690	0.940	0.962	0.974
7. Going to the teacher's office to ask questions	19.67	92.433	0.920	0.951	0.975
8. Asking a private teacher to tell me how to do an exercise	20.05	88.848	0.938	0.896	0.974

Table 21 shows the summary item means for each of the six subscales. Notice the statistics class test anxiety and the mathematics test anxiety are the higher levels of anxiety for this sample of students. Those subscales have the largest range of scores, and therefore the largest variance.

Table 21

Summary Item Means Statistics for all Subscales

	Mean	Minimum	Maximum	Range	Variance	# of Items
Mathematics Test Anxiety	3.330	2.095	4.286	2.190	0.449	15
Numerical Task Anxiety	1.514	1.238	1.810	0.571	0.046	5
Mathematics Course Anxiety	2.038	1.810	2.238	0.429	0.024	5
Statistics Class Test Anxiety	3.750	2.905	4.381	1.476	0.213	8
Statistics Interpreting Anxiety	2.283	1.842	2.632	0.789	0.087	8
Statistics Asking for Help Anxiety	2.845	2.619	3.238	0.619	0.058	8

Research Question One – Linear Regression

Linear regression was used to predict mathematics anxiety based on quantitative-course experience of number of high school and college-level courses taken from the math department. The seven assumptions required for linear regression as indicated by Laerd Statistics (2018a) were assessed to assure valid interpretations.

Assumptions

Assumption one – continuous dependent variable. The continuous dependent variable in this study was students' mathematics anxiety, measured on the interval scale using the Revised-Mathematics Anxiety Rating Scale (Alexander & Martray, 1989). Each of the 25 items were measured on a Likert scale from 1 to 5 with 1 being "not at all" to 5 being "very much." The R-MARS consists of three subscales, mathematics test anxiety, numerical task anxiety, and mathematics course anxiety.

Assumption two – continuous independent variable. The continuous independent variable in this study was quantitative-course experience. It was measured on the ratio scale by asking participants the number of high school and college-level courses they had taken from the math department.

Assumption three – needs to be a linear relationship between the dependent and independent variables. The regression scatter plots for each of the subscales of mathematics anxiety display a positive linear relationship (see Appendix C, Assumptions).

Assumption four – independence of residuals. Each of the three subscales in mathematics anxiety, mathematics test anxiety, numerical task anxiety, and mathematics course anxiety, were assessed by a Durbin-Watson (D-W) statistic of 1.907, 1.141, and 2.377, respectively. Table 22 displays this data. These values are in the acceptable range of 0 to 4 as indicated by Laerd Statistics (2018a), and therefore show independence of residuals, with greater independence indicated for measures closer to 2 on the D-W scale.

Table 22

Model Summary of Each Mathematics Anxiety Subscale (Durbin-Watson Statistic)

					Change Statistics					
Subscale	R	R Square	Adjusted R Square	Std. Error of the Estimate	R Square Change	F Change	df1	df2	Sig. F Change	Durbin-Watson
1	.135[a]	0.018	-0.091	14.509	0.018	0.166	2	18	0.848	1.907
2	.317[a]	0.101	0.001	3.074	0.101	1.007	2	18	0.385	1.141
3	.335[a]	0.112	0.014	4.525	0.112	1.140	2	18	0.342	2.377

1=Mathematics Test Anxiety; 2=Mathematics Numerical Task Anxiety; 3=Mathematics Course Anxiety. a. Predictors: (Constant), Gender, Quantitative-course Experience

Assumption five – no significant outliers. If the standardized residual is greater than ±3 standard deviations, this would be considered an outlier (Laerd Statistics, 2018a) and a Casewise Diagnostic would have been run by SPSS. Since this table was not produced, it can be assumed there were no outliers in the data. The scatterplots in Appendix C show no point beyond ±3.

Assumption six – data needs to show homoscedasticity. There was homoscedasticity, as assessed by visual inspection of the scatterplots of standardized residuals versus standardized predicted values. The variance of the residuals is constant across all the values of the independent variable. Scatterplots can be found in Appendix C.

Assumption seven – the residuals of the regression line are approximately normally distributed. Histograms for each mathematics anxiety subscale showed relatively normal distributions. Additionally, P-P plots showed points normally distributed near the diagonal line, therefore the assumption of normality was met. Histograms and P-P plots can be found in Appendix C.

Once all assumptions were met, linear regression was used in the prediction of mathematics anxiety from quantitative-course experience. How much variability in mathematics anxiety is accounted for by quantitative-course experience, was determined. Regression coefficients and standard error for each mathematics anxiety subscale can be found in Table 23.

Table 23

Mathematics Anxiety Subscales Regression Coefficients

Variables	B	Std. Error	β	t	Sig.
Mathematics Test Anxiety (Constant)	4.0449	20.802		1.944	0.068
Quantitative-course Experience	1.311	2.275	0.142	0.576	0.571
Gender	1.245	7.368	0.041	0.169	0.868
Overall Model: $F(2, 18) = 0.166$, $p > 0.05$, adj. $R^2 = -0.091$					
Mathematics Numerical Task Anxiety (Constant)	5.072	4.408		1.151	0.265
Quantitative-course Experience	0.590	0.482	0.288	1.224	0.237
Gender	-0.477	1.561	-0.072	-0.305	0.764
Overall Model: $F(2, 18) = 1.007$, $p > 0.05$, adj. R2 = 0.001					
Mathematics Course Anxiety (Constant)	3.639	6.488		0.561	0.582
Quantitative-course Experience	1.049	0.710	0.345	1.479	0.157
Gender	0.383	2.298	0.039	0.166	0.870
Overall Model: $F(2, 18) = 1.140$, $p > 0.05$, adj. $R^2 = 0.014$					

Mathematics Test Anxiety

A simple linear regression was calculated to predict mathematics test anxiety based on quantitative anxiety, β = .142, t(20) = 0.58, p> 0.05. The regression equation was not found to be significant (F (2, 18) = 0.166, p > .05, with an R^2 of .018.

Numerical Task Anxiety

A simple linear regression was calculated to predict mathematics numerical task anxiety based on quantitative anxiety, β = .288, t(20) = 1.22, p> 0.05. The regression equation was not found to be significant (F (2, 18) = 1.007, p > .05, with an R^2 of .101.

Mathematics Course Anxiety

A simple linear regression was calculated to predict mathematics course anxiety based on quantitative anxiety, β = .345, t(20) = 1.48, p> 0.05. The regression equation was not found to be significant (F (2, 18) = 1.140, p > .05, with an R^2 of .112.

Research Question Two – Linear Regression

Linear regression was used to predict statistics anxiety based on quantitative-course experience of number of high school and college-level courses taken from the math department. The seven assumptions required for linear regression as indicated by Laerd Statistics (2018a) were assessed to assure valid interpretations.

Assumptions

Assumption one – continuous dependent variable. The continuous dependent variable in this study was students' statistics anxiety, measured on the interval scale using the Statistical Anxiety Scale (Vigil-Colet et al., 2008). Each of the 24 items were measured on a Likert scale from 1 to 5 with 1 being "not at all" to 5 being "very much." The SAS consists of three

subscales, statistics class test anxiety, statistics interpreting anxiety, and statistics asking for help anxiety.

Assumption two – continuous independent variable. The continuous independent variable in this study was quantitative-course experience. It was measured on the ratio scale by asking participants the number of high school and college-level courses they had taken from the math department.

Assumption three – needs to be a linear relationship between the dependent and independent variables. The regression scatter plots for each of the subscales of statistics anxiety display a positive linear relationship (see Appendix C).

Assumption four – independence of residuals. Each of the three subscales in statistics anxiety, statistics class test anxiety, statistics interpreting anxiety, and statistics asking for help anxiety, were assessed by a D-W statistic of 2.694, 1.674, and 1.753, respectively (See Table 24). These values are in the acceptable range of 0 to 4 as indicated by Laerd Statistics (2018a), and therefore show independence of residuals, with greater independence indicated for measures closer to 2 on the D-W scale.

Table 24

Model Summary of Each Statistics Anxiety Subscale (Durbin-Watson Statistics)

					Change Statistics					
Subscale	R	R Square	Adjusted R Square	Std. Error of the Estimate	R Square Change	F Change	df1	df2	Sig. F Change	Durbin-Watson
4	.203[a]	0.041	-0.065	7.989	0.041	0.386	2	18	0.685	2.694
5	.281[a]	0.079	-0.036	8.433	0.079	0.688	2	16	0.517	1.675
6	.245[a]	0.060	-0.044	11.166	0.060	0.575	2	18	0.573	1.753

4=Statistics Class Test Anxiety; 5=Statistics Interpreting Anxiety; 6=Statistics Asking for Help Anxiety. a. Predictors: (Constant), Gender, Quantitative-course Experience

Assumption five – no significant outliers. If the standardized residual is greater than ±3 standard deviations, this would be considered an outlier (Laerd Statistics, 2018a) and a Casewise

Diagnostic would have been run by SPSS. Since this table was not produced, it can be assumed there were no outliers in the data. The scatterplots in Appendix C show no point beyond ±3.

Assumption six – data needs to show homoscedasticity. There was homoscedasticity, as assessed by visual inspection of the scatterplots of standardized residuals versus standardized predicted values. The variance of the residuals is constant across all the values of the independent variable. Scatterplots can be found in Appendix C.

Assumption seven – the residuals of the regression line are approximately normally distributed. Histograms for each statistics anxiety subscale showed relatively normal distributions. Additionally, P-P plots showed points normally distributed near the diagonal line, therefore the assumption of normality was met. Histograms and P-P plots can be found in Appendix C.

Once all assumptions were met, linear regression was used in the prediction of statistics anxiety from quantitative-course experience. How much variability in statistics anxiety is accounted for by quantitative-course experience, was determined. Regression coefficients and standard error for each statistics subscale can be found in Table 25.

