ABSTRACT

PREDICTORS OF STATISTICS ANXIETY AMONG
GRADUATE STUDENTS IN SAUDI ARABIA

by

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ABSTRACT OF GRADUATE STUDENT RESEARCH

Dissertation

Andrews University

College of Education and International Services

Title: PREDICTORS OF STATISTICS ANXIETY AMONG GRADUATE STUDENTS IN SAUDI ARABIA

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Date completed: May 2023

Problem

The problem addressed in this study is the anxiety experienced by graduate students toward statistics courses, which often causes students to delay taking statistics courses until the end of their program. Students believe that statistics courses are not essential and are the greatest obstacles to obtaining their degree. Previous theoretical models have focused on predicting student performance in statistics. However, this study aims to identify specific factors that could decrease student statistics anxiety and enhance positive attitudes and self-efficacy toward statistics. The study developed a conceptual model to predict statistics anxiety among graduate students in educational and social science majors in Saudi Arabia, which should improve the quality of statistics education in higher education.

Method

A cross-sectional non-experimental survey design was employed to collect data during the Spring of 2022 from 356 graduate students in Saudi Arabia. Participants completed a self-report survey measuring their (a) demographic information, (b) statistics anxiety (SAS), (c) attitudes toward statistics (SATS), and (d) current statistics self-efficacy (CSSE). The dependent variable was statistics anxiety, while the independent variables were previous statistics experience, attitudes toward statistics, and statistics self-efficacy. Data analyses included descriptive statistics and structural equation modeling (SEM) to evaluate the relationship among the study variables, while a multigroup analysis was used to examine gender differences in the study model.

Results

The study indicated that the participants reported a moderate level of statistics anxiety and positive attitudes toward statistics, and a low to moderate level of statistics self-efficacy. Results also found that attitudes toward statistics were negatively associated with statistics anxiety, but previous statistics experience positively predicted attitudes toward statistics and current statistics self-efficacy. Mediation analysis revealed that attitudes toward statistics significantly mediated the relationship between previous statistics experience and statistics anxiety. A multi-group analysis showed that the research model was equally applicable to males and females and no significant gender differences were observed at the individual path level.

Conclusions

The present study investigated the relationship among previous statistics experience, attitudes toward statistics, statistics self-efficacy, and statistics anxiety among

graduate students in Saudi Arabia. The findings suggest that positive previous statistics experience and attitudes toward statistics can account for reducing students' statistics anxiety. Results have important implications for educators and counselors who work with students experiencing statistics anxiety, such as promising positive attitudes toward statistics and enhancing students' experience with mathematics and statistics.

Andrews University

College of Education and International Services

PREDICTORS OF STATISTICS ANXIETY AMONG GRADUATE STUDENTS IN SAUDI ARABIA

A Dissertation

Presented in Partial Fulfillment

of the Requirements for the Degree

Doctor of Philosophy

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APPROVAL BY THE COMMITTEE:

Chair: Nadia Nosworthy	Dean, College of Education and International Services Alayne Thorpe
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DEDICATION

This work is dedicated to all those who watched me grow and supported me to make my dream come true. I owe my achievement to them and could never express my gratitude enough for the countless sacrifices they have made for me.

To my great father, words cannot fully express my gratitude for all that you have done for me. Your love, prayers, and guidance have made me the woman I am today. Thank you for being the best father a daughter could ask for.

To my lovely mother, I am beyond grateful for your unconditional love, endless prayers, and tireless support throughout my journey. Your selflessness in my success has inspired me beyond words. Without you, I would not be where I am today.

To my brother, Rafat, your love, kindness, and support have made all the difference in my life, and I cannot thank you enough for everything you have done for me. Thank you for being my rock and inspiration.

To my sister, Dania, your love and support have been a guiding light in my journey. I am forever grateful for your presence in my life. Thank you for being my biggest cheerleader and my source of strength.

To all of you, I love you and will never forget your contributions.

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LIST OF ABBREVIATIONS

ATS	Attitudes Toward Statistics
CFA	Confirmatory Factor Analysis
CSSE	Current Statistics Self-Efficacy Scale
EFL	English as a Foreign Language
MARS	Math Anxiety Rating Scale
SA	Statistics Anxiety
SAS	Statistical Anxiety Scale (Vigil-Colet et al., 2008)
SATS-28	Survey of Attitudes Toward Statistics (Schau et al., 1995)
SCT	Social Cognitive Theory
SEM	Structural Equation Modeling
SLT	Social Learning Theory
SPSS 26.0	Statistical Program for the Social Sciences
SSE	Statistics Self-Efficacy
STARS	Statistical Anxiety Rating Scale

ACKNOWLEDGEMENTS

I am thrilled to have achieved my dream through unwavering faith, solid skills, and the courage to spread my message. Countless blessings from Allah have surrounded me during my Ph.D. journey. I sincerely thank Allah for granting me the strength, motivation, guidance, and success to accomplish this endeavor.

I extend my most profound appreciation and perpetual gratitude to my parents, the constant source of generosity whose unfailing love, encouragement, and prayers have been with me every step of my life. I thank my brother and sister for their continuous inspiration and emotional support.

I am grateful to the GPC family and my dissertation committee for their invaluable knowledge, support, and encouragement. I express my heartfelt thanks to my advisor and dissertation chair, Dr. Nadia, for your guidance, support, and confidence in me throughout my academic journey, especially during those moments when I felt discouraged. The process would have been much more difficult without your patience and understanding. I also express my deepest gratitude to my methodologist, Dr. Kijai, who supported me in my first conference presentation and thought highly of me as a researcher. Your guidance, support, and inspiration were instrumental in my success. I am grateful for the time and energy you invested in my research, and I will never forget your impact on my academic life. Lastly, I thank Dr. Gabriel for embracing my research topic and encouraging my ideas even in their infancy. Thank you for imparting your knowledge, wisdom, and passion to me and pushing me to be the best version of myself.

I thank all my colleagues who cooperated with me during data collection. Finally, I would like to express my deepest gratitude to my friends, who kept me in their prayers and supported me emotionally on my journey, especially Dr. Ayat. Your presence in my life has been invaluable, and I will always cherish our shared memories.

Finally, for all those who have played a role in my journey, including other family members, mentors, and role models. Your support and influence have significantly impacted my life and helped me achieve my goals.

CHAPTER 1

INTRODUCTION

General Introduction

Statistics plays a crucial role in many aspects of life that require analysis, interpretation of findings, and using numbers (Alizamar et al., 2019). Therefore, it is included in curricula from primary school through higher education. As a result, academic performance in statistics is an important area of research in education.

In higher education, having strong statistical skills is a crucial competency that involves understanding statistical tables, managing data, using appropriate statistical tests to analyze data, and interpreting findings (Chew & Dillon, 2014c; Koh & Zawi, 2014). As a result, graduate students in multiple disciplines require adequate fundamental statistical knowledge to complete their degree (Koh & Zawi, 2014; O'Bryant, 2017). Understanding and conducting quantitative research is also crucial for students who plan to continue as researchers after graduation (Chew & Dillon, 2014c; Koh & Zawi, 2014).

Moreover, in today's job market, there is a growing demand for statistical experience across various careers and agencies (Onwuegbuzie & Wilson, 2003). Consequently, most graduate programs in social and educational sciences require at least one statistics course as a core component to help students acquire the necessary statistical skills (Chew & Dillon, 2014b; Koh & Zawi, 2014).

Despite the importance of statistical skills in graduate studies, students often lack confidence in working with statistics and perceive it as the most anxiety-provoking

subject in their academic major (Ali, 2020; Chew & Dillon, 2014b; DeVaney, 2016; Male & Lumbantoruan, 2021). For example, graduate students in educational sciences, in particular, have identified statistics as one of the most apprehensive, troubling, stressful, and least understandable classes in their academic programs (Baloğlu, 2003; Dykeman, 2011).

Statistics anxiety is a critical trigger of attrition in statistics and graduate programs, directly and indirectly affecting students' achievement (Dykeman, 2011; Koh & Zawi, 2014; Macher et al., 2013; Onwuegbuzie & Wilson, 2003; Supsopha, 2008). Students with statistics anxiety have lower academic performance than students who are not experiencing it. According to Onwuegbuzie (2004), approximately 80% of graduate students obstruct their statistics performance due to statistics anxiety. Consequently, these students have a higher chance of dropping out of school or taking an unnecessarily long time to graduate (De Vink, 2017; Philips et al., 2003; Steinberger, 2020).

Several factors, such as previous statistics knowledge, self-beliefs, and attitudes toward statisticas skills, have been found to predict statistics anxiety (Emmioğlu & Capa-Aydin, 2012; Faber & Drexler, 2019). Previous experience and statistical background of students are significant factors that contribute to statistics anxiety. Studies have found that students may struggle with understanding statistical content if they lack a mathematical or statistical background. Thus, students who have limited statistics backgrounds tend to display negative reactions toward statistics and demonstrate low statistical competency, resulting in higher levels of statistics anxiety (Chiesi & Primi, 2010; Faber & Drexler, 2019; González et al., 2016; Slootmaeckers et al., 2014). Previous experience with statistics also plays a vital role in shaping student attitudes, self-

efficacy, and motivation toward the subject. This highlights the importance of having a solid foundation in statistics to avoid potential difficulties and reduce the risk of experiencing statistics anxiety (Dempster & McCorry, 2009; Slootmaeckers et al., 2014; Waples, 2016).

Attitudes toward statistics also play a crucial role in student performance in statistics courses, reflecting their beliefs, feelings, and previous experiences regarding these classes (Haddock & Maio, 2004; Perepiczka et al., 2011). For example, graduate students often view statistics courses as overwhelming, impossible to navigate, and lacking a clear understanding of their relevance to their future careers. As a result, many students develop negative attitudes toward statistics, which leads to statistics anxiety (Pan & Tang, 2004).

Self-efficacy, which is individual confidence in their ability to perform a particular task, is a crucial factor in developing statistics anxiety among students. When students lack confidence in their statistical skills or ability to conduct research, they may experience anxiety with statistical tasks or research-related assignments (Schneider, 2011).

Additionally, research has investigated gender differences in statistics anxiety, with some studies finding varying levels of anxiety between males and females, while others have found no significant differences (Alizamar et al., 2019; Macher et al., 2013).

In conclusion, factors that contribute to statistics anxiety can be complex, and each one may have a different impact on a student's statistical performance (Chiesi & Primi, 2010; Faber & Drexler, 2019; González et al., 2016; Sesé Abad et al., 2015). While many studies have investigated the relationships among student previous statistics

experience, attitudes toward statistics, self-efficacy, and statistics anxiety (Dempster & McCorry, 2009; Perepiczka et al., 2011; Waples, 2016), there is relatively little research that examines the complex relationships and mediating effects among these variables, particularly among graduate students in Saudi Arabia

Rationale for the Study

Causal relationships among variables that predict statistics anxiety have been studied; however, these studies have been limited to analyzing these variables separately. In addition, while statistics anxiety has been studied as a universal problem across many cultures (Macher et al., 2012), this study targeted graduate students in Saudi Arabia. Thus, this study addressed this gap and provided a base for additional research on statistics anxiety and further validation of the Statistics Anxiety Scale. Furthermore, the results of this study are not generalizable to other populations and, therefore, contribute to the understanding of statistics anxiety among Saudi Arabian graduate students.

Statement of the Problem

A statistics course is one of the most thought-provoking mandatory courses for graduate students, especially in educational and social sciences programs. Many graduate students do not believe statistics is an important course, and often consider the course an obstacle to achieving their degree (Dykeman, 2011; Koh & Zawi, 2014). Therefore, students experience anxiety about statistics and often delay taking their statistics course(s) until the end of their program, often just before graduation (Ali, 2020; Chau, 2018; Chew & Dillon, 2014c; Macher et al., 2013).

Most theoretical models of statistics anxiety focused on predicting student performance in statistics courses. The goal here is to conceptualize and test empirically a

model identifying specific factors which could decrease student statistics anxiety while enhancing positive attitudes toward statistics and strong self-efficacy. A conceptual model was developed involving statistics anxiety and other variables, focusing on the extent to which independent variables predict statistics anxiety among graduate students in educational and social science majors. This model should improve the quality of studying and teaching statistics in higher education.

The Purpose of the Study

The purpose of this study was to develop and test a model that predicts statistics anxiety among graduate students by analyzing the impact of several factors, including previous statistics experience, attitudes toward statistics, and statistics self-efficacy. In addition, the study aimed to examine the gender differences in the conceptualized model of statistics anxiety among graduate students in colleges of educational and social sciences who are taking statistics courses as part of their academic programs at at Umm Al-Qura and King Abdul-Aziz University in Saudi Arabia.

Research Questions

This study investigated factors predicting statistics anxiety among graduate students and tested the hypotheses proposed in the theoretical model. Specifically, the study sought to answer the following research questions:

1. What are the levels of statistics anxiety, attitude toward statistics, and statistics self-efficacy among graduate students at Umm Al-Qura and King Abdul-Aziz University in Saudi Arabia?

2. To what extent do previous statistics experience, attitudes toward statistics, and current statistics self-efficacy explain statistics anxiety among graduate students at Umm Al-Qura and King Abdul-Aziz University in Saudi Arabia?
3. Do attitudes toward statistics and current statistics self-efficacy mediate the relationships between previous statistics experience and statistics anxiety among graduate students at Umm Al-Qura and King Abdul-Aziz University in Saudi Arabia?
4. Are there any gender differences in the conceptualized model of statistics anxiety among graduate students at Umm Al-Qura and King Abdul-Aziz University in Saudi Arabia?

Conceptual Framework

This conceptual framework provided foundation for investigating the complex nature of statistics anxiety and underlying antecedents and factors. Statistics anxiety is a persistent and habitual fear that arises from exposure to statistical content, problems, and situations, as evidenced by previous research (Cruise et al., 1985; Onwuegbuzie, 2004; Onwuegbuzie & Daley, 1999). Antecedents of statistics anxiety can be classified into dispositional, environmental, and situational factors (Cui et al., 2019). The dispositional antecedents include experiences associated with statistics classes or related classes in similar domains, such as math experience, while attitude toward statistics is a critical situational antecedent. Negative attitudes toward statistics predict higher levels of statistics anxiety and lower performance (Ferla et al., 2010). Student statistical self-efficacy is another dispositional antecedent that is negatively correlated with statistics anxiety. Students with higher self-efficacy invest more time and effort in studying and

have lower levels of statistics anxiety (Baloğlu et al., 2017; Condron et al., 2018; Finney & Schraw, 2003; Ogbogo & Amadi, 2018; Peixoto & Almeida, 2010). Environmental factors such as gender, age, and ethnicity can influence students' statistics anxiety before taking a statistics class (Luttenberger et al., 2018; Onwuegbuzie et al., 1997). Gender is a commonly studied factor of statistics anxiety, with several studies finding that females report higher levels of statistics anxiety than males (Alizamar et al., 2019; Rodarte-Luna & Sherry, 2008). However, there are conflicting findings, with some studies suggesting that males may have higher numerical anxiety (Baloğlu & Kocak, 2006). In general, student statistics anxiety can be predicted by multiple factors related to the three antecedents of anxiety and can be reduced by modifying factors such as student attitudes toward statistics, self-efficacy, and previous experience with statistics.

Previous Experience and Statistics Anxiety

Previous statistics knowledge and math experience are important factors in determining a student's level of statistics anxiety. Studies have shown that students with a background in statistics and math experience tend to have lower levels of statistics anxiety than those with little to no previous experience (Baloğlu, 2003; Slootmaeckers et al., 2014; Zhang et al., 2012). This suggests that having a solid foundation in statistics and math can help reduce anxiety and increase confidence in dealing with statistical tasks and exams.

Attitudes Toward Statistics and Statistics Anxiety

Statistics anxiety is strongly associated with attitudes toward statistics, as demonstrated in several studies. Specifically, a negative correlation has been observed between statistics anxiety and attitudes toward statistics, indicating that as attitudes

toward statistics become more positive, levels of statistics anxiety tend to decrease. On the other hand, when students hold positive attitudes toward statistics, they are more likely to experience low levels of statistics anxiety (Chiesi et al., 2011; Macher et al., 2015; Najmi et al., 2018; Rosli et al., 2017).

Statistics Self-Efficacy and Statistics Anxiety

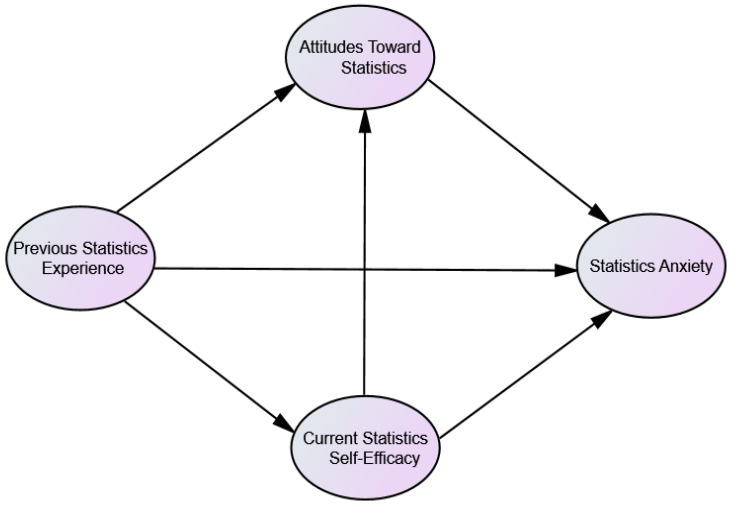
Research has shown a negative association between self-efficacy and statistics anxiety (Chang & Beilock, 2016; Finney & Schraw, 2003; McMullan et al., 2010; Schneider, 2011). High levels of self-efficacy lead to confidence in performing statistics tasks and exams successfully (Ban, 2019; Finney & Schraw, 2003; Zare et al., 2011), thereby reducing or eliminating statistics anxiety. Statistics self-efficacy is, therefore, an essential factor in determining whether a student experiences low or no statistics anxiety (Schneider, 2011).

Previous Statistics Experience, Attitudes Toward Statistics, Statistics Self-Efficacy and Statistics Anxiety

Previous statistics experience, attitudes toward statistics, and statistics self-efficacy contribute to statistics anxiety in college students. Students with less math and quantitative knowledge are more likely to have negative attitudes toward statistics and experience higher levels of statistics anxiety (Bechrakis et al., 2011; Levpušček & Cukon, 2020; Marchis, 2011). Additionally, students with low statistics skills are less confident in their ability to complete statistics tasks, which further contributes to their statistics anxiety (DeCesare, 2007; Dempster & McCorry, 2009; Slootmaeckers et al., 2014). These factors, combined with low statistical literacy levels, increase statistics anxiety in students (Luttenberger et al., 2018; Schneider, 2011; Zeidner, 1991). Figure 1 provides a conceptual model of these relationships.

Figure 1

The Conceptual Model



Significance of the Study

This study has potential to contribute to the understanding of factors that predict statistics anxiety among graduate students in Saudi Arabia. The results of this study may help inform statistics instructors and school administrators in developing strategies to reduce students' statistics anxiety and improve their performance in statistics courses. Additionally, this study may provide a basis for further research on statistics anxiety in different populations and contribute to validating the Statistics Anxiety Scale (SAS) in the Saudi Arabian context. Finally, the study's findings may have implications for researchers interested in exploring the relationships among other variables predicting statistics anxiety.

Delimitations

In this study, the following delimitations were set:

1. The study only included graduate students from two specific universities in Saudi Arabia, and the findings may not be generalizable to graduate students in other universities or other countries.
2. The study had a narrow focus on statistics anxiety and did not consider other aspects that could impact student performance in statistics courses, such as the teaching style of instructors, study habits, or motivation.
3. The study solely consisted of students who were currently registered in statistics courses and did not comprise those who had dropped out of the course or had already finished statistics courses in the past.
4. The study solely employed quantitative data collection methods without incorporating qualitative data or observing students' actual behavior in statistics courses.
5. The study only examined the relationship among certain predictor variables (previous statistics experience, attitudes toward statistics, and statistics self-efficacy) and statistics anxiety and did not include other potential predictor variables.

Limitations

Several limitations to this study were considered when interpreting the results:

1. The sample was limited to graduate students enrolled in colleges of educational and social sciences at two universities in Saudi Arabia, which may limit the generalizability of the findings to other populations or contexts.

2. The study relied on self-reported data, which may be subject to response bias or social desirability bias, potentially impacting the accuracy of the results.
3. The study used a cross-sectional design, which limits the ability to establish causal relationships among variables. Future studies with longitudinal designs could provide more insight into the temporal relationships between variables.
4. The study only examined a limited number of factors that may contribute to statistics anxiety, and there may be additional variables that were not considered in the conceptual model that could influence the development of statistics anxiety.

Definitions of Terms

Attitudes toward statistics: This term refers to "positive and negative feelings concerning statistics" (Sesé, 2015, p. 870). Attitudes toward statistics includes four components: "(a) affect—positive and negative feelings concerning statistics, (b) cognitive competence—attitudes about intellectual knowledge and skills when applied to statistics, (c) value—attitudes about the usefulness, relevance, and worth of statistics courses for students and their professional life; and (d) difficulty—attitudes about the difficulty of statistics as a subject" (Schau et al., 1995, p. 13-14).

Gender: In this study, gender refers to either of the two sexes (male and female).

Previous statistics experience: In this study, previous experience was assessed by the number of previous statistics courses taken and student undergraduate major.

***Self-efficacy*:** Refers to the "personal beliefs held by individuals that they possess the capacity to complete certain tasks in certain domains of functioning, under certain conditions" (Bandura, 1997, p. 23).

Statistics Self-Efficacy (SSE): Refers to the current growth of graduate student self-efficacy in a statistics course in which they are enrolled in during the current semester. It was defined as ‘‘confidence in one’s abilities to solve specific tasks related to statistics (Finney & Schraw, 2003, p.164).

Statistics Anxiety: refers to “anxiety that occurs as a result of encountering statistics in any form and at any level” (Chew & Dillon, 2014c, p. 199). Statistics anxiety includes three subscales: “(a) *Examination Anxiety*: refers to anxiety students suffer when taking statistics exams, (b) *Asking for Help Anxiety*: refers to anxiety students suffer when asking the course teacher, another student, or private teacher questions about statistics, (c) *Interpretation Anxiety*: refers to anxiety students suffer when they are required to interpret statistical data and understand the formulations used in statistics” (Vigil-Colet et al., 2008, p.176).

Summary

This chapter introduced the study and background of this study, stating the problem, the purpose of the study, the research questions, rationale of the study, the conceptual framework, delimitations, and limitations. The study terms were defined. The following chapters comprise a literature review, methodology, results, and discussion. Chapter 2 reviews relevant research studies, theoretical frameworks, and concepts related to the research topic. Chapter 3 describes the research design, sampling procedures, data collection methods, and data analysis techniques used. Chapter 4 presents the findings of the study, using statistical analyses to illustrate the results. Finally, Chapter 5 interprets the study results, relates them to the existing literature, and discusses their implications, while addressing any limitations and suggests areas for future research.

CHAPTER 2

LITERATURE REVIEW

Introduction

The purpose of this literature review is to critically evaluate the current research examining statistics anxiety among graduate students in statistics class settings and the influence of factors connected with statistics anxiety. Many studies have illustrated the impact of statistics anxiety on student achievement. The narrative investigation of how and which factors relate to students' performance in statistics provided precise insight into the impact of statistics anxiety on achievement. However, the variability in the scales designed to assess statistics anxiety obfuscates the precise criteria used to compare and synthesize findings across studies. Therefore, this literature review aims to identify the commonalities and differences in assessing statistics anxiety.

In addition, the literature review encompasses a comprehensive analysis of previous research on statistics anxiety among graduate students. This review considered studies that involve multiple populations, instruments, and limitations. By identifying the strengths and weaknesses in previous research, this study aimed to avoid potential drawbacks and limitations. Additionally, this review specifically focused on studies that provide insights into the population of graduate students, thereby narrowing the scope of research. Furthermore, the literature review analyzed peer-reviewed, research-based empirical journals.

The literature review aimed to compare the results of current and previous studies to provide a clearer understanding of the criteria used to determine correlations among statistics anxiety, previous statistics experience, attitudes toward statistics, and statistics self-efficacy. The review is organized into four main sections: (a) literature search strategies; (b) historical and theoretical overviews of statistics anxiety, attitudes toward statistics, and statistics self-efficacy; (c) the relationships among the research variables; and (d) an analysis and synthesis of the literature review.

Literature Search Strategies

The literature review relied on findings in previous research to determine the criteria for future studies regarding the influence of several factors on student statistics anxiety. The literature review is organized to include several categories. Examining how statistics anxiety is directly and indirectly influenced by several factors, this study drew from previous research proposing various theories on the topic. The literature includes previous research sourced through several online databases, such as ERIC, EBSCOhost, PubMed, and Google Scholar based on the following primary search terms: statistics anxiety, attitudes toward statistics, statistics self-efficacy, statistics achievement, gender differences in statistics anxiety, predictors of statistics anxiety, and relationship between statistics anxiety and other predictor variables. A more advanced search then used keywords such as "statistics anxiety in graduate students." Irrelevant and duplicate research was eliminated, while the relevant research was searched manually for other references of interest.

The criterion used to build this review was the relevance of the research topic to the specific focus of this study—statistics anxiety. Therefore, the literature review

selected peer-reviewed literature targeting undergraduate and graduate students in academic settings.

Statistics Anxiety

A Brief Historical Overview

The concept of anxiety is complex and can be defined in different ways. According to the *Diagnostic and Statistical Manual of Mental Disorders* (DSM-5), anxiety disorders are described as "a group of mental disorders characterized by feelings of anxiety and fear where anxiety is a worry about future events and fear is a reaction to current events" (p. 210). In addition, Strawderman (1985) defined anxiety as "a complex reaction that is a transitory condition of the organism that varies in intensity and fluctuates overtime" (p. 21), while Vitasari et al. (2010) declared that anxiety is "a psychological and physiological response to threat" (p. 190).

The concept of anxiety is characterized into two types: trait anxiety and state anxiety. Trait anxiety is a chronic phenomenon that is an individual's consistent personality attribute and is inherent in their character. Individuals with high-trait anxiety experience higher anxiety and a persistent tendency to respond with state anxiety in specific threat situations than people with low-trait anxiety (Endler & Kocovski, 2001; Saviola et al., 2020; Spielberger, 1971). Trait anxiety involves four dimensions: feeling self-conscious in social situations, discomfort with uncertainty, fear of harm or injury, and excessive worry or rigidity about maintaining routine (Endler & Kocovski, 2001). For instance, fear of certain statistical situations, such as analyzing data read from statistics tables, can be an example of trait anxiety. Another example of trait anxiety related to statistics could be a persistent and general feeling of unease or apprehension

about taking any statistics course, even before encountering any specific statistical situation. This can lead to avoidance behaviors, such as taking non-statistics classes or putting off statistics requirements until the last moment. This persistent anxiety can be a trait-like characteristic that follows the individual across multiple situations and contexts related to statistics.

On the other hand, state anxiety is a temporary reaction and the feeling that individuals experience when perceiving situational stressors (Saviola et al., 2020). It is defined as "transitory unpleasant feelings of apprehension, tension, nervousness or worries, often accompanied by activation of the autonomic nervous system" (McDowell, 2006, p. 319). State anxiety includes mental worry and physiological events viewed as physiological symptoms (Bradley, 2016; Endler & Kocovski, 2001). For example, students may show signs of stress stemming from perceived cognitive decline and potential effects, leading to emotional responses/reactions, such as frustration when facing a statistical situation. Another example of state anxiety related to statistics could be a student experiencing nervousness and worry before taking a statistics exam. This temporary feeling of apprehension and tension is a reaction to the situational stressor of the upcoming exam and can be considered state anxiety. In addition, the student may experience physiological symptoms, such as a racing heart or sweaty palms, and mental worry, such as concerns about their ability to perform well on the statistics exam (Onwuegbuzie & Wilson, 2003).

In academic settings, anxiety can have harmful effects on students. Students may feel threatened, resulting in increased fear or anxiety, especially when facing situations like exams and career development. Learners may exhibit test or performance anxiety

related to a specific course or domain (Blazer, 2011; Luttenberger et al., 2018). Academic anxiety is a reaction to stimuli associated with student experiences that can cause anxiety (Sansgiry & Sail, 2006). Hembree (1990) classified academic anxiety into two main types: test anxiety and mathematics anxiety, which is associated with statistics anxiety. For example, graduate students may experience anxiety when taking challenging courses such as statistics, research methods, and theories (Macheski et al., 2008).

Furthermore, Vitasari et al. (2010) classified academic anxiety into seven primary types: examination, mathematics, linguistic, social, library, family, and anxiety related to presentations in class. Dykeman (2011) found that students enrolled in statistics classes exhibited higher academic anxiety levels than students taking other classes. These findings suggest that statistics classes may be particularly anxiety-inducing for students.

Students with high levels of anxiety may experience negative academic outcomes. Studies have shown that these students tend to have poor conceptual understanding (Sansgiry & Sail, 2006), difficulties with concentration and memory (Vitasari et al., 2010), and are more likely to underperform academically due to the negative impact on their psychological and physiological well-being (McCraty, 2007). In addition, statistics anxiety has been shown to negatively affect students statistical reasoning skills and their ability to comprehend and master the content and statistics concepts, leading to statistical illiteracy (Schield, 2004). Therefore, addressing and alleviating anxiety among students is important to support their academic success and well-being.