Table 25

Statistics Anxiety Subscales Regression Coefficients

Variables	B	Std. Error	β	t	Sig.
Statistics Class Test Anxiety (Constant)	22.236	11.454		1.941	0.068
Quantitative-course Experience	0.295	1.253	0.057	0.236	0.816
Gender	3.562	4.057	0.213	0.878	0.392
Overall Model: F(2, 18) = 0.386, p > 0.05, adj. R^2 = -0.065					
Statistics Interpreting Anxiety (Constant)	4.391	12.290		0.357	0.726
Quantitative-course Experience	1.478	1.361	0.273	1.086	0.293
Gender	3.248	4.358	0.187	0.745	0.467
Overall Model: F(2, 16) = 0.688, p > 0.05, adj. R^2 = -0.036					
Statistics Asking for Help Anxiety (Constant)	9.066	16.010		0.566	0.578
Quantitative-course Experience	0.582	1.751	0.080	0.332	0.743
Gender	6.082	5.671	0.258	1.072	0.298
Overall Model: F(2, 18) = 0.575, p > 0.05, adj. R^2 = -0.044					

Statistics Class Test Anxiety

A simple linear regression was calculated to predict statistics class test anxiety based on quantitative anxiety, β = .057, t(20) = 0.24, p> 0.05. The regression equation was not found to be significant (F (2, 18) = 0.386, p > .05, with an R^2 of .041.

Statistics Interpreting Anxiety

A simple linear regression was calculated to predict statistics interpreting anxiety based on quantitative anxiety, β = .273, t(18) = 1.09, p> 0.05. The regression equation was not found to be significant (F (2, 16) = 0.688, p > .05, with an R^2 of .079.

Statistics Asking for Help Anxiety

A simple linear regression was calculated to predict statistics asking for help anxiety based on quantitative anxiety, β = .080, t(20) = 0.33, p> 0.05. The regression equation was not found to be significant (F (2, 18) = 0.575, p > .05, with an R^2 of .060.

Research Question Three – Multiple Regression

Multiple regression was used to predict quantitative anxiety, mathematics anxiety and statistics anxiety, based on gender (male and female) and on quantitative-course experience of the number of high school and college-level courses taken from the math department. In the SPSS analyses, gender was coded as males = 1 and females = 2. The eight assumptions required for multiple regression as indicated by Laerd Statistics (2018b) were assessed to assure valid interpretations.

Assumptions

Assumption one – continuous dependent variable. The continuous dependent variables in this study were students' quantitative anxiety, mathematics anxiety and statistics anxiety, measured on the interval scale using the Revised-Mathematics Anxiety Rating Scale (Alexander & Martray, 1989) and the Statistical Anxiety Scale (Vigil-Colet et al., 2008). Each of the scale's items were measured on a Likert scale from 1 to 5 with 1 being "not at all" to 5 being "very much." The R-MARS consists of three subscales, mathematics test anxiety, numerical task anxiety, and mathematics course anxiety. The SAS consists of three subscales, statistics class test anxiety, statistics interpreting anxiety, and statistics asking for help anxiety.

Assumption two – two or more independent variable which can be continuous or categorical. There are two independent variables for this study. The quantitative-course experience was measured on the ratio scale by the number of high school and college-level mathematics and statistics courses the participant had taken. The second independent variable was gender, male or female, measured on the nominal scale.

Assumption three – independence of residuals. Each of the six subscales within the two anxiety measures were assessed by a D-W statistic. The range of values were from 1.141 to

2.694 (see Table 22 and Table 24). These values are in the acceptable range of 0 to 4 as indicated by Laerd Statistics (2018b), and therefore show independence of residuals, with greater independence indicated for measures closer to 2 on the D-W scale.

Assumption four – linearity exists. Scatterplots were created to test for linearity between the dependent variable and each of the independent variables, as well as between the dependent variable and the independent variables collectively. All scatterplots display linearity without obvious funnel patterns. See Appendix C.

Assumption five – data needs to show homoscedasticity. There was homoscedasticity, as assessed by visual inspection of the scatterplots of standardized residuals versus standardized predicted values (see Appendix C). The variance of the residuals is constant across all the values of the independent variables.

Assumption six – data must not show multicollinearity. Assessment of the six subscale correlation tables revealed all correlations less than 0.7, which indicates the independent variables are not highly correlated with each other (Laerd Statistics, 2018b), see Table 26. The range of tolerance scores were all 0.905, except for statistics interpreting anxiety which had a Tolerance score of 0.912. Tolerance scores less than 0.1 indicate multicollinearity (Laerd Statistics, 2018b), therefore there were no concerns regarding multicollinearity.

Table 26

Collinearity Statistics

Anxiety Subscales	Independent variables	Correlations		Collinearity Statistics	
		Partial	Part	Tolerance	VIF
Mathematics Test Anxiety	Quantitative-course Experience	0.135	0.135	0.905	1.105
	Gender	-0.002	0.040	0.905	1.105
Numerical Task Anxiety	Quantitative-course Experience	0.277	0.274	0.905	1.105
	Gender	-0.072	-0.068	0.905	1.105
Mathematics Course Anxiety	Quantitative-course Experience	0.329	0.328	0.905	1.105
	Gender	-0.068	0.039	0.905	1.105
Statistics Class/Test Anxiety	Quantitative-course Experience	0.055	0.054	0.905	1.105
	Gender	0.195	0.203	0.905	1.105
Statistics Interpreting Anxiety	Quantitative-course Experience	0.262	0.261	0.912	1.096
	Gender	0.183	0.179	0.912	1.096
Statistics Asking for Help Anxiety	Quantitative-course Experience	0.078	0.076	0.905	1.105
	Gender	0.233	0.245	0.905	1.105

Assumption seven – no significant outliers in the groups of the independent variable. If the standardized residual is greater than ±3 standard deviations, this would be considered an outlier (Laerd Statistics, 2018b) and a Casewise Diagnostic would have been run by SPSS. Since this table was not produced, it can be assumed there were no outliers in the data. The scatterplots in Appendix C show no point beyond ±3.

Assumption eight – residuals are approximately normally distributed. Histograms for each of the six subscales measured show approximately normal distributions (see Appendix C), therefore the assumption of normality was met.

Mathematics Test Anxiety

No statistical significance was found by the multiple regression model in mathematics test anxiety by gender or quantitative-course experience, $F(2, 18) = 0.166$, $p > 0.50$, adj. $R^2 = -0.09$. Mathematics test anxiety and gender had a very low negative correlation of -0.002. Gender had a negative weak correlation with quantitative-course experience of -0.309. Quantitative-

course experience had a very low positive correlation (0.129) with mathematics test anxiety. The model summary indicates that 1.8% of the variance related to mathematics test anxiety is explained by gender and quantitative-course experience.

Numerical Task Anxiety

No statistical significance was found by the multiple regression model in numerical task anxiety by gender or quantitative-course experience, $F(2, 18) = 1.007$, $p > 0.50$, adj. $R^2 = 0.001$. Mathematics numerical task anxiety and gender had a very low negative correlation of -0.161. Gender had a negative moderate correlation with quantitative-course experience of -0.309. Quantitative-course experience had a moderate positive correlation (0.310) with mathematics numerical task anxiety. The model summary indicates that 10.1% of the variance related to mathematics numerical task anxiety is explained by gender and quantitative-course experience.

Mathematics Course Anxiety

No statistical significance was found by the multiple regression model in mathematics course anxiety by gender or quantitative-course experience, $F(2, 18) = 1.140$, $p > 0.50$, adj. $R^2 = 0.014$. Mathematics course anxiety and gender had a very low negative correlation of -0.068. Gender had a moderate negative correlation with quantitative-course experience of -0.309. Quantitative-course experience had a moderate positive correlation (0.333) with mathematics course anxiety. The model summary indicates that 11.2% of the variance related to mathematics course anxiety is explained by gender and quantitative-course experience.

Statistics Class Test Anxiety

No statistical significance was found by the multiple regression model in statistics class test anxiety by gender or quantitative-course experience, $F(2, 18) = 0.386$, $p > 0.50$, adj. $R^2 = -0.065$. Statistics class test anxiety and gender had a weak positive correlation of 0.195. Gender

had a moderate negative correlation with quantitative-course experience of -0.309. Quantitative-course experience had a very low negative correlation (-0.009, nearly no correlation at all) with statistics class test anxiety. The model summary indicates that 4.1% of the variance related to statistics class test anxiety is explained by gender and quantitative-course experience.

Statistics Interpreting Anxiety

No statistical significance was found by the multiple regression model in statistics interpreting anxiety by gender or quantitative-course experience, $F(2, 16) = 0.688$, $p > 0.50$, adj. $R^2 = -0.036$. Statistics interpreting anxiety and gender had a weak positive correlation of 0.106. Gender had a low negative correlation with quantitative-course experience of -0.296. Quantitative-course experience had a low positive correlation (0.217) with statistics interpreting anxiety. The model summary indicates that 7.9% of the variance related to statistics interpreting anxiety is explained by gender and quantitative-course experience.

Statistics Asking for Help Anxiety

No statistical significance was found by the multiple regression model in statistics asking for help anxiety by gender or quantitative-course experience, $F(2, 18) = 0.575$, $p > 0.50$, adj. $R^2 = -0.044$. Statistics asking for help anxiety and gender had a weak positive correlation of 0.233. Gender had a moderate negative correlation with quantitative-course experience of -0.309. Quantitative-course experience had no correlation (0.000) with statistics asking for help anxiety. The model summary indicates that 6.0% of the variance related to statistics asking for help anxiety is explained by gender and quantitative-course experience.

Once all assumptions were met, the multiple regression was used to determine the relationship of each quantitative anxiety subscale with gender and quantitative-course experience. The multiple regression was used to determine how much of the variance was

explained by each independent variable. Regression coefficients and standard error can be found for each subscale in Table 23 and Table 25.