Conceptualization of Statistics Anxiety

The origins of the problem of statistics anxiety date back to math anxiety, which was first studied by Dreger and Aiken (1957). They introduced the concept of number

anxiety as "a syndrome of emotional reactions to arithmetic and mathematics" (p. 344). In the 1970s, researchers like Sells (1978) and Stent (1977) proposed that math anxiety must be more clearly defined as a construct, but there was some disagreement about how to characterize it. Some studies described math anxiety as trait anxiety (Byrd, 1982) or a specific form of test anxiety (Brush, 1981), while others made distinctions between math anxiety and trait anxiety (Zeidner, 1991), leading to its definition as state anxiety (Richardson & Suinn, 1972).

The terms fear, phobia, and anxiety have often been used interchangeably with math anxiety (Robertson & Claesgens, 1983), but Byrd (1982) emphasized that these terms are distinct from math anxiety and should not be used as synonyms.

The earliest definition of math anxiety was proposed by Richardson and Suinn (1972), who defined it as "feelings of tension and anxiety that interfere with manipulating numbers and solving mathematical problems in a wide variety of ordinary life and academic situations" (p. 551). Based on this definition, Richardson and Suinn developed the Math Anxiety Rating Scale (MARS), which suggested that a high score indicated a participant was experiencing anxiety in academic and everyday life situations. Byrd (1982) defined math anxiety more broadly as "any situation in which an individual experiences anxiety when confronted with any mathematics in any way" (p. 38), while Ashcraft and Kirk (2001) defined math anxiety in the classroom as "a feeling of tension, apprehension, or fear that interferes with mathematics performance" (p. 1).

Andrews and Brown (2015) noted that a growing number of students are facing difficulties in passing math courses that are necessary for obtaining their associate degree, leading to an increase in focus on the issue of math anxiety in higher education.

For instance, according to Skomsvold (2014), approximately 29% of first and second-year undergraduate students in public four-year colleges and 41% in public two-year community colleges enroll in remedial math courses. Moreover, Radford and Horn (2012) found that about 68% of community college students take at least one remedial math course during their undergraduate degrees. The lack of math knowledge and students' inability to comprehend math concepts often lead to anxiety. This has prompted researchers to investigate factors related to math anxiety and student academic performance, interventions and instructional strategies to alleviate student stress while taking college math courses.

Statistics is an essential subject that students study from high school through college, and it is taught in many scientific fields, such as medicine, education, and economics, at the undergraduate and graduate levels. Statistics is a mathematical discipline that involves understanding and implementing quantitative methods (Male & Lumbantoruan, 2021). There are two main types of statistics: descriptive and inferential. Descriptive statistics explain how statistical data might be gathered, summarized, and presented. On the other hand, inferential statistics utilize information collected from a sample to draw conclusions or generalizations about a population (Chattopadhyay & Chattopadhyay, 2014).

Several studies have shown that many students perceive statistics as an extension of mathematics and believe it requires advanced math knowledge, high computational ability, and abstract thinking. However, statistics and math differ in their cognitive processes and mental procedures. Statistics involves distinct mental processes and is more than just manipulating mathematical symbols. In addition, statistics involves

thinking abilities that are more similar to verbal reasoning abilities than numerical reasoning abilities. Finally, solving statistics problems requires more logical skills than math skills (Baloğlu et al., 2011; Buck, 1987; Macher et al., 2013; Zerbolio, 1989).

The distinction between statistics anxiety and mathematics anxiety has been studied for decades. Some studies suggest that the nature of statistics anxiety is similar to math anxiety (Schacht & Stewart, 1990). Math anxiety and statistics anxiety can be categorized as either situation-specific or content-oriented (Cruise et al., 1985). Moreover, some studies have found that statistics and math anxiety share identical dimensions. Therefore, researchers have developed modified versions of math anxiety scales by replacing words related to math with words related to statistics, such as the Statistics Anxiety Inventory (SAI) by Zeidner (1991) and the Statistical Anxiety Scale (SAS) by Pretorius and Norman (1992) (Chew & Dillon, 2014c; Plake & Parker, 1982; Wentzel, 1998; Zeidner, 1991).

On the other hand, while there is a strong relationship between math anxiety and statistics anxiety, some studies have shown significant differences between the two constructs in their antecedents, nature, effects, and interventions (Cruise et al., 1985; Macher et al., 2013; Zerbolio, 1989). As a result, these studies have used original instruments explicitly designed to measure statistics anxiety (Baloğlu, 2003; Cruise et al., 1985; Onwuegbuzie et al., 1997). For instance, Cruise et al. (1985) conceptualized statistics anxiety as a multidimensional construct with six different factors: "worth of statistics, interpretation anxiety, test and class anxiety, computation self-concept, fear of asking for help, and fear of statistics teachers" (p.149). Therefore, Cruise et al. argued that the existing measures of math anxiety were insufficient to capture each aspect of

statistics anxiety, leading them to develop the Statistical Anxiety Rating Scale (STARS) (Cruise et al., 1985). In contrast, Onwuegbuzie et al. (1997) identified statistics anxiety as a concept consisting of four components, including instrument anxiety (computational self-concept and statistical computing anxiety), content anxiety (fear of statistical terminology, dread of statistical software, and insight into the value of statistics), interpersonal anxiety (dread of approaching statistics professors for assistance), and failure anxiety (test anxiety and evaluation anxiety).

Furthermore, math anxiety is commonly characterized as a fear or apprehension about working with numbers, while statistics anxiety encompasses a broader range of concerns, such as interpreting data and understanding statistical outcomes (Williams, 2010). Studies found that math anxiety may improve performance whereas statistics anxiety negatively impacts statistical performance (Macher et al., 2015; Paechter et al., 2017; Sesé Abad et al., 2015). Individuals who experience statistics anxiety tend to have lower math knowledge, previous negative experiences with math, lower math achievement, and higher levels of math anxiety (Lalayants, 2012; McGrath, 2014). Therefore, math anxiety can be considered a predictor of statistics anxiety (Onwuegbuzie & Wilson, 2003).

Definition of Statistics Anxiety

Statistics anxiety is an affective construct that is defined in various ways. For example, Cruise et al. (1985) defined statistics anxiety as "the feelings of anxiety encountered when taking a statistics course or doing statistical analyses" (p.92), while Onwuegbuzie et al. (1997) described it more generally as "an anxiety which occurs when a student encounters statistics in any form and at any level" (p.28).

Zeidner (1991) characterized statistics anxiety as:

> an element of a performance characterized by extensive worry, intrusive thoughts, mental disorganization, tension, and physiological arousal... when exposed to statistics content, problems, instructional situations, or evaluation contexts, and is commonly claimed to debilitate performance in a wide variety of academic situations by interfering with the manipulation of statistics data and solution of statistics problems (p. 319).

Bandalos et al. (2003) added to this definition, describing statistics anxiety as "the physical, psychological, and emotional triggers experienced by a student when confronted with assignments, tests, or other deliverables." (p. 17).

Statistics anxiety has also been characterized as a persistent, chronic form of anxiety students experience when faced with statistics information or problems in educational or evaluative settings using statistics (Macher et al., 2015; Onwuegbuzie & Wilson, 2003). Chew and Dillon (2014c) expand on this definition, highlighting the connections between statistics anxiety, mathematics anxiety, and attitudes toward statistics. They define statistics anxiety as "a negative emotional state stimulated from any form of interaction with statistics and exacerbated by negative attitudes toward it; this negative feeling is associated with, but separate from, mathematics anxiety." (p. 199).

Dimensions of Statistics Anxiety

Statistics anxiety is a complex and multidimensional construct. Consequently, researchers have identified different factors that contribute to statistics anxiety. One commonly used model is the Statistical Anxiety Rating Scale (STARS) developed by Cruise et al. (1985). According to this model, statistics anxiety includes four factors:

- The Worth of Statistics: This subscale describes an individual's perception of the significance and usefulness of statistics. People with higher scores on this

subscale tend to have negative attitudes toward statistics, fear of failure, low statistics self-efficacy, and an inability to perform statistical analysis.

- Interpretation Anxiety: This factor indicates an inability to interpret statistical results and make statistical decisions. People with high scores on this subscale may struggle to accept or reject hypotheses and interpret daily statistical events.
- Test and Class Anxiety: This factor involves two types of anxiety experienced while taking statistics courses. The first type is related to student statistical information and attendance, while the second type is statistics examination anxiety, which correlates with student exam anxiety and an inability to focus during exams. Therefore, high scores on this factor may indicate student avoidance of statistics classes and poor performance.
- Computational Self-Concept: This factor describes an individual's anxiety when solving mathematical problems and calculating statistics. Higher scores on this factor are related to low self-esteem, negative attitudes, disengagement in statistics, and a low academic ability for data analysis.

Another model was proposed by Zeidner (1991), who identified two factors of statistics anxiety:

- Statistics Content Anxiety: This factor describes an individual's fear of statistics-related tasks such as working with statistical tables and figures or reading and interpreting results. It includes situations related to statistics classes and asking for help from statistics instructors.
- Statistics Test Anxiety: This factor refers to an individual's annoyance when solving statistics problems, preparing for and taking statistics tests.

Onwuegbuzie (1997) suggested three types of statistics anxiety:

- Perceived Usefulness of Statistics: This factor is related to how students benefit academically and professionally from statistics. Students with high anxiety in this factor typically perceive statistics as unbeneficial.
- Fear of Statistics Language: This factor describes a fear of statistical formulas, symbols, and terms. High scores in this type are associated with low performance in statistics classes.
- Fear of Application Statistics: This factor indicates a fear of using statistical principles in understanding research and study results or engaging with statistical analysis.

Other researchers, such as Baloğlu (2002) and Jaradat and Al-titi (2015), have proposed additional factors such as Fear of Asking for Help, which describes the anxiety students experience when they ask for help in solving statistics problems, and Fear of Statistics Teachers, which refers to the inability to interact with statistics instructors and the antagonistic relationships that may form between students and instructors.

Overall, these models highlight several dimensions of statistics anxiety and emphasize the need for tailored interventions to help individuals overcome this challenge.

Antecedents of Statistics Anxiety

Statistics anxiety is common among students and can arise due to cognitive and non-cognitive factors. According to Ashaari et al. (2010), cognitive factors are related to intellectuality, while non-cognitive factors include anxiety, attitude, expectations, motivation, perception, and interest. The literature has identified several sources of statistics anxiety, including attitudes toward statistics teachers, inadequate preparation,

teaching methods, and students' level of thinking (Casad et al., 2015; Lee, 2009; Peachter et al., 2017). Antecedents of statistics anxiety can be categorized as environmental, situational, and dispositional (Onwuegbuzie & Wilson, 2003). Dispositional and environmental antecedents can trigger situational factors, leading to anxiety (Alpert & Haber, 1960). Therefore, statistics anxiety is predicted by various factors and can affect many aspects of students characteristics.

Situational Antecedents

Situational antecedents are the factors related to individuals' immediate surroundings and significantly impact their statistics anxiety. These factors include the complexity of statistical concepts, course workload, time pressure, instructional methods, and the nature of statistics classes (Casad et al., 2015; Lee, 2009; Macher et al., 2012; Peachter et al., 2017). In addition, the teaching styles, instructors, and class atmosphere also contribute to the situational antecedents of statistics anxiety (Abd Hamid & Sulaiman, 2014; Fenster, 1992; Kaiser, 1992; Onwuegbuzie et al., 1997; Sutarso, 1992; Zeidner, 1991).

Research has shown that the number of completed mathematics/statistics courses can affect students' levels of statistics anxiety, self-rating of statistics experience, and academic research (Dempster & McCorry, 2009; Slootmaeckers et al., 2014; Waples, 2016). Similarly, fast-paced statistics classes and intensive pedagogical teaching styles impede student understanding and increase statistics anxiety (Pan & Tang, 2005). On the other hand, entertaining and humorously delivered statistics classes can reduce student statistics anxiety (Lesser & Reyes, 2015).

Statistics instructors have a considerable impact on student statistics anxiety. The type of instructor can explain about 6%-20% of student statistics anxiety variance (Williams, 2010). Providing students with convenient learning settings and decreasing the emphasis on math in statistics classes can help reduce student anxiety related to statistics instructors or seeking help from instructors or peers (Chew & Dillon, 2014a). Teaching styles are also important antecedents of statistics anxiety. Some studies have found that online statistics classes can decrease students' anxiety levels compared to on-campus classes (DeVaney, 2010). However, other research suggests that having an instructor present in the statistics class can reduce statistics anxiety and prevent unethical behavior during exams (Peled et al., 2019).

Dispositional Antecedents

Dispositional antecedents refer to the factors that students bring with them to the statistics classes, such as their attitudes, beliefs, and self-concepts (Casad et al., 2015; Lee, 2009; Peachter et al., 2017). Dispositional antecedents include personality traits, student perfectionism, self-efficacy, self-esteem, attitudes toward statistics, fear of failure, and learning strategies (Baloglu, 2003; Macher et al., 2012; Najmi et al., 2018; Onwuegbuzie, 1998; Onwuegbuzie & Daley, 1999; Onwuegbuzie & Wilson, 2003; Pan & Tang, 2004; Walsh & Ugumba-Agwunobi, 2002).

Research suggests that positive attitudes, commitment, self-concept, and adaptability toward statistics can reduce statistics anxiety (Najmi et al., 2018; Williams, 2014). Additionally, learning styles that involve rehearsal, elaboration, organization, critical thinking, and effort regulation have been associated with lower levels of statistics anxiety (Kesici et al., 2011; Radi, 2006). Williams (2014) also found that the preference

for numerical information is positively associated with math self-concept and negatively associated with statistics anxiety. Conversely, students with lower levels of academic self-efficacy, intelligence, and creativity may be more likely to experience high levels of statistics anxiety (Zeidner, 2000).

Environmental Antecedents

Environmental antecedents refer to factors in the external environment that can influence statistics anxiety, including individual and sociodemographic aspects such as age, gender, race, culture, previous experiences, and parental and teacher expectations (Casad et al., 2015; Lee, 2009; Papanastasiou & Zembylas, 2008; Peachter et al., 2017; (Zhang et al., 2019). Gender is the most commonly reported environmental antecedent of statistics anxiety. Women are more likely to experience higher anxiety and greater worry in statistics subjects (Baloğlu et al., 2011; Douga, 2009; Rodarte-Luna & Sherry, 2008). Age is another environmental factor linked to statistics anxiety. Studies indicated that older students experience higher levels of statistics anxiety than younger students (Baloğlu, 2003; Bell, 2003). Finally, cultural differences can also impact statistics anxiety. For example, some studies show no significant differences in statistics anxiety related to race (Bui & Alfaro, 2011), while others have found that American students report higher levels of statistics anxiety than Turkish students (Baloğlu et al., 2011). Additionally, Onwuegbuzie (1999) indicated that African American students experience greater statistics anxiety than CaucasianAmerican students.