Summary

The results from this study showed excellent internal consistency. The Cronbach's alpha scores ranged from .88 to .95 for the mathematics anxiety subscales and .93 to .98 for the statistics anxiety subscales. These were consistent with the high internal consistency found by the developers of R-MARS (Vigil-Colet et al., 2008) and SAS (Alexander & Martray, 1989), of .97 and .91 respectively. There were significant correlations found among the subscales with scores ranging from .613 to .878. Only statistics class test anxiety and mathematics numerical task anxiety was not found to be significant with a lower, but still moderately positive correlation of .412.

The correlation between gender and quantitative-course experience was negative in all anxiety subscales. Gender also negatively correlated with all mathematics anxiety subscales while it had positive correlations with the statistics anxiety subscales. In other words, males had more anxiety in mathematics than in statistics while females had more statistics anxiety. There were positive correlations between the mathematics anxiety subscales and quantitative-course experience while quantitative-course experience and the statistics anxiety subscales varied with a positive, a negative, and no correlation at all (interpreting anxiety, class test anxiety, and asking for help anxiety, respectfully).

When participants were asked what their most memorable experience was with mathematics or statistics, eight (38%) mentioned something that had to do with grasping the information, satisfaction of understanding, or an "aha" moment. A specific class or teacher was mentioned by four respondents (19%) and three participants (14%) referenced a fun activity in

the class such as learning the language through song. Two participants mentioned negative memories of “not being good at all.” Most of the respondents from this study had positive memories. Table 27 shows the most memorable experience responses, grouped by like category.

Table 27

Most Memorable Experiences

Understanding – Satisfaction - Aha Moment	Specific Class or Teacher
1. Figuring out the golden ratio equation 2. When I first understood algebra 3 years ago 3. Nothing specific stands out, other that I have always been good with numbers 4. When it still made sense. But really, when I had the aha lightbulb moment and everything clicked. That’s my favorite 5. Feeling satisfied after completing a hard problem 6. Whenever something finally clicks and I understand a concept 7. My most memorable experience with mathematics was probably taking my college algebra course. I understood the content very well and enjoyed the class a lot. 8. My most memorable experience would be when I made it through Pre Calc and understood what I was doing.	1. AP calculus in high school 2. My math professor at George Fox 3. My final project in my freshman year Quantitative Reasoning class 4. I enjoyed using math and statistics in AP Economics in high school :) **Fun Activities** 1. In my pre-calculus class, we had to make up a song and perform it in front of the class and use terms from our pre-calculus course! 2. Stats is more fun and interesting 3. 8th grade math teacher wrote songs for us to help us remember stuff
Not Good at All	**Using It**
1. It sucks 2. Being not very good at it ever	1. Back in high school pre calc when I could use a graphing calculator
Helping Others	**Specific Parts**
1. Tutoring math students	1. Z-scores because I like them 2. Histogram graph

Chapter 5

Discussion

Introduction

The purpose of this study was to examine the relationship between quantitative anxiety, specifically mathematics anxiety and statistics anxiety, and quantitative-course experience with gender. College students find statistics to be one of their most challenging courses (Chew & Dillon, 2014; Huang, 2018; Macher et al., 2012). Many procrastinate on taking the course until near the end of their degree program, placing graduation in jeopardy (Kinkead et al., 2016). Mathematics anxiety and statistics anxiety may be getting in the way. Social science majors often require less mathematics skills (Huang, 2018). For that reason, students with mathematics anxiety or statistics anxiety often choose a social science career path (Ashcraft, 2002; Morsanyi et al., 2019; Tarasi et al., 2013). Perhaps obtaining more quantitative experience before the required statistics course, without adding more quantitative classes, would be beneficial in reducing quantitative anxiety.

In this discussion chapter each of the research questions and hypotheses are discussed individually. Limitations from the research are provided along with suggestions for future research. The chapter ends with thoughts on practice and a closing conclusion.

Discussion

Research Question One – Hypothesis One

To what extent does quantitative-course experience predict mathematics anxiety in college-level social science majors? It was hypothesized that college-level social science majors' mathematics anxiety scores would decrease as their quantitative-course experience increased.

The students in this study had similar quantitative-course experience and they all experienced some level of mathematics test anxiety. Yet, there were several students who did not show any numerical task anxiety or mathematics class anxiety. It is possible that the lower scores on mathematics class anxiety could be due to all participants being a traditional student (age 18-24), going from high school right into college. The traditional student may be used to taking math courses and therefore expect math courses as part of their degree program. The same may be said for numerical task anxiety as the students are still familiar with number calculations. Had the participants been more diverse, the study may have seen more numerical task anxiety and mathematics course anxiety due to more time between when the last mathematics course was taken and this study.

It is also possible that the lower scores in numerical task anxiety and mathematics class anxiety came from the influence of the instructor(s). The pace of instruction, and the instructor's attitude can contribute to the level of mathematics anxiety felt by students (Pan & Tang, 2005). Mathematics anxiety could be reduced with the use of humor and instructor immediacy (Carey et al., 2018). What teachers say sends powerful messages about what counts as learning in their classroom, thus creating their environment. Environmental factors play a role in the development of mathematics anxiety (Blazer, 2011). Creating a learning environment that is emotionally supportive allows students to avoid anxieties and nurture self-efficacy (Waples, 2016). Building relationships with students in addition to teaching the necessary information provides an effective learning environment (Waples, 2016). These relationships build trust and maximizes student engagement and willingness to take on challenging tasks (Turner et al., 2002). For these participants, it seems relationships are important to them. Looking at the responses to the most memorable experience question, sixteen of the twenty-one participants mentioned some type of

positive emotional connection such as a specific class or teacher, helping other students, feeling satisfaction when understanding, or participating in a fun activity. The students in this study had been in the class for six weeks when the survey was completed, giving time to establish a relationship with the instructor(s).

Even in a supportive environment, anxiety may develop around testing. Studies have shown moderate correlations between test anxiety and mathematics anxiety (Dowker, et al., 2016; Hembree, 1990). In the academic setting, general test anxiety and mathematics anxiety appear to be the most common of anxieties (Hembree, 1990). People who think that they are bad at mathematics are more likely to develop mathematics anxiety (Dowker et al., 2016). So, even with a positive environment, if a student lacks confidence in their mathematics abilities and is being testing on that knowledge, mathematics test anxiety may increase. In this study all of the participants showed some level of mathematics test anxiety. Since the other subscales of mathematics anxiety were lower, perhaps general test anxiety is serving as a compounding variable. Future studies should account for this variable by first assessing general test anxiety then grouping like scores before assessing mathematics anxiety.

Although some studies have found quantitative-course experience as attributing to less mathematics anxiety (Dupuis et al., 2012), this study did not find this to be statistically significant. It may be that positive instructor influences are more effective in reducing mathematics anxiety than quantitative-course experience. A more diverse study allowing for different age groups and levels of college experience could provide more data for comparison.

Research Question Two – Hypothesis Two

To what extent does quantitative-course experience predict statistics anxiety in college-level social science majors? It was hypothesized that college-level social science majors' statistics anxiety scores would decrease as their quantitative-course experience increased.

While all the students in this study showed some level of statistics class test anxiety, there were some students showing no anxiety within the statistics interpreting anxiety and/or statistics asking for help anxiety. Similar to mathematics test anxiety, there may be some general test anxiety serving as a compounding variable. Future studies should account for this variable by first assessing general test anxiety then grouping like scores before assessing statistics anxiety.

Relationship with the course instructor may have an impact on the level of statistics anxiety for these students, playing a more significant role than quantitative-course experience. Instructors who use their rapport with students to create an atmosphere of support could diminish the reputation of statistics being a difficult course (Waples, 2016). Online courses with their lack of face-to-face synchronous interaction may generally be considered more difficult than if such students took the same course in a traditional face-to-face format (Lu & Lemonde, 2013). The physical separation of instructor and student in online classes may make it more challenging to create rapport (Tichavsky, Hunt, Driscoll & Jicha, 2015), however, the instruction method in this study was face-to-face, allowing for positive relationships to develop, establishing an atmosphere of support. Students who feel more support by their instructors are more likely to engage in academic work, including expending effort or asking for help (Baloglu et al., 2017). This rapport may have been a factor in the anxiety level of statistics asking for help.

In the statistics asking for help anxiety subscale, students in this study were normally distributed along a flattened bell curve. The students in the lower end could be seen as having confidence in their abilities or a positive relationship with the instructor while those students in the upper end may fear they would be viewed in a negative manner, deemed stupid, if they ask for help (Onwuegbuzie, 1997). Future research should look at asking for help anxiety in other subjects to determine if there is a generalized asking for help anxiety. To alleviate anxiety, instructors could incorporate asking for help lessons into their classroom. This can be done so all students feel comfortable asking for help. Questions could become exit tickets (an exit ticket is something asked for by the instructor before a student leaves the class, usually to show obtainment of the day's objective). Questions could be placed in a can at the door so the instructor can answer them at the beginning of the next class. Even the instructor can place a question in the can, just to encourage all types of questions. For students who may still feel uncomfortable (being seen putting a question in the can), perhaps an option of emailing the instructor with a question could be available. Future research may look at whether more experience given to students in asking for help in a non-threatening environment, produces less anxiety. It may be that it is experience in asking for help rather than quantitative-course experience having more of an impact on statistics asking for help anxiety.

Statistics interpreting anxiety showed surprisingly low levels of anxiety. This may be due to experience, just not quantitative-course experience. Statistics is often referred to as if it were a different language (Forte, 1995; Malik, 2015). Language acquisition occurs as a person is exposed to more and more of the language. It may be that the students in this study were familiar with some of the language of statistics. There were eight questions assessing statistics interpreting anxiety. Of those eight questions two had low means that could indicate familiarity:

1) “Reading an advertisement for an automobile which includes figures on gas mileage, compliance with population regulations, etc.” and 2) “Trying to understand the odds in a lottery.” The participants in this study were at an age when they may be researching, or have recently researched for the purchase of a car. Understanding gas mileage can be an important feature to vehicle purchase. Many people also calculate gas mileage when they fill their tanks. These terms are familiar to the students so may not have created anxiety. Lotteries are played in many states. Whether these students understood the odds of winning or not, they are probably familiar with lotteries. Familiarity with items reduces anxiety. It is a treatment technique used in desensitization therapy.

A third item from the statistics interpreting anxiety subscale was also low, “Copying a mathematical demonstration from the blackboard while the teacher is explaining it.” Many students in the 18-24 age range may think of blackboards an something their grandparents used. This term may have brought humor as a variable into the subscale item, reducing the anxiety level and thereby affecting the rating of that item. The use of humor has been shown to reduce statistics anxiety in several studies (Chew & Dillon, 2014; Malik, 2015; Pan & Tang, 2005). So, three of the eight items in the statistics interpreting anxiety subscale may have been impacted by confounding variables.

Similar to Faber and Drexler (2019), this study did not find quantitative-course experience to be an effective predictor for statistics anxiety. Perhaps more positive, supportive relationships between instructors and students, along with language familiarity is more impactful. A more diverse study allowing for different age groups and levels of college experience could provide more data for comparison.

Research Question Three – Hypothesis Three

To what extent does quantitative-course experience interact with gender to predict quantitative anxiety in college-level social science majors? It was hypothesized that college-level social science majors’ gender would moderate the influence of quantitative-course experience on mathematics anxiety scores and statistics anxiety scores.

Literature has provided mixed results when looking at gender and quantitative anxiety. Some studies show females having more quantitative anxiety than males Casad et al., 2015; Dew, Galassi and Galassi, 1983). Other studies show no significant differences (Baloglu, 2003; Lussier, 1996). Devine, Fawcett, Szucs & Dowker (2012) believe the lack of consistent findings of gender differences in quantitative anxiety is in line with research that gender differences are declining, or non-existent in gender equal countries. This could have an impact on the number of females selecting STEM courses. Data from the US Bureau of Labor Statistics (2019) show that in 2018 computer and mathematical occupations were represented by only 25.6% females. Occupations in architecture and engineering were even lower with 15.9% females. If quantitative anxiety is not impacted by gender then we should start seeing increases in these percentages.

This study sided with Baloglu (2003) and found no significance of quantitative anxiety by gender. Females showed slightly more statistics anxiety however the data was not significant. Females may be more willing to admit to feelings of anxiety than males because the expression of emotion by females tends to be more accepted whereas the expression of anxiety in males may be viewed as less acceptable (Devine et al., 2012). This could occur from the different ways in which males and females are socialized during childhood. If females believe that males are better in mathematics, perhaps males then believe they have to be better and therefore take more mathematics classes. When males have difficulties, they are not able to express their anxiety for

fear of showing their inabilities. Devine et al. (2012) believe male's quantitative performance may be more negatively affected by quantitative anxiety since they are less likely to show quantitative anxiety and therefore not be shown effective strategies for dealing with quantitative anxiety.

When examining the total effect composed by each of the six anxiety subscales, it can be seen that 1.8% of the effect is explained by the influence that quantitative-course experience and gender has on mathematics test anxiety; that 10% of the effect is explained by the influence that quantitative-course experience and gender has on mathematics numerical anxiety; that 11% of the effect is explained by the influence that quantitative-course experience and gender has on mathematics course anxiety; that 4% of the effect is explained by the influence that quantitative-course experience and gender has on statistics class test anxiety; that 7.9% of the effect is explained by the influence that quantitative-course experience and gender has on statistics interpreting anxiety; and that 6% of the effect is explained by the influence that quantitative-course experience and gender has on statistics asking for help anxiety. Taken together these results indicate that quantitative-course experience and gender do not have much of an impact on quantitative anxiety. Only in mathematics numerical anxiety and mathematics course anxiety are the percentages in double digits. With males coded as 1 and females coded at 2, the 11% effect explained by the influence that quantitative-course experience and gender has on mathematics course anxiety may indicate males take more mathematics courses, but not a significant amount more. The 10% effect explained by the influence that quantitative-course experience and gender has on mathematics numerical anxiety may indicate a reverse stereotype threat in that males believe they should perform better than females and when they do not, anxiety sets in.

This study was not large enough, nor diverse enough to look at varying levels of quantitative-course experience. All the participants were the same age, had the same face-to-face instruction and had about the same number of previous mathematics and/or statistics classes. A larger, more diverse sample size should be obtained in order to gather more complete data for this research topic.

Limitations

This study was limited by the low response rate. The expectation was to have both graduate and undergraduate students participate in order to assess more varied levels of quantitative-course experience. This sample had only undergraduate students within the same age group of 18-24. This limited the ability to look at relationships between graduate and undergraduate students as well as age. The similarity in the number of mathematics and statistics courses taken were nearly the same since the students were within the same age range. The number of courses question could be asked differently in future studies so data would show two course totals (the number of mathematics courses and the number of statistics courses). This difference may show more mathematics courses does not impact statistics anxiety while more statistics courses does impact statistics anxiety, or other combinations. Future studies should look earlier at course catalogues to plan ahead in order to include in the study several classes at multiple college course levels, in addition to various instructional methods (online, hybrid, face-to-face). This would ensure traditional and non-traditional students the option of participating and providing more diverse data.

Another limitation was in the administering of the survey. The researcher was not aware that another IRB had to be completed for the second university, per that university's requirements. This should have been explored sooner so surveys could have gone out earlier.

Conversations with all professors should have been made sooner so they were prepared for the request when all IRB approvals were completed. This would have allowed the professors time to incorporate the survey into their class planning and possibly provide more student responses.

This study had planned to look at age related differences, however, since all the participants were within the same age bracket, this was not able to be accomplished. The study was also going to look at the impact of when the last mathematics and/or statistics course was taken. The researcher did not word the question specific enough to get data that could be used. The question was stated, “When was your last mathematics or statistics course, prior to this one? Please provide approximate month and year.” Some answers just gave the course number that was taken (Math 105). Other answers said, “last spring” or “as a senior in high school.” Some participants gave the beginning of the course date while others gave the ending of the course date. The question should have been more direct and only allow the participants to provide numerical answers.

Suggestions for Future Research

Future research should continue to explore quantitative-course experience incorporating larger samples of graduate and undergraduate students in the same study. As Huang (2018) says, graduate and undergraduate students have very different backgrounds. Studies could be incorporating bias if both groups are not looked at together. Looking at both groups would provide more age diversity. A diverse age sample may show more distinct differences in quantitative anxiety in relation to quantitative-course experience. To gather a large sample may require the use of multiple universities. For this study, the researcher learned that each university required their own IRB approval before allowing students to participate. It would be necessary to check the requirements of universities to determine specific rules before asking for participation.

Statistics language familiarity might come from experience in reading articles that contain charts and graphs. To distinguish between course experience and everyday experience, future studies should control for this, possibly by adding a question in the survey about amount of time spent reading articles that contain statistic language, such as charts and graphs.

With mathematics anxiety considered a widespread problem for all ages across the globe (Luttenberger et al., 2018), future research may want to look at sampling the universities throughout the United States (U. S.). This would provide several classes of graduate and undergraduate students from various backgrounds. This would not be targeting any one geographic area but the whole country. Once the connections are made with universities, the college-level statistics classes could have the research study as part of their syllabi for a few years to look at trends in quantitative anxiety. Statistics instructors could be part of the study to determine if their mathematics anxiety or statistics anxiety has an impact on their students. Other countries may want to do the same and then compare data, looking for similarities and differences between countries.

Future research should continue to explore gender in a way that stereotype beliefs can be eliminated from the assessment. It is difficult to know if anxiety scores from females are due to females being more in touch with their feelings and willing to share their anxieties while males keep those feelings to themselves. Perhaps willingness to share and knowledge of feelings should be assessed first, then like subjects grouped together to assess for mathematics anxiety and statistics anxiety.

Practice

Quantitative anxiety is a real concern among students and instructors (Lin, Durbin & Rancer, 2016). Statistics anxiety is one of the most significant challenges students face in

completing many college degree programs (Kinkead et al., 2016; Koh & Zawi, 2014; Onwuegbuzie & Wilson, 2003). Students with quantitative anxiety suffer from strong failure expectations and lack of confidence (Faber & Drexler, 2019). Challenges were reported in a) the number of students postponing statistics courses until late in a course of study, b) poor class attendance, c) procrastination on assignments, and d) poor performance on assessments (Kinkead et al. 2016). Instructors need to be aware of the signs of quantitative anxiety in order to intervene with students. Onwuegbuzie et al. (1997) share some signs to watch for which include: depression, frustration, anger, apprehension, nervousness, worry, panic, stress, and emotionality. Some physiological signs include: perspiration, palmar sweating, dry mouth, headaches, and feeling sick. Anxious behaviors may include: biting one's nails, voice tremors, use of improper language, fits of anger, irritability, a tight brow, and tears. A few related emotions include frustration, learned-helplessness, fear, uncertainty, reduction in self-esteem and independence, lack of concentration, blanking out, feelings of anticipation and disappointment.

Being cognizant of interventions available to help alleviate quantitative anxiety is a must for all math and statistics instructors. Designing teaching and learning experiences with real-world problems can help overcome quantitative anxiety by engaging students (Chamberlain et al., 2015). Chamberlain et al. (2015) also suggest that study materials be organized is a progressive fashion so they start with more simple tasks before introducing more complex tasks. This should be done over time at a pace best suited to students' ability and mathematical background. One way to decrease students' quantitative anxiety while improving their quantitative literacy is by introducing basic skills of data interpreting at a much earlier point in their college career and reinforcing the lessons and degree of complexity throughout all their courses (Lindner, 2012). This may create better communication with non-quantitative teaching

colleagues in utilizing mathematics and statistics language to help lessen students' quantitative anxiety while building students' self-confidence (Chamberlain et al., 2015).

More specific interventions to reducing quantitative anxiety are suggested by Chew & Dillon (2014): there should be less emphasis on mathematics in a statistics course, manual calculations should be reduced, use computers for calculations, instructors should use weekly quizzes to encourage students to keep up on reading, award grades for participation instead of correct answers, provide a system for anonymous questions, integrate humor, and instructors should manage their own anxieties.