In sum, it is worth noting that the interaction of different antecedent factors can exacerbate or alleviate statistics anxiety. For example, the lack of teacher support in a high-pressure workload situation can intensify statistics anxiety (Williams, 2010).

Understanding the antecedents of statistics anxiety can aid educators to help students overcome their fears and develop confidence in their statistical abilities.

Statistics Experience and Statistics Anxiety

Research has shown that an individual's background and experience in statistics play a significant role in developing statistics anxiety. Some research has identified several factors, such as degree programs, undergraduate majors, and prior knowledge of statistics, contributing to statistics anxiety. For example, Zhang et al. (2012) found that postgraduate medical students with strong math backgrounds and having taken an introductory statistics courses in their undergraduate majors had a positive attitude toward statistics. In addition, Williams (2014) indicated that students with higher preference for numerical information scores were less likely to experience anxiety when studying statistics. On the other hand, Hagen et al. (2013) reported moderate statistics anxiety among undergraduate students in nursing programs.

Statistics experience has also been shown to play a role in statistics anxiety in Middle Eastern countries where high school curriculums may limit exposure to math and science courses. High school is a three-year process in most Middle Eastern countries, such as Saudi Arabia. In the first year of high school, students continue to follow the same curriculum from middle school, including science courses, Arabic literature, grammar, poetry, English, and Islamic studies courses. Then, starting in the second year, students must choose one of two concentrations: the literary course plan or the science course plan, based on their academic record and personal preference. Students who choose the literary course plan will not take any science courses or math, while those who

choose science will not take any literary courses. The only courses these concentrations share are the Islamic studies courses.

Research indicated that previous statistics knowledge and previous math experience in high school are related to statistics anxiety (Al-Otaibi, 2019). Students with more statistics and math experience tend to be less anxious than students with limited statistics background (Baloğlu, 2003). In Algeria, Douga (2009) found that students in psychology major who took science courses in high school reported less anxiety than those with less math knowledge. In addition, Slootmaeckers et al. (2014) found that students with statistics experience had less statistics anxiety than those who had never experienced statistics classes. Similarly, Tutkun (2019) reported that math skills among graduate students are a crucial factor affecting anxiety in statistics courses.

Moreover, Arabic literature has also shown that students with a good understanding of statistics language and numerical backgrounds report less anxiety than those with limited knowledge of statistics (Malik, 2015). Abdul Sadiq (2016) found that math experience played a crucial role in predicting statistics anxiety among female college students majoring in psychology, where students with scientific degrees performed better than those in literary disciplines. Similarly, Abu Aish (2017) reported that students in literary disciplines had more statistics anxiety than those in scientific disciplines. Akila (2017) found that lower student experience in math was related to increased reported levels of statistics anxiety. Consistent with earlier research, Amirian and Abbasi-Sosfadi (2021) found that students with insufficient statistical backgrounds reported more anxiety in analyzing and interpreting statistical data.

Gender Differences on Statistics Anxiety

Many studies have been investigated the gender differences in statistics anxiety, although the nature of this association is complex and remains under-researched (Ralston et al., 2016). Most studies suggest that women are more likely to experience higher levels of statistics anxiety than men (Baloğlu et al., 2011; Douga, 2009; Jaradat et al., 2015; Ralston et al., 2016; Rodarte-Luna & Sherry, 2008). For example, Douga (2009) found that female psychology students in Algeria showed higher levels of statistics anxiety than males. In Jordan, Jaradat et al. (2015) observed gender differences in statistics anxiety for female graduate students studying in multiple departments in colleges of education. Similarly, In England, Ralston et al. (2016) reported that female sociology and social policy students aged 24 or younger were more likely to experience anxiety related to statistics than their male counterparts of the same age group. However, the opposite effect was found for male students aged 25 and older, who were more likely to experience statistics anxiety when compared to male students younger than 25. In Egypt, Akila (2017) found that female students reported higher scores on the statistics exam anxiety subscale than males. MacArthur (2020) also found that females reported more anxiety and negative attitudes toward statistics than male students. Levpušček and Cukon (2021) reported that female students suffered more from statistics anxiety than male students and scored higher on interpretation, test, and class statistics anxiety scales but lower on the worth of statistics scale. In addition, Baharun and Porter (2009) found that postgraduate male students had more self-confidence in understanding statistics than female students in the Health Informatics Department in Australia

On the other hand, some studies found that statistics anxiety was higher in males than females. For instance, in Saudi Arabia, Al-Qurashi (2012) found that men exhibited higher levels than women on the statistics anxiety subscales, except for the worth of the statistics subscale. Similarly, Koh and Zawi (2014) reported that men and non-science undergraduate degree students had more anxiety toward statistics than female students in Malaysia.

However, other studies have found no gender differences in statistics anxiety levels (Baloğlu, 2003; Ismail et al., 2017; Puteh & Khalin, 2016). For instance, Baloğlu (2003) found no effect of gender or the interaction of age and gender on statistics anxiety levels among college students. Likewise, Puteh and Khalin (2016) found no significant difference in statistics anxiety between female and male students, then Ismail et al. (2017) demonstrated also no differences based on gender in statistics anxiety levels among postgraduate students. Furthermore, Chau's study (2018) found no gender differences in statistics anxiety among doctoral students in health science. Finally, Alizamar et al. (2019) reported that levels of statistics anxiety for male and female college students were moderate and did not differ between genders.

The Effect of Statistics Anxiety on Academic Performance

Statistics anxiety can have a wide range of negative impacts on students, affecting their behavior, cognitive processes, emotions, and physical well-being. Students with statistics anxiety often experience anxiety symotoms similar to those with general anxiety and test anxiety (Luttenberger et al., 2018; Papousek et al., 2012). Behavioral symptoms may include compulsive and inflexible behaviors (Papousek et al., 2012), while cognitive effects may manifest as working memory issues, misconceptions, and feelings of

helplessness (Macher et al., 2012). Affective symptoms may involve anxiety, lack of confidence and enjoyment, nervousness, tension, despair, apprehension, fear, threat, and shame (Foley et al., 2017; Papousek et al., 2012). Finally, physiological symptoms may include difficulty concentrating, elevated heart rate, and sweating (Luttenberger et al., 2018; Papousek et al., 2012; Sheffield & Hunt, 2006). Statistics anxiety effects can be classified into both immediate and long-term effects.

The immediate effects of statistics anxiety, including cognitive processes and reading speed, leading to forgetting how to perform statistics-related tasks and content (McDonough & Ramirez, 2018), which therefore, impact students' performance. Researchers have reported a negative association between statistics anxiety and achievement (Foley et al., 2017; Luttenberger et al., 2018; McDonough & Ramirez, 2018; Papousek et al., 2012; Sheffield & Hunt, 2006). Some studies indicated a direct association between statistics anxiety and student performance (Zare et al., 2011; Macher et al., 2015; Sandoz et al., 2017). For example, Chew and Dillon (2014c) conducted a review that showed a consistent negative correlation between statistics anxiety and academic performance in many studies. Malik (2015) also supported this view, stating that anxious students are more prone to abandoning their studies and are more likely to perform poorly than non-anxious students. Macher et al. (2015) found that statistics anxiety significantly affects students' performance on statistics exams, further reinforcing this relationship.

Other studies indicated the indirect correlations between statistics anxiety and their performance. For instance, a study by Sandoz et al. (2017) on undergraduate students found that the willingness to engage with statistics and the importance placed on

statistics engagement played a moderate role in the relationship between statistics anxiety and exam performance. Although there was a negative correlation between statistics anxiety and performance, students who showed high levels of statistics anxiety and were willing to engage with the subject had higher scores on statistics exams.

In Saudi Arabia, Abu Aish (2017) investigated the relationship between statistics anxiety, motivation, and academic achievements among graduate students and found a negative correlation between statistics anxiety, student motivation, and academic achievements.

On the other hand, long-term effects of statistics anxiety include statistics avoidance, low self-esteem, learned helplessness, and compulsive behaviors (McDonough & Ramirez, 2018; Peachter et al., 2017). Moreover, statistics anxiety may lead to a long-term negative attitude toward learning and acquiring math knowledge, resulting in a lack of cognitive reflection on statistics assignments and a narrow connection with daily math tasks (Morsanyi et al., 2014).

However, some studies have shown no correlation between statistics anxiety and academic performance (MacArthur, 2020; Schneider, 2011). For example, Abd Hamid and Sulaiman (2014) found that statistics anxiety was unrelated to the academic performance of students majoring in psychology. Another study done by De Vink (2017) have shown that statistics anxiety does not affect the relationships among self-efficacy, academic background, attitudes toward statistics, big five personality traits, and statistical achievement. Additionally, Afdal et al. (2019) found that only 10.4% of statistics anxiety contributed to student achievements in Negeria. Overall, it is clear that statistics anxiety

can have significant negative effects on academic performance and long-term attitudes toward statistics-related courses.

Strategies for Reducing Statistics Anxiety

Studies have found that several strategies can be employed to decrease student statistics anxiety and improve their achievement. For instance, Harpe et al. (2012) found that a learning-centered strategy improved student understanding and attitudes toward statistics, increasing their statistical knowledge and positive perceptions of the learning environment. Hagen et al. (2013) recommended team-based teaching methods to enhance undergraduate students' attitudes toward learning statistics and reduce their anxiety. In addition, Chiou et al. (2014) assessed the effectiveness of the "one-minute paper strategy" in applied statistics courses and found that it can reduce student statistics anxiety and improve their achievement. Similarly, Youssef (2016) investigated the effectiveness of self-regulated learning strategies on student achievement and statistics anxiety in a Principles of Educational Statistics course in Saudi Arabia. The results showed that using self-regulated learning strategies reduced statistics anxiety and increased student achievement. Furthermore, some studies found that educating students about the usefulness of statistics courses can also enhance their perceptions of the subject (Baloğlu, 2003; Harpe et al., 2012). Regarding students, Hagen et al. (2013) found that students prefer appropriate course pacing, clear and timely feedback, real-world examples, and visual teaching aids. Instructors should also exhibit patience, friendliness, expertise in statistics, and humor to help students feel comfortable and confident in the subject.

Attitudes Toward Statistics

Background and Definition

Attitude concepts have been defined differently. According to the psychological view, an attitude is "a mental condition in a person, shaped through experience, and will influence a person's reaction toward an object or related phenomenon" (Ashaari et al., 2011, p. 288). Ajzen (1989) described attitudes as "an individual's disposition to respond favorably or unfavorably to any discriminable aspect of the individual's world" (p. 241). Eagly and Chaiken (1993) defined attitude as "a psychological tendency that is expressed by evaluating a particular entity with some degree of favor or disfavor" (p. 1). Zhang and Campbell (2010) suggested that attitude is "a very complex and unique concept, which integrates multiple properties and has different domains" (p. 597). More recently, Male and Lumbantoruan (2021) proposed that attitude explains how individuals approach their environment and deal with learning situations and circumstances.

However, Gal (2002) distinguished between attitudes and beliefs, stating that attitudes are "relatively stable, intense feelings that develop through gradual internalization of repeated positive or negative emotional responses over time" (p. 18). On the other hand, Gal indicated that beliefs: "take time to develop, and they are less emotionally intense than attitudes and are stable and quite resistant to change compared to attitudes" (pp. 18-19).

Attitudes consist of three components: cognitive, affective, and behavioral. The cognitive aspect involves an individual's thoughts and beliefs toward the phenomena. The affective component includes the emotional reactions of the individual toward the phenomena, while the behavioral aspect comprises individual actions toward the

phenomena (Myers, 2005). Whereas Aronson et al. (2007) categorized attitudes into two types: cognitively-based and affectively-based. Cognitively-based attitudes are based on individual preferences toward a particular subject, topic, or performance. In contrast, affectively-based attitudes stem from emotions, values, or previous experiences, either vicarious or influenced by others.

Attitudes toward statistics is considered a complex and multi-dimensional construct (Emmioğlu & Çapa-Aydın, 2012; Ramirez et al., 2012; Schau et al., 2003). Schau et al. (1995) proposed a four-component model for attitudes toward statistics that includes affect (student feelings towards statistics), cognitive competence (student attitudes about their intellectual knowledge and skills as applied to statistics), value (student attitudes about the usefulness, relevance, and worth of statistics in personal and professional life), and difficulty (student attitudes about the level of difficulty of statistics as a subject). Schau (2003) later updated this model to include two additional components: interest and effort. The interest component refers to the degree to which a student is interested in statistics, while effort describes the amount of time and effort a student invests in learning statistics. In addition, Ashaari et al. (2011), indicated that attitudes consist of five components: emotion, goal, direction, strength, and consistency. Each component can be positive, neutral, or negative. A positive attitude is essential to encourage students to learn a particular subject, while a negative attitude can be an obstacle to understanding the subject successfully (Fullerton & Umphrey, 2001; Liau et al., 2015).

Attitude Theories

Several theories explain the development of attitudes toward statistics. One of the most commonly used theories is the Planned Behavior Theory (TPB), developed by Ajzen (1991). It is a psychological theory used to understand human behavior, particularly in decision-making. The TPB posits that an individual's behavior is shaped by their intention to engage in that behavior. This intention is influenced by three factors: their attitude toward the behavior, their perception of social norms surrounding the behavior, and their perceived level of control over it. In other words, a behavior is determined by intentions and influenced by the attitude toward the behavior (e.g., what others think about it, and how easy or difficult to perform it).

The TPB can be used to understand how students' attitudes toward statistics influence their levels of statistics anxiety and academic performance. For example, a student with a positive attitude toward statistics is more likely to have a stronger intention to engage in statistics-related tasks (such as studying, attending class, or completing assignments), which can ultimately lead to reduced statistics anxiety and better academic performance in statistics (Althubaiti, 2021; Dykeman, 2011; Sandoz et al., 2017).

Another theory is the Elaboration Likelihood Model (ELM) developed by Cacioppo et al. (1986). It is a theoretical framework that helps explain how people process persuasive messages and make decisions. The ELM proposes that attitudes can be created or modified by two methods: the central and peripheral paths. The central path includes an individual's cognitive processing of the message, while the peripheral path relies on non-cognitive cues such as the speaker's attractiveness or the message's source.

The ELM suggests that students may process information related to statistics through either the central or peripheral route. If students are highly motivated and can process statistics-related information deeply, they may take the central route and carefully evaluate the evidence presented, leading to a more informed and accurate attitude toward statistics (Egodawatte, 2019; Petty & Cacioppo, 2012).