All students should have the opportunity to be successful in quantitative courses. Quantitative anxiety should not be the reason students are waiting until the last term of their degree program to complete statistics. By modeling their own thinking processes, instructors demonstrate that being unsure, learning from mistakes, and asking questions are natural and necessary parts of learning (Turner et al., 2002). Understanding the factors that influence quantitative anxiety are important not only to instructors in terms of improving pedagogy but also to those at the advisory level who help guide students in selecting appropriate course loads.

Conclusion

This study examined the relationship between social science majors' quantitative-course experience and their quantitative anxiety. Data collected from the Revised-Mathematics Anxiety Scale and the Statistical Anxiety Scale were analyzed using linear regression and multiple regression. All six anxiety subscales had high correlations ranging from $r = .613$ to $r = .878$. There was excellent reliability with Cronbach's alpha ranging from .877 to .978.

After analyzing the data, this study was similar to Baloglu (2003) in that no significant differences were found in quantitative anxiety by gender. Like Faber and Drexler (2019), there

was no statistical significance found in quantitative anxiety by quantitative-course experience. Any small effects may be attributed to confounding variables such as general test anxiety or instructor influence.

The participants in this study were all within the 18-24 age range, which is considered a traditional student. With this data of showing no significance in gender when it comes to quantitative anxiety, perhaps the stereotype threat which claims males are better at mathematics than females, is declining for this age group.

A larger sample size should be obtained in order to gather more diverse data. With the inclusion of graduate students and online students, the data would provide more variance in the number of courses taken and when the last mathematics and/or statistics course was taken. This kind of data would allow the impact of quantitative-course experience on quantitative anxiety to be analyzed. In the meantime, instructors can support students with mathematics anxiety or statistics anxiety by being aware of the signs, integrating humor into the classroom, and encouraging colleagues to use mathematics and statistics language in every class. All students deserve the opportunity to succeed in their quantitative courses.

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Appendix A

Informed Consent

RESEARCH SUBJECT INFORMED CONSENT FORM

Prospective Research Subject: Read this consent form carefully and ask as many questions as you like before you decide whether you want to participate in this research study. You are free to ask questions at any time before, during, or after your participation in this research.

Project Information

Project Title: The Relationship between Social Science Majors' Quantitative-course Experience and their Quantitative Anxiety	Project Number:
Site IRB Number:	Sponsor: George Fox University Doctor of Education Program
Principal Investigator: Kelly McIntyre	Organization: George Fox University
Location: Hillsboro, Oregon	Phone: 808-927-1856
Other Investigators: Dane Joseph (Chair)	Organization: George Fox University
Location: Newberg, Oregon	Phone: 503-554-2855

1. **PURPOSE OF THIS RESEARCH STUDY**
    - The purpose of this study is to examine the differences in quantitative anxiety in relation to gender and quantitative-course experience.
2. **PROCEDURES**
    - You will be asked to complete a mathematics anxiety scale and a statistics anxiety scale sometime during your course work.
    - There will also be a demographic page to complete which will include gender, age, graduate level (undergraduate or graduate), your major course of study, type of statistics course instruction (online or face-to-face), number of high school and college-level courses taken from the math department and number of months/years since last mathematics and statistics course taken.
    - This is a completely voluntary, non-experimental design.
    - Your course professor can answer any questions you may have at any time during this study or forward your questions to the researcher.
3. **POSSIBLE RISKS OR DISCOMFORT**

- The minimal risk to you is loss of time.
- This study is not a part of your statistics course and will not affect your grade in any way, whether you participate or not.
- Typical psychological burden from completing the assessments, such as answering questions related to mathematics anxiety and statistics anxiety, may affect your mood.

4. OWNERSHIP AND DOCUMENTATION OF SPECIMENS

- All assessment data will be stored on a secure flash drive and kept in the principal researcher's office, in a locked file box, for five years and then destroyed.

5. POSSIBLE BENEFITS

- The results of this research may benefit future students taking statistics courses. Professors in non-mathematics and statistics courses may be able to introduce general concepts and terminology of statistics prior to taking the required statistics course. Providing students more experience with mathematics and statistics may alleviate statistics anxiety and increase student success.

6. FINANCIAL CONSIDERATIONS

- There is no financial compensation for your participation in this research study.
- After the completion of mathematics anxiety scale and statistics anxiety scale, you are eligible to enter a drawing for one of six $25 Amazon gift cards by providing your email address, if you choose.

7. CONFIDENTIALITY

- Your identity in this study will be treated as confidential. The results of this study, including data, may be published for scientific purposes but will not give your name or include any identifiable references to you.
- However, any records or data obtained as a result of your participation in this study may be inspected by the sponsor, by any relevant governmental agency (e.g., U.S. Department of Education), by the George Fox University Institutional Review Board, or by the persons conducting this study, providing that such inspectors are legally obliged to protect any identifiable information from public disclosure, except where disclosure is otherwise required by law or a court of competent jurisdiction. These records will be kept private in so far as permitted by law.

8. TERMINATION OF RESEARCH STUDY

- You have the right to refuse to participate in this study or to withdraw at any time without loss of any benefits for which you are already eligible, up until results are published.

9. AVAILABLE SOURCES OF INFORMATION

- Any further questions you have about this study will be answered by the Principal Investigator:

  Name: Kelly McIntyre
  Phone Number: 808-927-1856

- Any questions you may have about your rights as a research subject will be answered by:

Name: Kelly McIntyre
email: kmcintyre15@georgefox.edu
Phone Number: 808-927-1856

Or

Dane Joseph, PhD
email: djoseph@georgefox.edu
Phone Number: 503-554-2855

10. AUTHORIZATION

I have read and understand this consent form, and I volunteer to participate in this research study. I understand that I will receive a copy of this form. I voluntarily choose to participate, but I understand that my consent does not take away any legal rights in the case of negligence or other legal fault of anyone who is involved in this study. I further understand that nothing in this consent form is intended to replace any applicable Federal, state, or local laws.

Participant Name (Printed or Typed):
Date:

Participant Signature:
Date:

Principal Investigator Signature:
Date:

Signature of Person Obtaining Consent:
Date:

Appendix B

Quantitative Survey

Quantitative Anxiety

1. What is your gender?

- Male
- Female

2. What is your age?

- 18-24
- 25-34
- 35-44
- 45-54
- 55-64
- 65+

3. What is your graduate level?

- Undergraduate
- Graduate

4. What is your major course of study?

5. What type of instruction does this statistics course use?

- Online
- Face-to-face
- Both online and face-to-face

6. How many total high school and college level course have you taken from the math department?

- 3-4
- 5-6
- 7-8
- 9-10
- 11-12
- 13 or more

7. When was your last mathematics or statistics course, prior to this one?
Please provide approximate month and year.

8. What is your most memorable experience with mathematics or statistics?

Quantitative Anxiety

9. Determine the level of anxiety associated with each item.

	not at all	a little	a fair amount	much	very much
Studying for a math test	○	○	○	○	○
Taking math section of college entrance exam	○	○	○	○	○
Taking an exam (quiz) in a math course	○	○	○	○	○
Taking an exam (final) in a math course	○	○	○	○	○
Picking up math textbook to begin working on a homework assignment	○	○	○	○	○
Being given homework assignments of many difficult problems that are due the next class meeting	○	○	○	○	○
Thinking about an upcoming math test 1 **week** before	○	○	○	○	○
Thinking about an upcoming math test 1 **day** before	○	○	○	○	○
Thinking about an upcoming math test 1 **hour** before	○	○	○	○	○
Realizing you have to take a certain number of math classes to fulfill requirements	○	○	○	○	○
Picking up math textbook to begin a difficult reading assignment	○	○	○	○	○
Receiving your final math grade in the mail	○	○	○	○	○
Opening a math or stats book and seeing a page full of problems	○	○	○	○	○
Getting ready to study for a math test	○	○	○	○	○

	not at all	a little	a fair amount	much	very much
Being given a "pop" quiz in a math class	◯	◯	◯	◯	◯
Reading a cash register receipt after your purchase	◯	◯	◯	◯	◯
Being given a set of numerical problems involving addition to solve on paper	◯	◯	◯	◯	◯
Being given a set of subtraction problems to solve	◯	◯	◯	◯	◯
Being given a set of multiplication problems to solve	◯	◯	◯	◯	◯
Being given a set of division problems to solve	◯	◯	◯	◯	◯
Buying a math book	◯	◯	◯	◯	◯
Watching a teacher work on an algebraic equation on the blackboard	◯	◯	◯	◯	◯
Signing up for a math course	◯	◯	◯	◯	◯
Listening to another student explain a math formula	◯	◯	◯	◯	◯
Walking into a math class	◯	◯	◯	◯	◯

Quantitative Anxiety

10. Determine the level of anxiety associated with each item.

	not at all	a little	a fair amount	much	very much
Studying for an examination in a statistics course.	○	○	○	○	○
Interpreting the meaning of a table in a journal article.	○	○	○	○	○
Going to ask my statistics teacher for individual help with material I am having difficulty understanding.	○	○	○	○	○
Realizing the day before an exam that I cannot do some problems that I thought were going to be easy.	○	○	○	○	○
Asking a private teacher to explain a topic that I have not understood at all.	○	○	○	○	○
Reading a journal article that includes some statistical analyses.	○	○	○	○	○
Asking the teacher how to use a probability table.	○	○	○	○	○
Trying to understand a mathematical demonstration.	○	○	○	○	○
Doing the final examination in a statistics course.	○	○	○	○	○
Reading an advertisement for an automobile which includes figures on gas mileage, compliance with population regulations, etc.	○	○	○	○	○
Walking into the classroom to take a statistics test.	○	○	○	○	○

	not at all	a little	a fair amount	much	very much
Asking the teacher about how to do an exercise.	○	○	○	○	○
Getting to the day before an exam without having had time to revise the syllabus.	○	○	○	○	○
Waking up in the morning on the day of a statistics test.	○	○	○	○	○
Realizing, just before you go into the exam, that I have not prepared a particular exercise.	○	○	○	○	○
Copying a mathematical demonstration from the blackboard while the teacher is explaining it.	○	○	○	○	○
Asking one of your teachers for help in understanding a printout.	○	○	○	○	○
Trying to understand the odds in a lottery.	○	○	○	○	○
Seeing a classmate carefully studying the results table of a problem he has solved.	○	○	○	○	○
Going to a statistics exam without having had enough time to revise.	○	○	○	○	○
Asking a teacher for help when trying to interpret a results table.	○	○	○	○	○
Trying to understand the statistical analyses described in the abstract of a journal article.	○	○	○	○	○
Going to the teacher's office to ask questions.	○	○	○	○	○
Asking a private teacher to tell me how to do an exercise.	○	○	○	○	○