The Social Cognitive Theory (SCT) developed by Bandura (1986) is another psychological theory that emphasizes the role of cognitive, behavioral, and environmental factors in shaping human behavior. According to SCT, attitudes are formed through observation, reinforcement, and imitation of others. Individuals' attitudes are influenced by previous experiences and perceptions of their ability to perform a particular behavior.

The SCT suggests thatstudent beliefs and attitudes about statistics are influenced not only by their previous experience but also by the attitudes of others. For example, if students perceive that their peers and instructors have negative attitudes toward statistics, they may develop a negative attitude toward statistics (Lent et al., 1994).

Finally, the Affective Events Theory (AET) developed by Weiss and Cropanzano (1996) proposes that attitudes are influenced by emotional events that occur in the workplace. The AET indicated that individual's affective reaction to an event influence their attitudes and subsequent behaviors.

The AET suggests that students' emotions and affective experiences can influence their attitudes toward statistics. For example, if students have negative experience with a statistics assignment or exam, they may develop negative attitudes toward statistics in general. Alternatively, positive statistics experience may lead to more positive attitudes. Additionally, the AET suggests that the emotional climate of the learning environment

can impact student attitudes and statistics performance. For instance, a positive and supportive class environment that encourages student engagement and provides opportunities for success may lead to more positive attitudes and better academic performance (Weiss & Cropanzano, 1996).

Attitudes Toward Statistics and Statistics Anxiety

Attitudes toward statistics have been shown to predict statistics anxiety and vice versa, with both variables influencing each other (Chiesi et al., 2011; Mokhele, 2018). Studies have used different scales to measure attitudes and anxiety and reported a significant relationship between them. For example, Mokhele (2018) found that statistics anxiety was negatively related to attitudes toward statistics among business students in South Africa, while Najmi et al. (2018) suggested that positive attitudes toward statistics could reduce statistics anxiety in Pakistani higher education. Rosli et al. (2017) also confirmed a negative relationship between attitudes and anxiety among postgraduate students in education. Levpušček and Cukon (2019) demonstrated that Slovenian college students who perceived math and statistics as a threat had the highest levels of statistics anxiety, and Abu Foudeh (2020) found that both attitudes and anxiety contributed to student achievement in Jordan, with attitudes having a greater impact on statistics scores. In Saudi Arabia, Rashwan and Abdelghany (2021) also showed that improving habits of mind could improve student attitudes toward statistics and reduce statistics anxiety, with a positive correlation between academic achievement and attitude toward learning statistics. Overall, attitudes toward statistics and statistics anxiety are interrelated and can impact student performance and achievement.

Attitudes Toward Statistics and Gender Differences

Several studies have been explored the relationship between attitudes toward statistics and gender differences. Some studies have found no significant differences in attitudes toward statistics between male and female students (Aslemand, 2018; Cashin & Elmore, 2005), while others have reported gender gaps in attitudes. For example, Van Es and Weaver (2018) found that female students had lower scores than males in affect, cognitive competency, and subject difficulty factors in an introductory statistics course. Similarly, Rejón-Guardia et al. (2019) reported that female students in social sciences had lower attitudes towards statistics in affect, value, and difficulty factors but higher scores in the effort factor. Opstad (2020) also found that males had more positive attitudes toward statistics than females among business students in Norway, although math skills and personal characteristics reduced this gap. However, other studies have shown that females have more positive attitudes toward statistics than males. For example, Al-alfi (2018) found that female master's students in Saudi Arabia had more positive attitudes toward statistics than males, particularly in the component of pleasure and the effect of the instructor.

Overall, gender differences in attitudes toward statistics vary depending on the study context and the specific attitude components examined. Additional research is needed to understand better the factors that contribute to these differences and to identify strategies for promoting more positive attitudes towards statistics among all students, regardless of gender.

Statistics Self-Efficacy

A Brief Historical Overview

The concept of self has a rich history dating back to ancient Greek philosophers, who viewed the self as a soul and spiritual entity (Remes & Sihvola, 2008). The Middle Ages introduced the concept of mind and body duality, with Aquinas positing that the self includes both the soul and body. Descartes, in 1659, proposed the philosophy of thinking and introduced the idea of self-awareness as the foundation of metacognitive strategies. However, belief during past eras was mainly attributed to religion (Descartes, 2008).

In the twentieth century, William James proposed the concepts of self-consciousness, self-reflection, and self-esteem. Cooley established the Looking-Glass Self Theory, while Freud developed the Psychoanalytic Theory, which divided the self into three components—id, ego, and superego. Later, humanism entered the discussion of consciousness, with Maslow's Hierarchy of Needs Theory explaining that human motivation fulfills various needs to achieve self-esteem and self-actualization (Bandura, 1991).

Behaviorists focused on external stimuli, but Bandura believed that people's thoughts play an active role in the self, establishing the concept of self-efficacy. In the 1970s, Bandura examined techniques to help people who suffer from phobias and found that self-efficacy more substantially affects motivation than outcome expectations. Therefore, individuals differ in their levels of self-efficacy (Schunk & Pajares, 2002; Zimmerman, 2000).

Bandura conducted many studies to examine the role of self-efficacy on individual behaviors and, in 1986, proposed the Social Cognitive Theory, highlighting the role of self-efficacy in cognition, behavior, emotions, and motivations. From 1991–1997, Bandura reported that individuals utilize their self-beliefs to create impressions of their capabilities when interacting with the environment. Hence, individual self-efficacy determines expectations about performance, which impact the consequences. High expectations boost performance, while low expectations undermine it (Bandura, 1997).

Definition of Self-Efficacy

Self-efficacy refers to "beliefs in one's capabilities to organize and execute the courses the courses of action required to produce given levels of attainments" (Bandura, 2000, p.16). It is a fundamental component of Bandura's Social Cognitive Theory and plays a significant role in shaping an individual's behavior, emotions, and motivation. Math self-efficacy is a specific application of the construct related to an individual's beliefs or perceptions concerning mathematical abilities (Bandura, 1997). Similarly, statistics self-efficacy is an individual's confidence in completing specific statistics-related tasks (Ogbogo & Amadi, 2018). This includes the ability to understand, analyze, and interpret statistical information and carry out statistical tasks such as interpreting output and navigating statistical software (Blanco, 2011; Finney & Schraw, 2003; Leimer, 2015). Finally, self-efficacy to learn statistics refers to an individual's confidence in their ability to successfully comprehend the necessary statistical skills (Perepiczka et al., 2011).

Theories of Self-Efficacy

Self-efficacy theory suggests that self-efficacy is a belief specific to a particular situation, and it reflects students' confidence in their ability to acquire the necessary skills and knowledge to perform a task satisfactorily (Olivier et al., 2019). Self-Determination Theory (SDT) also refers to the concept of self-perception of competence, which describes individuals psychological need to feel competent to achieve their goals and master challenging activities (Deci & Ryan, 2000; Schunk & Mullen, 2012). On the other hand, Expectancy-Value Theory uses ability beliefs that describe students' evaluation of their competence based on their insights into an extensive field. Student ability beliefs are connected to a broad domain and current competence, while expectancy for success is linked with specific tasks and concerns future outcomes (Wigfield & Eccles, 2000).

In the mid-1970s, Albert Bandura developed Social Cognitive Theory (SCT), which describes how individuals learn and interact within social systems using several processes, such as acquiring and adopting knowledge (Bandura, 1977, 1986). SCT posits that individuals learn through various drivers, responses, and rewards. Self-efficacy, a critical concept in SCT, reflects an individual's belief that a task can be effectively accomplished within a specific setting. Bandura introduced this concept of SCT in 1977, emphasizing that cognitive mediation of action influences and promotes the processing of stimuli to change behaviors and actions (Middleton et al., 2019; Pálsdóttir, 2013). Finally, Social Learning Theory (SLT) is one of the main antecedents of SCT, which describes how people can learn through social processes such as modeling, mimicking, and observing (Bandura, 1977).

Antecedents of Self-Efficacy

Self-efficacy is derived from four primary sources of information: direct experiences, vicarious learning, verbal persuasion, and affective state (Hu, 2020; Sheu et al., 2018). However, Bandura (1997) reported that direct experiences of performance accomplishments are the most active factor.

Previous experience is a critical antecedent of self-efficacy. Mastery experience is the strongest predictor of self-efficacy, especially when measured subjectively (Byars-Winston et al., 2017; Loo & Choy, 2013; Sheu et al., 2018). Previous achievements form individuals' future expectations of their performance. Individuals who have experienced success tend to have higher expectations for their future performance, as they perceive themselves as highly competent in similar tasks (Bandura, 1986; Hu, 2020). Self-efficacy belief can also result from learning similar experiences, such as successes in previous performances of related tasks. For example, students who perform well in a statistics class are more likely to have positive beliefs about their future performance in statistics courses (Hu, 2020; Sheu et al., 2018). These positive expectations can lead to increased motivation and effort, leading to further success and higher levels of self-efficacy.

Vicarious experiences influence self-efficacy, such as social comparisons from observational learning, imitation, or modeling. For example, observing successful peers can increase self-efficacy as students evaluate their performance relative to peer levels of success. However, observing failure among peers can decrease self-efficacy, especially when students perceive tasks as challenging (Hu, 2020). Vicarious experiences have a weaker impact on self-efficacy than direct mastery experiences (Maddux & Gosselin, 2012).

Social and verbal persuasion are also essential factors that affect self-efficacy, including praise, inspiration, and reinforcement from others. Believable social messages can increase students' confidence, while criticism can have a negative impact. However, social persuasion has weaker impacts on promoting self-efficacy than direct and indirect experiences. The source's trustworthiness, expertness, and attractiveness also affect verbal persuasion (Bandura, 1997; Hu, 2020; Maddux & Gosselin, 2012).

Emotional and physiological experiences can also be effective sources of self-efficacy. For example, negative emotional and physiological states are associated with lower behavioral performance and decreased confidence, while positive states increase self-efficacy. Stress, fatigue, pain, and anxiety are some physiological experiences that can influence self-efficacy (Bandura, 1997; Maddux & Gosselin, 2012; Schunk & DiBenedetto, 2016; Zimmerman, 2000).

Self-Efficacy and Achievement

Self-efficacy has been found to play a significant role in influencing student academic performance, including their motivation, effort, learning outcomes, persistence, self-regulation, and achievements (Honicke & Broadbent, 2016; Schunk & DiBenedetto, 2016; Schunk & Usher, 2012; Zumbrunn et al., 2020). Students with high self-efficacy are more likely to engage in and persist through challenging tasks, invest more effort into completing tasks, use effective learning strategies, and practice self-regulation skills that support achievement (Honicke & Broadbent, 2016; Zimmerman, 2000). Furthermore, Schunk and Pajares (2010) emphasize the importance of self-efficacy in shaping students cognitive, affective, and behavioral responses throughout the teaching and learning process.

Research has consistently shown a positive relationship between self-efficacy and academic achievement across various fields, such as engineering, mathematics, sciences, the English language, and economics. For instance, Amil (2000) found a positive association between self-efficacy and academic performance among economics students in Singapore. Liem et al. (2008) found that self-efficacy predicts English performance scores among the English language students in Singapore. More recently, Asakereh and Yousofi (2018) studied relationships among reflective thinking, self-efficacy, self-esteem, and achievement, confirming a positive association between self-efficacy and academic achievement among English as a Foreign Language (EFL) students.

In the United States, Louis and Mistele (2011) found that self-efficacy is a predictor of math and science achievement. Similarly, Olivier et al. (2019) suggested that positive math self-efficacy correlates with a long-lasting effect on achievement. Tenaw (2013) reported an association between self-efficacy and achievement among students in analytical chemistry. Among engineering students, Loo and Choy (2013) showed that self-efficacy plays a positive role in student performance, indicating that student self-efficacy was associated with math achievement scores and GPA when receiving their engineering diplomas. In addition, Kolo et al. (2017) examined academic self-efficacy and its relationship with scholastic outcomes among students in Nigerian colleges of education, showing that 80.82% had high levels of academic self-efficacy, indicating a positive relationship between academic self-efficacy and student performance. Whereas Atia (2019) found that self-efficacy predicted about 21% of academic achievement among special education students in Saudi Arabia. Finally, Basith et al. (2020) studied student teachers in Indonesia, to examine academic self-efficacy within educational

science. Results indicated that Self-efficacy was linked positively with student academic achievement. Finding showed also that students majors significantly affected their self-efficacy. Students in social science majors had higher levels of self-efficacy than their counterparts in science majors.

Gender Differences and Self-Efficacy

From a gender differences perspective, research has shown that females often exhibit lower self-efficacy than males. For instance, Amil (2000) found that female economics majors at junior colleges had lower self-efficacy than their male counterparts. Similarly, Louis and Mistele (2011) reported gender differences in self-efficacy among math and science students, with females having lower self-efficacy in math but not science. However, in the language arts domain, Huang (2013) found that female students exhibited higher self-efficacy than males, whereas males had higher self-efficacy in math, computer science, and social sciences. In contrast, Sachitra and Bandara (2017) discovered that female students in a commerce program in Sri Lanka showed higher academic self-efficacy than males. Despite these findings, some studies have shown no significant gender differences in self-efficacy, such as Tenaw's (2013) study on analytical chemistry college students of teacher education in Ethiopia.

The Role of Statistics Self-Efficacy in Statistics Anxiety

Self-efficacy is a crucial determinant of statistics anxiety, influencing several aspects of statistics performance, including cognitive, affective, psychological, motivational, and environmental factors (Chang & Beilock, 2016; McMullan et al., 2010). Research has established that self-efficacy is positively associated with math self-efficacy, attitudes toward statistics, achievement goals, and performance while negatively

associated with statistics test anxiety (Finney & Schraw, 2003; Zare et al., 2011). Students who possess high self-efficacy and expectations for success tend to perform better in statistics courses and consequently have lower statistics anxiety (Onwuegbuzie, 2003; Pan & Tang, 2005; Papanastasiou & Zembylas, 2008). In addition, students with high perceived self-efficacy demonstrate greater effort, dedication, persistence, and belief in their ability to succeed in statistics, leading to reduced statistics anxiety (Ban, 2019; DeCesare, 2007; Finney & Schraw, 2003). Moreover, students with confidence in performing statistics tasks exhibit lower anxiety when taking statistics exams or following statistics-related instructions (Schneider, 2011). However, the lack of confidence in one's ability to succeed significantly contributes to anxiety and avoidance of statistics courses among social science students (Condron et al., 2018).

Studies have also examined the relationship between statistics anxiety and self-efficacy, along with other factors such as personality traits (De Vink, 2017), motivational beliefs (Baloğlu et al., 2017), and learning styles (Ogbogo & Amadi, 2018; Perepiczka et al., 2011). These studies have shown that self-efficacy and other factors can collaborate as predictors of statistics anxiety among graduate students. Additionally, in the Middle East research has also explored the role of statistics self-efficacy in statistics anxiety, with findings indicating a negative association between self-efficacy, irrational beliefs, and statistics anxiety but a positive association with statistics outcomes (Abdul Sadiq, 2016). Studies in Egypt have also reported negative relationships between low statistics self-efficacy scores and high statistics anxiety scores among graduate students (Ali, 2020; Atia, 2019).

Statistics Experiences, Attitudes Toward Statistics, Self-Efficacy, and Statistics Anxiety

Research suggests that students statistics experience significantly influences their statistics anxiety. Previous experience in statistics and math contributes to student self-efficacy and attitudes toward statistics, ultimately affecting their levels of statistics anxiety.

Statistics Experiences: Discipline and Number of Previous Statistics Classes

Scholars have conducted research to explore whether students' level of statistics anxiety varies depending on their academic field. Unsurprisingly, students who earned a bachelor's degree in non-science disciplines generally exhibit negative attitudes toward statistics, whereas those enrolled in math or statistics-based majors have more favorable attitudes. As an illustration, Alsarayreh and Alzaboun's (2018) study demonstrated that a student's academic specialization in their undergraduate degree and their statistical background were the most significant factors in distinguishing between individuals with high or low levels of statistics anxiety. Similarly, Welch et al. (2015) examined the statistics anxiety levels among graduate dental hygiene students in the United States and discovered that students' anxiety levels were generally moderate to low. Nonetheless, students demonstrated more anxiety on the statistics interpretation scale. Furthermore, Comerchero and Fortugno (2013) proposed that undergraduate statistics classes could help alleviate statistics anxiety among graduate students.

Statistics Experiences, Attitudes Toward Statistics, and Statistics Anxiety

Studies indicated that students' previous experiences with math or statistics might lead to negative attitudes toward statistics (Bechrakis et al., 2011; Nasser, 2004; Sesé

Abad et al., 2015). Negative attitudes are more likely to develop in students who have had unpleasant experiences in statistics and math courses, causing them to focus on the difficulty of these classes rather than the benefits of statistics. Furthermore, students math achievement in previous courses is more related to their attitudes toward statistics than the number of math courses they have taken (Chiesi & Primi, 2010; Nasser, 2004; Paxton, 2006). For instance, Carmona et al. (2005) examined the relationship between Spanish college students mathematical background and their attitudes toward statistics. The study found that student math background was associated with affective responses to statistics but not how they valued statistics. Sesé Abad et al. (2015) also found that students with a background in math exhibited positive attitudes toward statistics and low anxiety. On the other hand, Dykeman (2011) reported no differences in attitudes toward statistics between students with and without previous statistics experience. Faber and Drexler (2019) also found that introductory statistics experiences have a minor effect on predicting statistics anxiety, while student mathematics self-concept and negative utility value were stronger predictors of statistics anxiety.

Statistics Experiences, Self-Efficacy, and Statistics Anxiety

Research suggested that students previous experiences with math and statistics contributed to forming their self-efficacy. Graduate students with low research and statistics skills may have low self-efficacy and require more support and encouragement when learning statistics. However, introductory statistics experiences are more predictive of student self-beliefs than their actual performance in statistics (Slootmaeckers et al., 2014). Students more involved in statistics courses tend to have higher confidence in completing statistics tasks and requirements; therefore, they experience less anxiety and

worry about failure in statistics courses (Dempster & McCorry, 2009). DeCesare (2007) stated that students with statistics experience were more confident in their statistics ability, leading to higher self-efficacy and lessening statistics anxiety. In addition, Dempster and McCorry (2009) suggested that students perceptions of their math ability and previous statistics experiences contributed to their self-efficacy to understand statistics, which influenced their attitude toward statistics. However, negative self-beliefs about statistics performance can also stem from cultural factors, such as negative perceptions of math or statistics classes, poor previous statistics experiences (Waples, 2016), or negative portrayals of statistics courses by other students (Chiesi & Primi, 2010).

Overall, while previous statistics experience and math background can play a role in statistics anxiety, attitudes towards statistics, and statistics self-efficacy, the effect is complex and influenced by several factors. However, it is essential to address students' attitudes toward statistics and their self-efficacy in statistics to reduce their statistics anxiety and improve their performance in statistics courses.

Summary

This review emphasized the importance of understanding statistics anxiety among graduate students and its impact on academic performance. The review discussed the theoretical framework of statistics anxiety, the factors that influence its development, and the lack of research on statistics anxiety among graduate students in Saudi Arabia. The review also noted that statistics anxiety is a common problem among students, particularly in non-math majors like psychology, education, and sociology. The Statistical Anxiety Rating Scale (STARS) and the Statistical Anxiety Scale (SAS) are the

most reliable and valid measures for assessing statistics anxiety. Moreover, the literature review revealed a paucity of studies investigating statistics anxiety among graduate students in the Middle East, particularly in Saudi Arabia. Additionally, there is a discrepancy among studies that explored gender differences in statistics anxiety.

To address this research gap, the present study aimed to investigate the factors that contribute to statistics anxiety among graduate students in Saudi Arabia and determined the impact of attitudes towards statistics, self-efficacy, and statistics experience on predicting statistics anxiety.

CHAPTER 3

METHODOLOGY

General Introduction

This chapter presents the methodology used to investigate the relationships among previous statistics experience, attitudes toward statistics, statistics self-efficacy, and statistics anxiety. The study utilized a cross-sectional non-experimental survey design to collect data from graduate students at two universities in Saudi Arabia during the Spring of 2022. The dependent variable was statistics anxiety, while the independent variables were previous statistics experience, attitudes toward statistics, and statistics self-efficacy. This chapter describes the research design, data collection procedures, population and sample, and definition of variables. Furthermore, the instrumentation and data analysis techniques used in this study are outlined in this chapter.

Type of Study

This study utilized a quantitative, descriptive, non-experimental, correlational, predictive research design. Specifically, a model-testing method was employed to assess a theoretical model proposing that previous statistics experience, attitudes toward statistics, and statistics self-efficacy predict statistics anxiety among graduate students in Saudi Arabia. Based on the study's questions and purposes, a quantitative approach was chosen, as it allowed for quantifying the relationships among variables and generating numerical data from a larger sample population (Patten & Newhart, 2017). The predictive

research design helped to identify predictor variables and factors influencing the criterion variable, statistics anxiety (Hair et al., 2010). The correlational design allowed for assessing the strengths and direction of relationships among the variables.

Population and Sample

The study population consisted of 365 graduate students enrolled in statistics classes during the Spring 2022 semester at Umm Al-Qura and King Abdul-Aziz university in Saudi Arabia. Participants were recruited from the college of Education and Social Science. There were fifteen classrooms for females and ten classrooms for males.

The sample for this study was selected using convenience sampling, a non-probability sampling method. To determine the appropriate sample size for this study, the number of survey items was multiplied by five, following the recommendation of Hair et al. (2010), leading to an appropriate sample size of 330 participants. The researcher emailed all students in the population and relied on those who chose to respond to the survey. However, the number of participants who completed the study instruments determined the final sample size, which was 356. It is important to note that this final sample size is larger than the appropriate sample size of 330.

Variable Definitions

The variables included in this study were statistics anxiety, previous statistics experience, attitudes toward statistics, and statistics self-efficacy. The following section provides detailed definitions and descriptions of each variable, followed by a discussion of how variables were measured in this study. More illustrations of these variables can be found in Appendices A through C.

Statistics Anxiety (SA)

Statistics anxiety (SA) refers to "the specific feelings of anxiety that students experience when they encounter statistics, for example, gathering, processing, and interpreting data" (Cruise et al., 1985, p. 12). Statistics Anxiety Scale (SAS) developed by Vigil-Colet et al. (2008) was used to measure SA. The SAS is comprised of 24 items that cover three subscales: examination anxiety, asking for help anxiety, and interpretation anxiety. Examination anxiety refers to anxiety experienced by students when taking statistics exams or studying for an exam in a statistics course. Asking for help anxiety refers to anxiety experienced when asking the course instructor or another student about statistics or related concepts. Interpretation anxiety occurs when a student must interpret statistical data and understand the formulation, such as interpreting the meaning of a table in a journal article (Vigil-Colet et al., 2008).

Responses were collected on a five-point Likert-type scale ranging from 1 (no anxiety) to 5 (considerable anxiety). The level of statistics anxiety was operationalized by summing the values of the responses on the 24 items, resulting in an interval scale ranging from 24 to 120. The higher the score, the higher the level of statistics anxiety. More information on the SAS and its psychometric properties can be found in Appendix A.

Attitudes Toward Statistics (ATS)

Attitudes toward statistics (ATS) refers to "not directly observable, inferred aspects, consisting of beliefs, feelings, and behavior predispositions towards the object to which they are directed" (Auzmendi, 1992, p. 17, cited in Mondéjar-Jiménez & Vargas-Vargas, 2010). The Survey of Attitudes Toward Statistics (SATS-28) developed by

Schau et al. (1995) was used in this study to measure attitudes toward statistics. The SATS-28 consists of 28 items designed to assess four aspects of individual attitudes toward statistics: affect, cognitive competence, value, and difficulty.

Affect refers to students' emotional reactions to statistics, such as interest, enjoyment, or stress. Cognitive competence reflects students attitudes toward their intellectual knowledge and skills applied in statistics, including their ability to learn and understand statistics concepts. Value measures how much students believe in the necessity and relevance of statistics in their personal and professional life. Difficulty assesses students attitudes toward the complexity of statistics, including how easy or challenging it is for them to comprehend formulas and calculations.

The SATS-28 uses a five-point Likert scale ranging from 1 (strongly disagree) to 5 (strongly agree). Nineteen items are reverse-scored, and higher scores indicate more positive attitudes toward statistics. The scale produces an interval score ranging from 28 to 140. More details about the concepts and items are provided in Appendix B.

Statistics Self-Efficacy (SSE)

Statistics self-efficacy (SSE) refers to "an individual's perceived capability in performing necessary tasks to achieve goals" (Bandura, 1997, p. 18). This study measured self-efficacy using the Current Statistics Self-Efficacy Scale (CSSE) developed by Finney and Schraw (2003). The CSSE (see Appendix C) is a 14-item scale that assesses the growth of graduate students self-efficacy in a statistics course they are currently enrolled in. After conducting an exploratory factor analysis on the Current Statistics Self-Efficacy Scale (CSSE), the scale was divided into two factors: descriptive statistics and inferential statistics. Descriptive statistics items included statistics skills

such as describing the basic characteristics of a set of data and using graphs and tables to summarize data. Inferential statistics included skills such as applying statistical tests to draw inferences from a sample to a population and interpreting the results of a statistical analysis. Respondents rate their confidence on a 6-point Likert scale, ranging from 1 (no confidence at all) to 6 (complete confidence). The ranking is calculated to form an interval scale ranging from 14 to 84.

Previous Statistics Experience (PSE)

To assess participants previous statistics experience, two variables were used: the number of statistics courses they had taken prior to the current study, and their undergraduate major. The former was obtained through self-report, while the latter was coded based on participants' self-reported major.

Gender

Gender was assessed by asking participants to self-identify as male or female.

Instruments

The data collection instruments comprised of four parts, including a self-report demographic questionnaire and three scales to measure statistics anxiety, attitudes toward statistics, and current statistics self-efficacy.

The self-report demographic questionnaire was developed by the researcher to gather information from each participant in the sample. It included items on gender, age, current degree level, degree program, number of prior statistics classes taken, and undergraduate major (see Appendix D). Detailed tables of the definitions of the variables and the instruments appear in Appendix E.

The Statistics Anxiety Scale (SAS), developed by Vigil-Colet et al. (2008), is a 24-item self-report instrument designed to assess anxiety experienced by students in statistics courses. The SAS consists of three subscales: (a) examination anxiety, (b) asking for help anxiety, and (c) interpretation anxiety. Items were rated on a Likert scale ranging from 1 (no anxiety) to 5 (considerable anxiety), with higher scores indicating higher levels of statistics anxiety. The scale takes about 10 minutes to complete (Vigil-Colet et al, 2008, p.178) (see Appendix A).

Internal consistency of the SAS was assessed by Cronbach's alpha and found to be .90 for the total scale, with $\alpha = .87$ for examination anxiety, $\alpha = .92$ for asking for help anxiety, and $\alpha = .82$ for interpretation anxiety (Vigil-Colet et al., 2008). The SAS is positively correlated with other measures of statistics anxiety and negatively correlated with measures of attitudes toward statistics. The factor structure of the SAS has been validated in Italian, Spanish, and Bangladeshi versions, confirming the original English version of the scale (Chew & Dillon, 2014c; Chiesi et al., 2011; Paul et al., 2018).

The Survey of Attitudes Toward Statistics (SATS) was developed by Schau et al. (1995). It is a 28-item instrument designed to assess an individual's attitudes toward statistics. The SATS-28 consists of four subscales: affect, cognitive, value, and difficulty. Responses were indicated on a five-point Likert scale, with 1 indicating "strongly disagree," 4 indicating "neutral," and 7 indicating "strongly agree." Respondents completed the survey in 10-15 minutes (see Appendix B).

For the validity and reliability of the SATS-28, internal consistency was assessed by Cronbach's alpha and found to be .90 for reliability and .92 for validity. The affect subscale had an internal consistency of .86, while both the cognitive and the value

subscales had an internal consistency of .86. The difficulty subscale had a reliability of .67 (Schau, 2003).

The Current Statistics Self-Efficacy (CSSE) was used to assess the level of current statistics self-efficacy and was developed by Finny and Schraw (2003). The instrument consisted of 14 items, and item responses were indicated on a six-point Likert scale ranging from 1 (no confidence at all) to 6 (complete confidence). Factor analysis showed that one factor accounted for 44.53% of the variance, while the other factors accounted for less than 10% of the variance and had eigenvalues below 1.00 (Schneider, 2011). The CSSE demonstrated high internal consistency, with a Cronbach's alpha coefficient of .90, and item-total correlations for all 14 items exceeded .53 (Finny & Schraw, 2003; see Appendix C).

The Validity of the Scales in Saudi Arabia

A rigorous translation process was undertaken to ensure the validity of the scales in Saudi Arabia. First, the researcher translated the original English versions of the scales (SAS, SATS-28, and CSSE) into Arabic. The translated scales were then back-translated into English by an independent, bilingual translator. Next, the original and back-translated forms were compared to ensure the accuracy and consistency of the Arabic versions of the scales. Finally, a pilot study was conducted with a randomly selected sample of 50 graduate students who were not included in the main study to evaluate the psychometric properties of the Arabic survey form. The results of the pilot study were used to assess the reliability and validity of the scales in the Arabic context.