Appendix C

Assumptions

Figure C1

Mathematics Test Anxiety Distribution Histogram

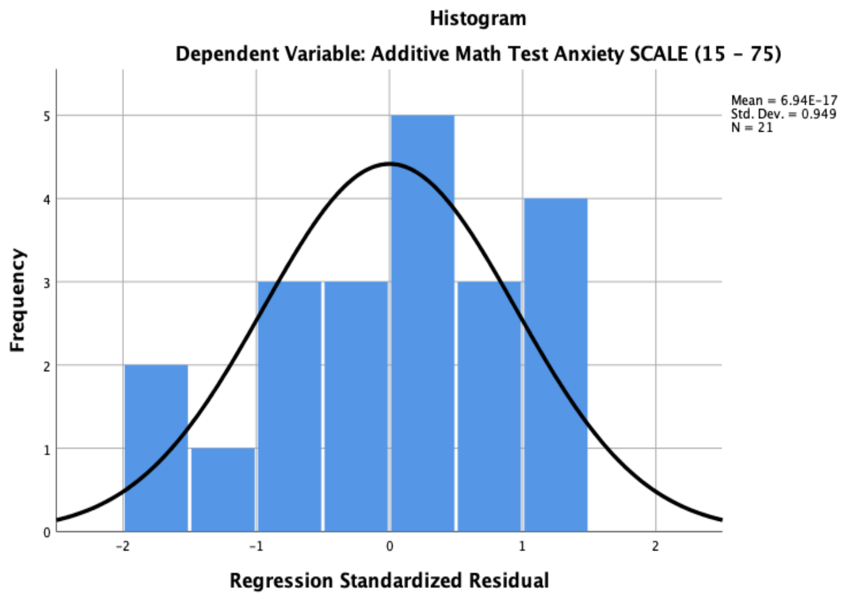

Figure 2

Numerical Task Anxiety Distribution Histogram

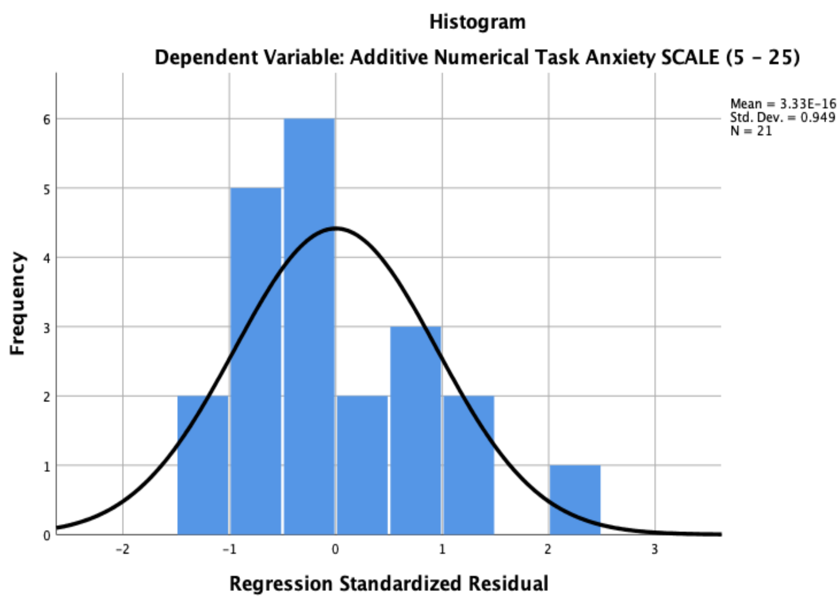

Figure C3

Mathematics Course Anxiety Distribution Histogram

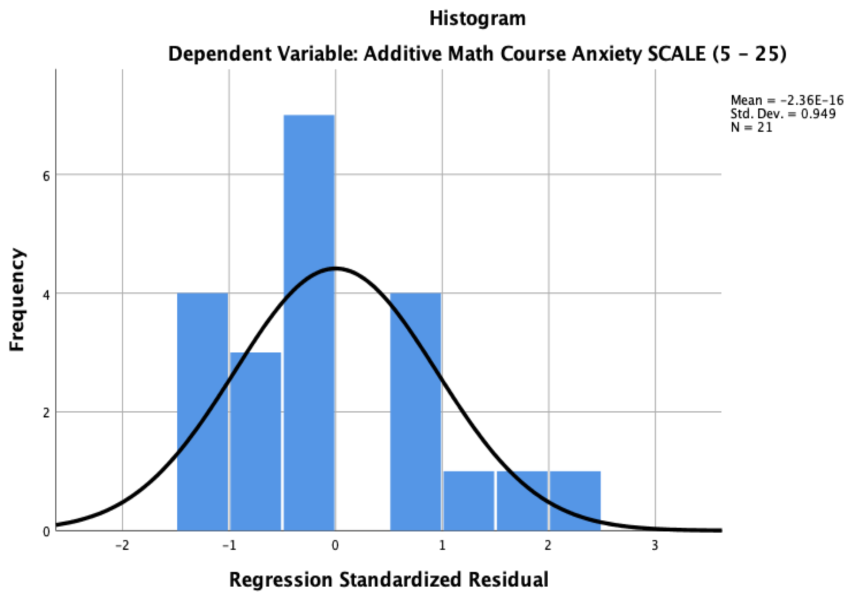

Figure C4

Statistics Class Test Anxiety Distribution Histogram

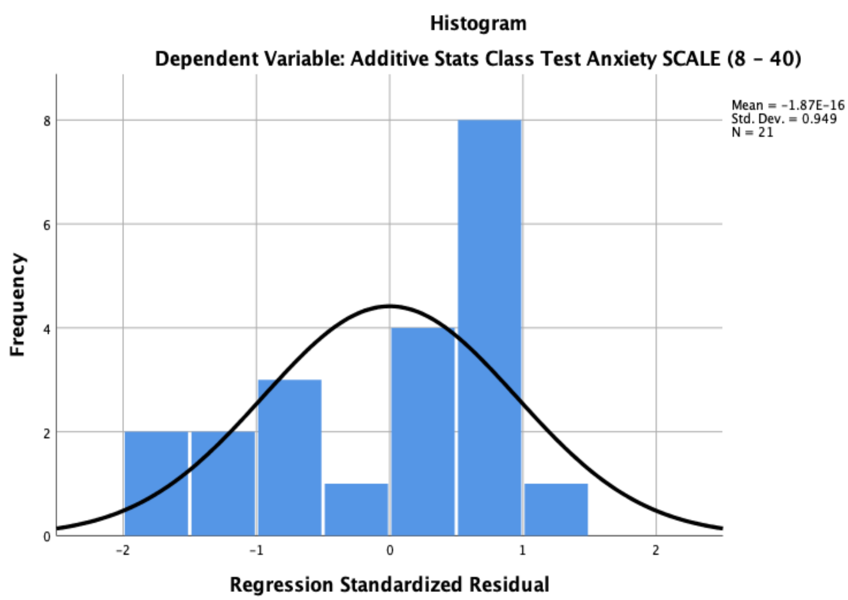

Figure C5

Statistics Interpreting Anxiety Distribution Histogram

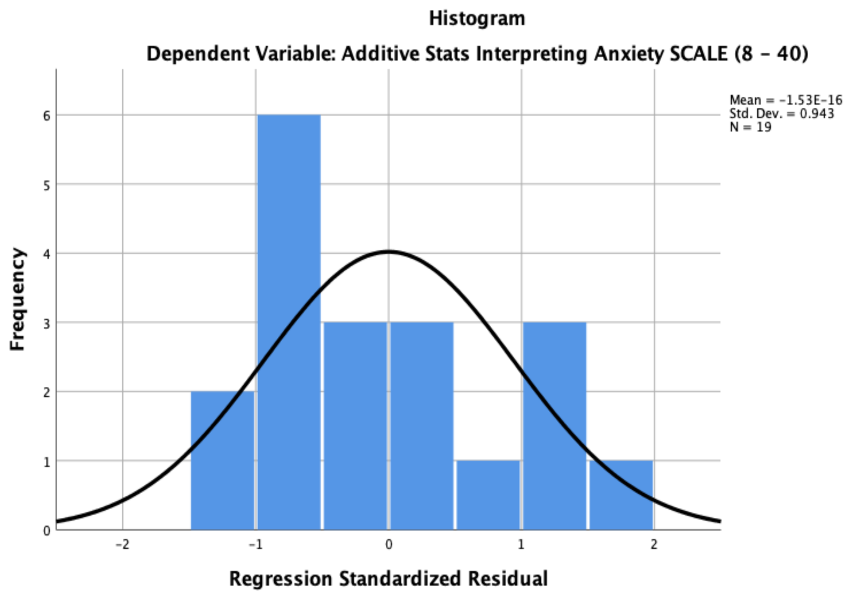

Figure C6

Statistics Asking for Help Anxiety Distribution Histogram