Data Collection

The study was conducted among graduate students attending statistics classes in Spring 2022 at Umm Al-Qura and King Abdul-Aziz university in Saudi Arabia. The sample included students from the college of education and college of social sciences. The researcher obtained permission from the two universities and the Internal Review Board (IRB) of Andrews University (Appendix F) before conducting the study. The psychology departments at the two universities were contacted to identify the number of statistics classes, the number of students in each class, and the professors who taught statistics classes in Spring 2022.

Data were collected online through a survey distributed to student school email accounts during the third week of the semester. The survey was accompanied by a consent form includes a brief explanation of the study's purpose (Appendix G), and students were informed that their participation was voluntary and that their responses would be anonymous. To protect student privacy, the researcher assigned each participant an identification number that was linked to their survey responses. The data were analyzed using SPSS and AMOS software.

Data Analysis

According to the research questions, the type of research, and the variables, structural equation modeling (SEM) was used to investigate the relationships among independent variables (previous statistics experience, attitudes toward statistics, statistics self-efficacy) and the dependent variable statistics anxiety. The multigroup analysis also used to examine gender differences in the model of statistics anxiety. Descriptive and

SEM analyses were conducted using the Statistical Program for the Social Sciences (SPSS 28.0) and IBM SPSS AMOS (version 26).

Descriptive Analysis

Descriptive statistics, including frequencies, means, and standard deviations, were calculated for all criterion and predictor variables. Additionally, figures and tables were created to present the criterion and predictor variables distributions.

Structural Modeling Analysis

The SEM analysis aimed to confirm whether the hypothesized model fit the data and to evaluate the relationships among the variables (Bollen & Long, 1993). Specifically, SEM was used to analyze whether previous statistics experience, attitudes toward statistics, and statistics self-efficacy were predictors of statistics anxiety. The analysis examined the mediating role of attitudes toward statistics and current statistics self-efficacy on the association between previous statistics experience and statistics anxiety. Finally, a multigroup structural equation modeling analysis was conducted to investigate potential gender differences in the research model (see Figure 2).

In the SEM analysis, multiple fit indices were used to evaluate the model fit. These included the chi-square statistic, comparative fit index (CFI), root mean square error of approximation (RMSEA), and standardized root mean square residual (SRMR). A good model fit is indicated by a non-significant chi-square statistic, CFI values greater than .90, RMSEA values less than .08, and SRMR values less than .10.

Furthermore, bootstrapping was used to examine the significance of the indirect effects of previous statistics experience on statistics anxiety through attitudes toward statistics and current statistics self-efficacy. Bootstrapping is a resampling method that

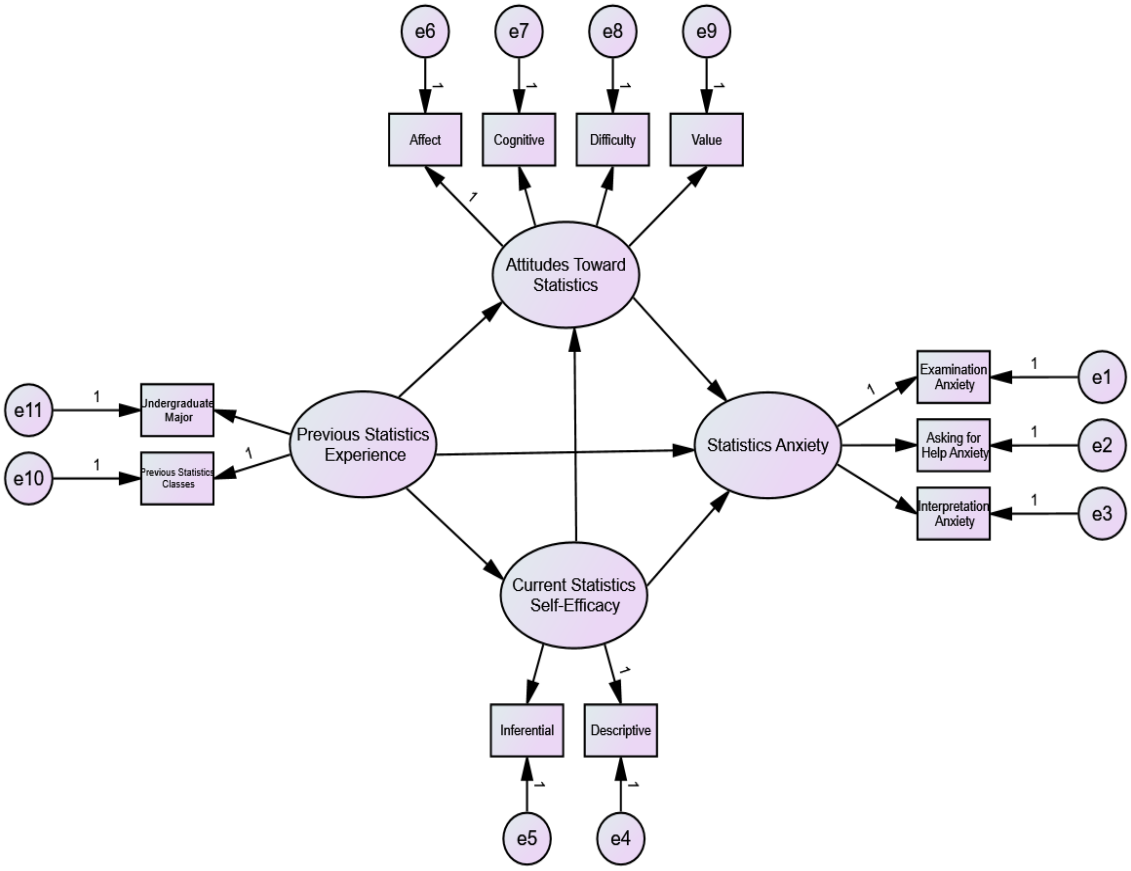
generates multiple samples from the original data set to estimate the sampling distribution of an estimator (Hayes, 2013). The results show a significant indirect impact, as the 95% confidence interval does not contain zero.

Summary

This chapter described the research design, population and sample, data collection procedure, and data analysis. The three scales used in the study (SAS, SATS-28, and CSSE) were translated into Arabic and validated through a pilot study. The data were collected through an online survey distributed to graduate students attending statistics classes at tow universities in Saudi Arabia. The data were analyzed using descriptive statistics and structural equation modeling (SEM) to examine the associations between the predictors and criterion variables.

Figure 2

The Hypothesized Structural Model of Statistics Anxiety



CHAPTER 4

RESULTS

Introduction

This chapter presents an analysis of the current study's findings, which aimed to explore the relationships among previous statistics experience, attitudes toward statistics, statistics self-efficacy, and statistics anxiety. SEM was employed to examine the interrelationships among the variables. This chapter also provides details on participant response rates, demographic characteristics, descriptive statistics, the analysis procedure, results of the research questions, and a summary of the findings.

Demographic Characteristics

The study surveyed 356 graduate students enrolled in statistics courses during the Spring 2022 semester at Umm al-Qura and King Abdulaziz Universities in the Colleges of Education and Social Sciences. The sample comprised 284 female participants (79.8%) and 72 male participants (20.2%). Most participants were pursuing a master's degree (n = 251, 70.5%), and the rest were enrolled in a doctorate program (n = 105, 29.5%). The sample ranged in age from 21 to 60 years old, with the highest number of participants in the 21-30-year-old group (n = 148, 41.6%) and the 31-40-year-old group (n = 156, 43.8%). The age group of 41-50 represented 13.5% (n = 48) of the sample and 1.1% (n = 4) of the participants were 51-60 years-old. Regarding participant undergraduate majors, most had non-science backgrounds (n = 238, 66.9%), while 118

(33.1%) had a science major. In terms of previous statistics experience, 42 participants (11.8%) reported never having taken a statistics course, 158 participants (44.4%) reported having taken one previous statistics course, and 156 participants (43.8%) reported having taken two or more previous statistics courses (see Table 1).

Preliminary Analyses

Data Screening

Before conducting the statistical analyses, the data were scrutinized for missing values, influential outliers, normality, linearity, and homoscedasticity assumptions. The study sample initially consisted of 380 participants. However, after excluding those not enrolled in educational or social sciences colleges, 356 participants were included in the final analysis. In order to conduct accurate statistical analyses, the responses to negatively worded items on SATS-28 were reverse scored.

Normality

The results of skewness and kurtosis revealed that all variables in the data had univariate normal distributions. Skewness for all variables were between -0.50 and 0.50, indicating the distributions were nearly symmetric. Based on examination of the distribution value of statistics anxiety and its components (statistics examination, asking for help, and interpretation anxiety) the z-scores were -0.46, 0.49, 0.32 respectively. For the distribution of attitudes toward statistics and its components the z-scores were as follows: affect (-0.17), cognitive (-0.33), difficulty (-0.05), and value (-0.59). The z-score of descriptive statistics self-efficacy was 0.01, while the z-score of inferential statistics self-efficacy was 0.43. All skewness values were within 3 standard deviations of the mean. Therefore, all variables had univariate normal distributions (see Table 2).

Table 1

Demographic Characteristics of Participants in the Data (N = 356)

	N	%
Gender		
Male	72	20.2
Female	284	79.8
Age		
21-30	148	41.6
31- 40	156	43.8
41- 50	48	13.5
51- 60	4	01.1
Degree Currently Seeking		
Master	251	70.5
Doctorate	105	29.5
Undergraduate Major		
Science	118	33.1
Non-science	238	66.9
Previous Statistics Classes		
0	42	11.8
1	158	44.4
2 or more	156	43.8

Table 2

Descriptive Statistics for All Variables (N = 356)

	M	*SD*	Min	Max	Skewness
Statistics anxiety	2.93	0.98	1	5	0.18
Examination anxiety	3.48	1.14	1	5	-0.46
Asking for help	2.51	1.11	1	5	0.49
Interpretation anxiety	2.79	1.05	1	5	0.32
Attitudes toward statistics	3.22	0.74	1	5	-0.43
Affect	3.23	1.03	1	5	-0.17
Cognitive	3.38	0.83	1	5	-0.33
Difficulty	2.70	0.69	1	5	-0.05
Value	3.50	0.89	1	5	-0.59
Statistics self-efficacy	3.24	1.09	1	6	0.17
Descriptive	3.54	1.23	1	6	0.01
Inferential	2.90	1.09	1	6	0.43

Linearity

Linearity is used to assess the linear relationships between latent variables by checking bivariate scatterplots. A bivariate scatterplot of statistics anxiety versus attitudes toward statistics, and a bivariate scatterplot of statistics anxiety versus statistics self-efficacy showed linear shapes which indicate that the best-fitted functions representing the scatterplot is a straight line. Therefore, the assumption of linearity was met and these variables were linearly associated with each other.

Homoscedasticity

Levene's tests were used to assess homoscedasticity. The equal levels of variability across gender, age, and degree seeking status of the participants were assessed

for the students' statistics anxiety, attitudes toward statistics, and statistics self-efficacy. All p-values of Levene's tests were not statistically significant at $\alpha = .05$. Thus, the assumption of homoscedasticity was met.

Exploratory Factor Analysis

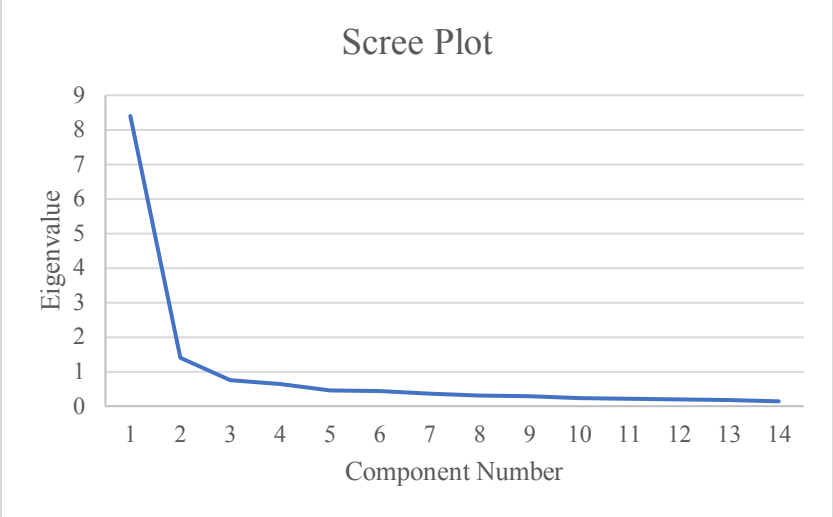
Since there were no theories regarding the nature of the CSSE scale's underlying factor structure, exploratory factor analysis (EFA) was used to determine the structure of the scale's underlying constructs factor and explored how the items were grouped. The EFA was also used to assess the internal reliability of the scale.

Principal component analysis was performed using oblique rotation since the subcategories are typically correlated (Field, 2013). The results of the CSSES analyses were analyzed and interpreted using three different methods. The first method used the Kaiser criterion, which looked at items with eigenvalues greater than one. The second method involved examining scree plots to identify components with sharp eigenvalue descent before leveling off. The final method ensured that the components accounted for at least 70% of the total variability.

The Kaiser criterion was used for factors with eigenvalues greater than +1; two factors were extracted. The cumulative variance for the factors was 69.95%. Upon examination of the Scree Plot (Figure 3), the first component was larger in eigenvalue magnitude than other components. Upon further examination, the second component had higher eigenvalues than the remaining components. The line began to level off at the third component. Therefore, the number of factors was restricted to two. All items loaded above 0.50 on their respective factors and were placed in the categories that resulted from the analysis as shown in Table 3.

Figure 3

Scree Plot for Principal Component Analysis of CSSES



The factors represent logical classification categories as follows: Factor I was Descriptive Statistics which summarizes data using indexes such as central tendency (Mishra et al., 2019). These items address students' abilities to identify and distinguish between descriptive analyses such as central tendency, sampling distribution, and population parameters (e.g., "Identify the scale of measurement for a variable," "Identify when the mean, median, and mode should be used as a measure of central tendency"). Factor II was Inferential Statistics, which uses statistical analyses to draw conclusions from data (Mishra et al., 2019). These items address students' abilities to select the appropriate statistical test to be used to answer research questions and interpret the results (e.g., "Interpret the probability value (*p*-value) from a statistical procedure," "Identify the factors that influence power").

Table 3

Factor Loading of the Statistics Self-Efficacy Survey

	Item	Factor Loading	
		1	2
1	Identify the scale of measurement for a variable.		.71
2	Interpret the probability value (*p*-value) from a statistical procedure.	.68	
3	Identify if a distribution is skewed when given the values of three measures of central tendency.		.74
4	Select the correct statistical procedure to be used to answer a research question.	.79	
5	Interpret the results of a statistical procedure in terms of the research question.	.83	
6	Identify the factors that influence power.	.87	
7	Explain what the value of the standard deviation means in terms of the variable being measured.	.82	
8	Distinguish between a Type I error and a Type II error in hypothesis testing.	.87	
9	Explain what the numeric value of the standard error is measuring.	.85	
10	Distinguish between the objectives of descriptive versus inferential statistical procedures.		.76
11	Distinguish between the information given by the three measures of central tendency.		.88
12	Distinguish between a population parameter and a sample statistic.		.84
13	Identify when the mean, median and mode should be used as a measure of central tendency.		.89
14	Explain the difference between a sampling distribution and a population distribution.		.83

Notes: Extraction Method: Principal Component Analysis; Rotation Method: Promax with Kaiser Normalization.