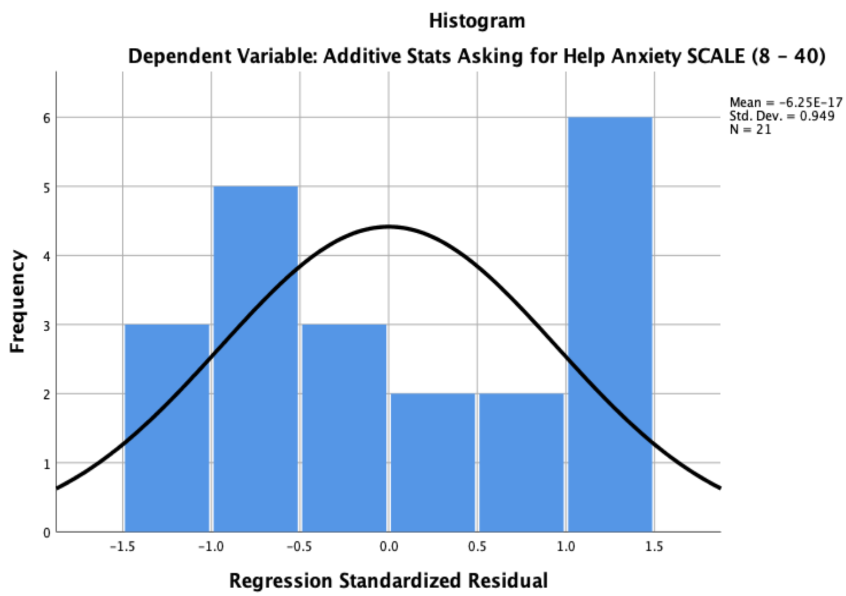

Figure C7

Mathematics Test Anxiety Normal P-P Plot

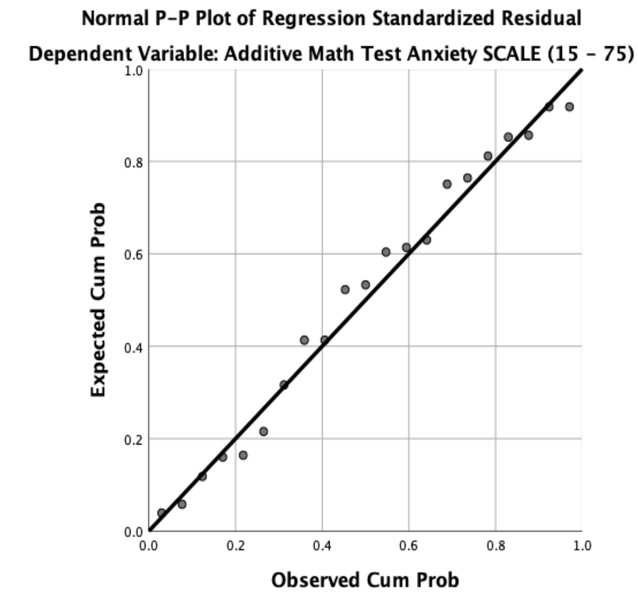

Figure C8

Numerical Task Anxiety Normal P-P Plot

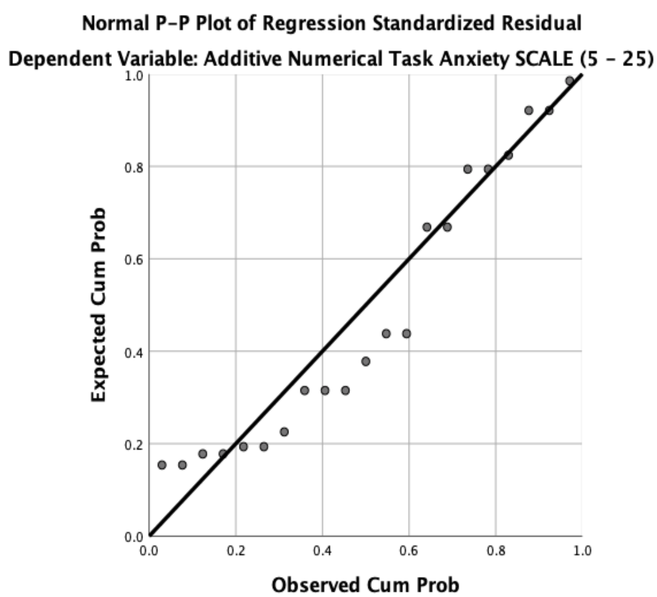

Figure C9

Mathematics Course Anxiety Normal P-P Plot

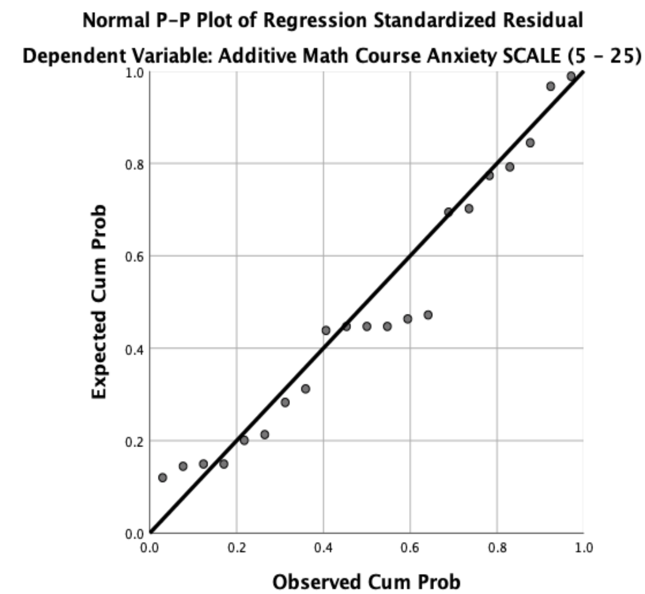

Figure C10

Statistics Class Test Anxiety Normal P-P Plot

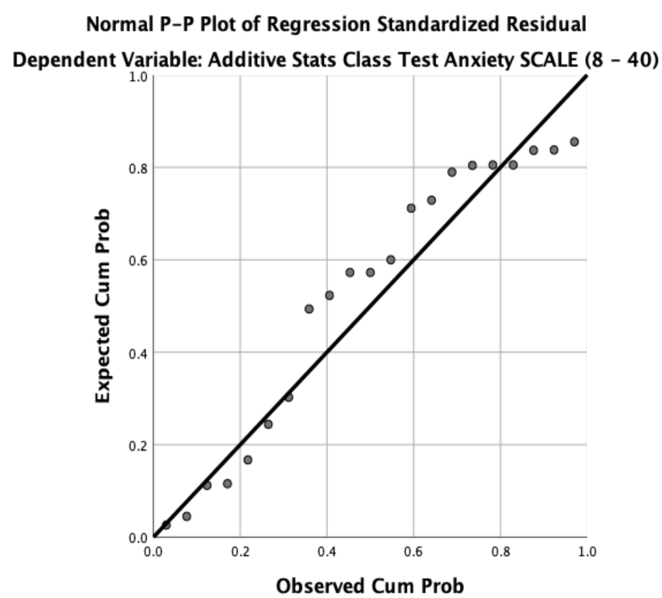

Figure C11

Statistics Interpreting Anxiety Normal P-P Plot

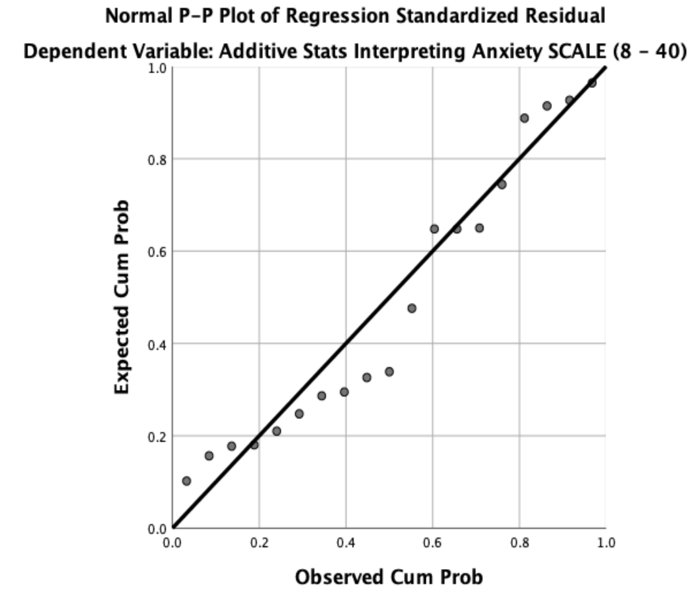

Figure C12

Statistics Asking for Help Anxiety Normal P-P Plot

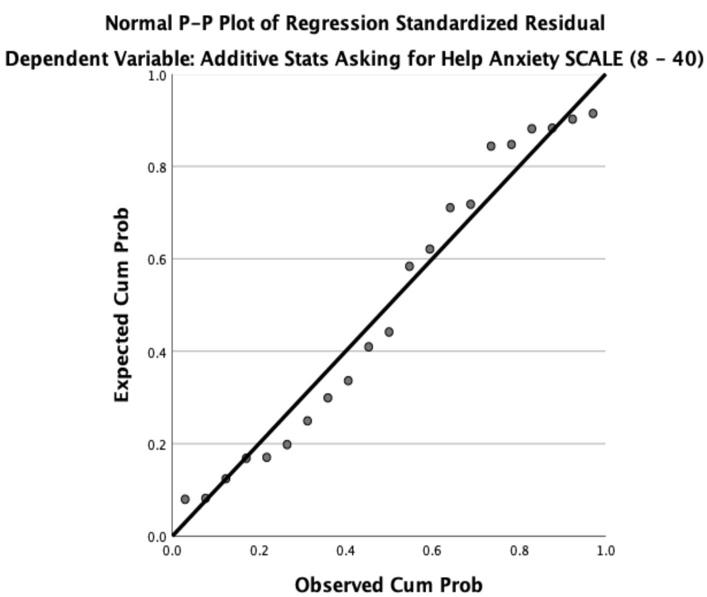

Figure C13

Mathematics Test Anxiety Scatterplot

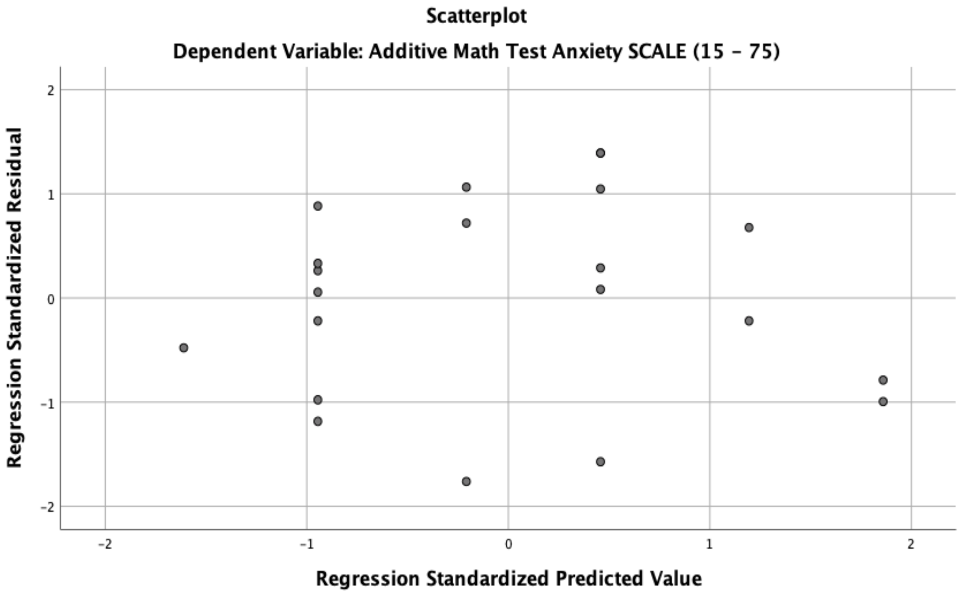

Figure C14

Numerical Task Anxiety Scatterplot

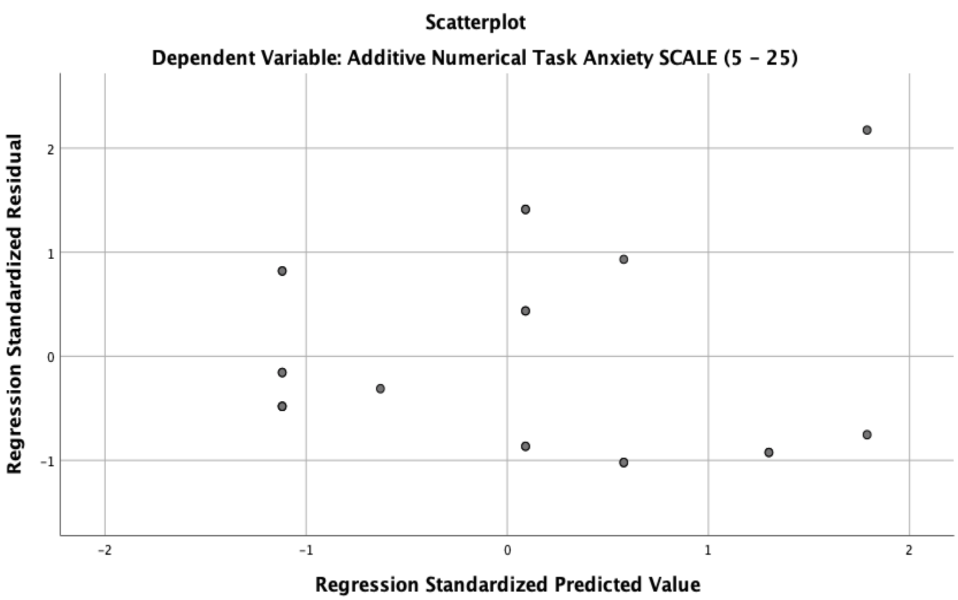

Figure C15

Mathematics Course Anxiety Scatterplot

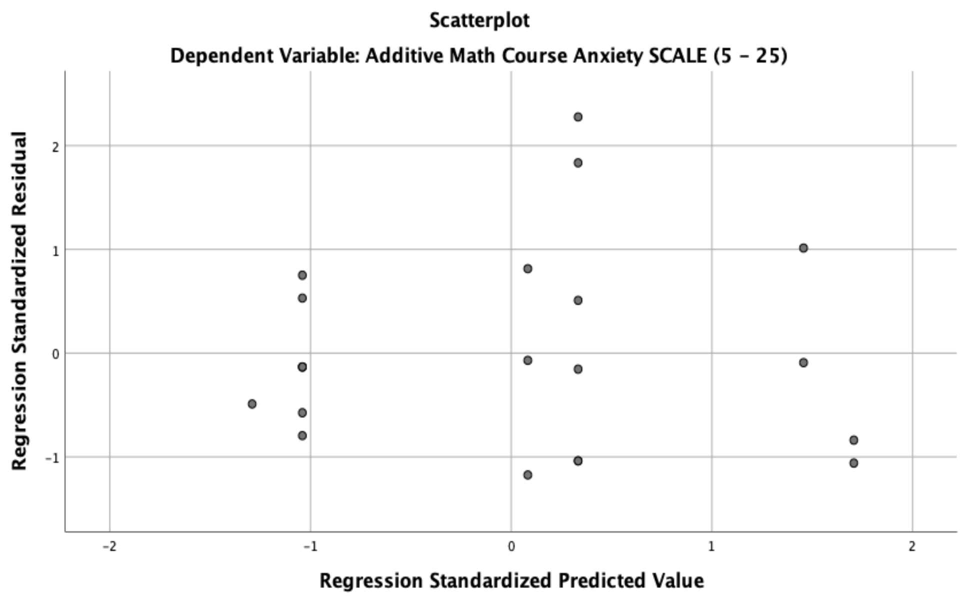

Figure C16

Statistics Class Test Anxiety Scatterplot

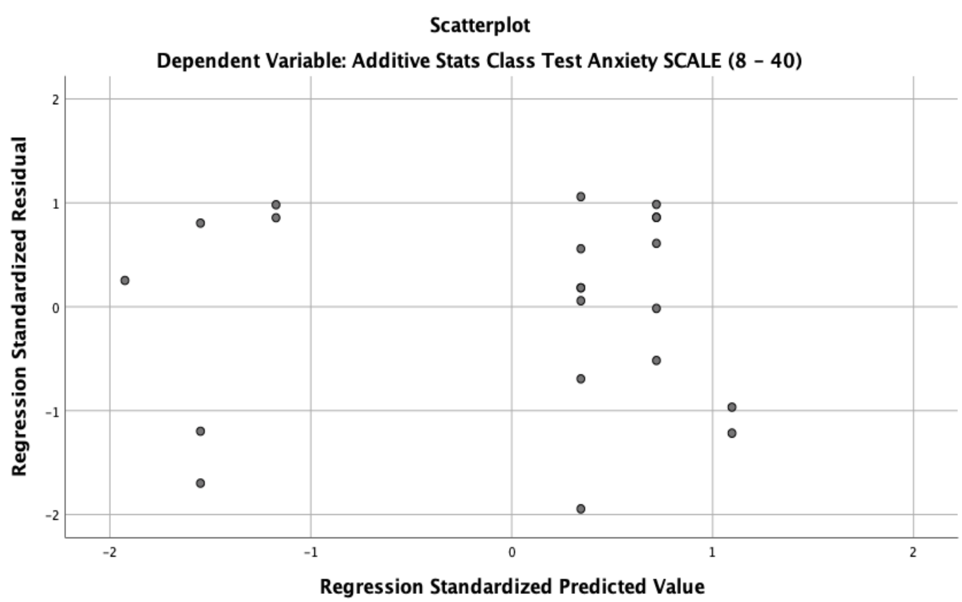

Figure C17

Statistics Interpreting Anxiety Scatterplot

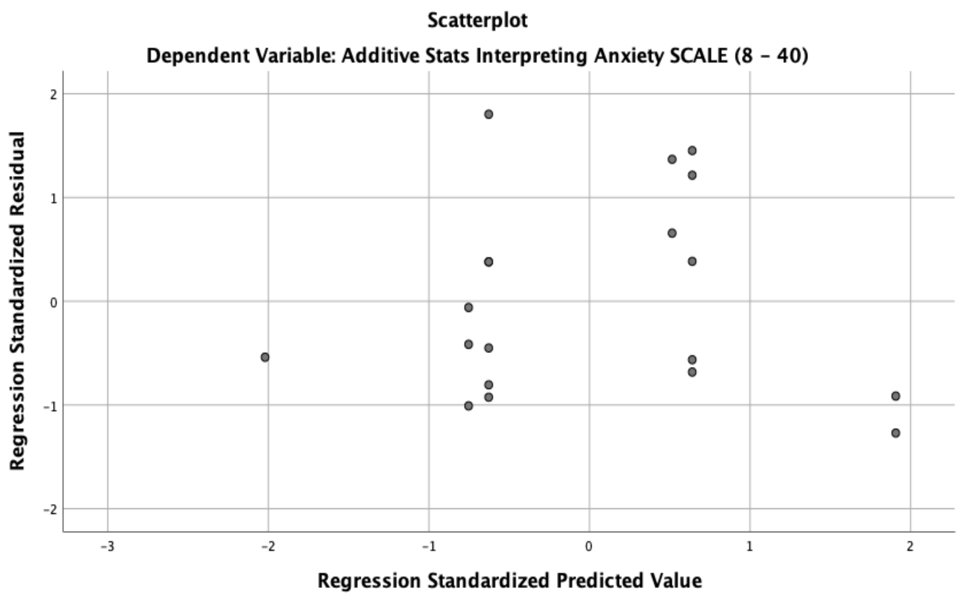

Figure C18

Statistics Asking for Help Anxiety Scatterplot