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Reliability Estimates

Reliability estimates were conducted using SPSS 28 to assess the consistency of participants' responses. A Cronbach's alpha was calculated for each scale on the ordinal response (SAS, SATS, and CSSES) to analyze the internal consistency of items. Table 4 presents Cronbach's alpha statistics for the scales and subscales. The alpha coefficient for the three scales was .90 or higher (α = .96 on the 24 items of the SAS, α = .94 on the 28 items of the SATS, and α = .95 on the 14 items of the CSSES), indicating acceptably high levels of reliability (Brown, 2002; Taber, 2018).

Table 4

Cronbach's Alpha for Primary Factors (N = 356)

Variable	Sub-Construct	N^a	Cronbach's alpha
Statistics Anxiety	Examination anxiety	8	.93
	Asking for help	8	.92
	Interpretation anxiety	8	.90
Attitudes Toward Statistics	Affect	6	.90
	Cognitive	6	.83
	Value	9	.89
	Difficulty	7	.76
Current Statistics Self-Efficacy	Descriptive Statistics	7	.91
	Inferential Statistics	7	.93

Note: [a] Number of items in each scale

Testing the Research Questions

In this section, the results of the study are presented and organized according to the research questions:

Q_1. What are the levels of statistic anxiety, attitudes toward statistics, and statistics self-efficacy among graduate students in Saudi Arabia?

The mean score of statistics anxiety ranged between 1 (no anxiety) and 5 (extremely anxiety). Based on Table 2, results indicated that, on average, graduate students reported moderate level of statistics anxiety (M = 2.93, SD = 0.98). Graduate students reported the highest responses in the examination anxiety subscale (M = 3.48, SD = 1.14), followed by the interpretation anxiety subscale (M = 2.79, SD = 1.05), and finally the asking for help subscale (M = 2.51, SD = 1.11).

Participants also rated their attitudes toward statistics from 1 (strongly disagree) to 5 (strongly agree). Attitudes toward statistics had a mean of 3.22 and a standard

deviation of 0.74. Results indicated that, on average, graduate students reported a moderate positive attitude toward statistics. Graduate students reported the highest responses in the value component (M = 3.50, SD = 0.89), followed by the cognitive component (M = 3.38, SD = 0.83), then the affect component (M = 3.23, SD = 1.03), and the lowest responses in the difficulty component (M = 2.70, SD = 0.69) (see Table 4).

In regard to current statistics self-efficacy, students responded to a scale range from 1 (no confidence at all) to 6 (completely confidence). As shown in Table 2, results indicated that statistics self-efficacy had a moderate mean (M = 3.24, SD = 1.09). Participants reported higher responses in descriptive statistics (M = 3.50, SD = 1.23). than inferential statistics (M = 2.90, SD = 1.09).

Table 5 shows the descriptive analyses for level of examination anxiety items. The percentages in Table 5 show responses for the options 4 (agree) and 5 (strongly agree). The scale level of examination anxiety indicated that the highest level of anxiety among the participants (73.6 %) was item 20 “Going to a statistics exam without having had enough time to revise” (M = 4.11, SD = 1.24). On the other hand, 44.4 % of the participants reported that item 13 “Getting to the day before an exam without having had time to revise the syllabus” was the lowest level of anxiety among the examination anxiety factor (M = 3.18, SD = 1.46).

Table 5

Scale and Item Level of Examination Anxiety (N = 356)

	Item	*M*	*SD*	%
20	Going to a statistics exam without having had enough time to revise	4.11	1.24	73.6
15	Realizing, just before you go into the exam, that I have not prepared a particular exercise	3.77	1.35	63.8
14	Waking up in the morning on the day of a statistics test	3.46	1.48	53.9
9	Doing the final examination in a statistics course	3.43	1.43	52.2
1	Studying for an examination in a statistics course	3.35	1.38	47.8
4	Realizing the day before an exam that I cannot do some problems that I thought were going to be easy	3.34	1.33	48.3
11	Walking into the classroom to take a statistics test	3.20	1.49	45.6
13	Getting to the day before an exam without having had time to revise the syllabus	3.18	1.46	44.4

Note: % represents the percentages of "considerable anxiety" and "extremely anxiety" responses.

Table 6 shows the descriptive analyses for level of asking for help items. Analysis indicated that item 7 "Asking the teacher how to use a probability table" noted the highest anxiety level (28.1%) among the graduate students ($M = 2.63$, $SD = 1.41$). However, 22.5 % of participants reported that item 17 "Asking one of your teachers for help in understanding a printout" had the lowest anxiety level of the asking for help anxiety factor ($M = 2.39$, $SD = 1.39$).

Table 6

Scale and Item Level of Asking for Help (N = 356)

	Item	*M*	*SD*	%
7	Asking the teacher how to use a probability table	2.63	1.41	28.1
21	Asking a teacher for help when trying to interpret a results table	2.61	1.39	26.4
3	Going to ask my statistics teacher for individual help with material I am having difficulty understanding	2.54	1.37	25.6
12	Asking the teacher about how to do an exercise	2.54	1.36	24.4
23	Going to the teacher's office to ask questions	2.53	1.41	27.0
21	Asking a private teacher to explain a topic that I have not understood at all	2.43	1.41	23.9
24	Asking a private teacher to tell me how to do an exercise	2.43	1.34	20.5
17	Asking one of your teachers for help in understanding a printout	2.39	1.39	22.5

Note: % represents the percentages of "considerable anxiety" and "extreme anxiety" responses.

Table 7 shows the scale level of interpretation anxiety items, which indicated that half of the participants (50.3 %) agreed that item 2 "Interpreting the meaning of a table in a journal article" was the highest level of interpretation anxiety ($M = 3.46$, $SD = 1.30$), while 16.8 % of the participants agreed that item 19 "Seeing a classmate carefully studying the results table of a problem he has solved" was the lowest level of the interpretation anxiety factor ($M = 2.29$, $SD = 1.26$).

Table 7

Scale and Item Level of Interpretation Anxiety (N = 356)

	Item	*M*	*SD*	%
2	Interpreting the meaning of a table in a journal article	3.46	1.30	50.3
8	Trying to understand a mathematical demonstration	2.89	1.40	36.2
22	Trying to understand the statistical analyses described in the abstract of a journal article	2.89	1.35	33.7
10	Reading an advertisement for an automobile which includes figures on gas mileage, compliance with population regulations, etc.	2.80	1.40	33.4
6	Reading a journal article that includes some statistical analyses	2.79	1.39	32.0
18	Trying to understand the odds in a lottery	2.60	1.33	24.5
16	Copying a mathematical demonstration from the blackboard while the teacher is explaining it	2.57	1.40	25.3
19	Seeing a classmate carefully studying the results table of a problem he has solved	2.29	1.27	16.8

Note: % represents the percentages of "considerable anxiety" and "extremely anxiety" responses.

Table 8 shows the mean score for each item under the affect attitude component. The respondents exhibited their agreement and disagreement toward the items in the component. The percentages in Table 8 show responses for 4 (agree) and 5 (strongly agree). Participants showed a highly positive attitude toward item 15 "I will enjoy taking statistics courses" (M = 3.38, SD = 1.23), item 1 "I will like statistics" (M = 3.35, SD = 1.26), and item 2 "I will feel insecure when I have to do statistics problems" (M = 3.16, SD = 1.26). On the other hand, a negative attitude was displayed for item 21 "I am scared by statistics" (M = 2.77, SD = 1.30), item 14 "I will be under stress during statistics classes" (M = 2.72, SD = 1.30), and item 11 "I will get frustrated going over statistics tests in class" (M = 2.69, SD = 1.21).

Table 8

Scale and Item Level of Affect (N=356)

	Item	*M*	*SD*	Positive attitude %
15	I will enjoy taking statistics courses	3.38	1.24	51.1
1	I will like statistics	3.35	1.27	50.0
2	I will feel insecure when I have to do statistics problems	3.16	1.26	45.5
21	I am scared by statistics	2.77	1.30	33.2
14	I will be under stress during statistics classes	2.72	1.29	30.6
11	I will get frustrated going over statistics tests in class	2.69	1.21	26.7

Note: % represents the percentages of "agree" and "strongly agree" responses

Table 9 shows the mean score for each item under the cognitive attitude component. Participants have shown a highly positive attitude toward item 24 “I will understand statistics equations” (M = 3.94, SD = 0.89). However, a highly negative attitude was displayed for item 9 “I will have no idea of what's going on in statistics” (M = 2.75, SD = 1.32).

Table 10 shows the mean score for each item under the difficulty attitude component. Participants showed a highly positive attitude toward item 18 “learning statistics requires a great deal of discipline” (M = 4.19, SD = 0.83), while a highly negative attitude was displayed for item 6 “statistics is a complicated subject” (M = 2.90, SD = 1.18).

Table 9

Scale and Item Level of Cognitive (N=356)

	Item	*M*	*SD*	Positive attitude%
24	I will understand statistics equations	3.94	0.89	78.1
23	I can learn statistics	3.28	1.05	48.0
27	I will find it difficult to understand statistics concepts	2.97	1.14	36.3
20	I will make a lot of math errors in statistics	2.79	1.11	30.0
3	I will have trouble understanding statistics because of how I think	2.75	1.36	32.6
9	I will have no idea of what's going on in statistics	2.43	1.17	17.4

Note: % represents the percentages of “agree” and “strongly agree” responses

Table 10

Scale and Item Level of Difficulty (N=356)

	Item	*M*	*SD*	Positive attitude %
18	Learning statistics requires a great deal of discipline.*	4.19	0.83	86.8
26	Statistics is highly technical.*	3.55	1.05	59.0
22	Statistics involves massive computations.*	3.40	1.05	53.1
28	Most people have to learn a new way of thinking to do statistics.*	3.24	1.10	45.8
4	Statistics formulas are easy to understand	3.15	1.13	40.7
17	Statistics is a subject quickly learned by most people	3.01	1.08	37.4
6	Statistics is a complicated subject.*	2.90	1.19	33.7

Note: % represents the percentages of "agree" and "strongly agree" responses; *indicates items that were reversed scored

Table 11 shows the mean score for each item under the value attitude component. Participants showed a highly positive attitude toward item 7 "statistics should be a required part of my professional training" (*M* = 3.71, *SD* = 1.33). A negative attitude was displayed for item 5 "statistics is worthless" (*M* =1.92, *SD* =1.13).

Table 12 shows the mean score for each item under statistics self-efficacy scale. Respondents exhibited their confidence with each item and showed high confidence toward item 11 "Distinguish between the information given by the three measures of central tendency" (*M* = 4.28, *SD* = 1.56). The lowest confidence score was displayed for item 9 "Explain what the numeric value of the standard error is measuring" (*M* = 2.54, *SD* = 1.72).

Table 11

Scale and Item Level of Value (N = 356)

	Item	*M*	*SD*	Positive attitude (%)
7	Statistics should be a required part of my professional training	3.71	1.33	65.2
8	Statistical skills will make me more employable	3.60	1.11	54.2
13	I use statistics in my everyday life.	3.13	1.22	45.0
25	Statistics is irrelevant in my life*	2.80	1.21	28.4
12	Statistical thinking is not applicable in my life outside my job*	2.70	1.29	27.8
10	Statistics is not useful to the typical professional*	2.61	1.27	25.6
16	Statistics conclusions are rarely presented in everyday life*	2.47	1.15	18.8
19	I will have no application for statistics in my profession*	2.42	1.16	18.6
5	Statistics is worthless*	1.92	1.13	11.3

Note: % represents the percentages of “agree” and “strongly agree” responses,*indicates items that were reversed scored

Table 12

Scale and Item Level of Statistics Self-Efficacy (N = 356)

	Item	*M*	*SD*	%
11	Distinguish between the information given by the three measures of central tendency	4.28	1.57	67.5
13	Identify when the mean, median and mode should be used as a measure of central tendency	4.03	1.59	62.1
14	Explain the difference between a sampling distribution and a population distribution	3.62	1.54	49.4
12	Distinguish between a population parameter and a sample statistic	3.58	1.58	50.0
1	Identify the scale of measurement for a variable	3.41	1.36	43.0
10	Distinguish between the objectives of descriptive versus inferential statistical procedures	3.28	1.48	41.6
3	Identify if a distribution is skewed when given the values of three measures of central tendency	3.15	1.42	35.4
5	Interpret the results of a statistical procedure in terms of the research question	3.11	1.36	37.1
7	Explain what the value of the standard deviation means in terms of the variable being measured	3.03	1.319	34.3
4	Select the correct statistical procedure to be used to answer a research question	3.02	1.36	33.1
2	Interpret the probability value (*p*-value) from a statistical procedure	2.83	1.38	26.5
6	Identify the factors that influence power	2.78	1.24	24.5
8	Distinguish between a Type I error and a Type II error in hypothesis testing	2.71	1.29	23.6
9	Explain what the numeric value of the standard error is measuring	2.54	1.27	19.7

Note: % represents the percentages of "much confidence," "very much confidence," and "complete confidence" responses.

Q_2. To what extent do attitudes toward statistics, current statistics self-efficacy, and previous statistics experience explain graduate student Statistics Anxiety at Umm Al-Qura and King Abdul-Aziz University in Saudi Arabia?

To respond to the second question, which indicates to what extent the Structural Variance-covariance matrix is equivalent to the empirical covariance matrix, SEM with Maximum Likelihood estimation (MLE) method was conducted. The criteria used to determine acceptable model fit include: "Goodness of Fit Index (GFI ≥ .95), Comparative Fit Index (CFI ≥ .95), Normed Fit Index (NFI ≥ .95), Tucker-Lewis Index (TLI ≥ .90), Relative Fit Index (RFI ≥ .95), Incremental Fit Index (IFI ≥ .95), Root Mean Square Error of Approximation (RMSEA ≤ .06), and Standardized Root Mean Square Residual (SRMSR ≤ .10). Values between .90 and .95 indicate an acceptable level of fit" (Meyers et al., 2016, p. 611). Chi-square is one of the fit indexes used to evaluate model fit. However, it is not recommended when evaluating models that involve a large sample size (Bentler, 1990). If the sample size is large, it can be difficult to reach a non-significant Chi-square (Hooper et al., 2008). However, the value of Chi-square divided by its degree of freedom between 2 and 5 is recommended as an acceptable fit (Marsh & Hocevar, 1985).

Means and standard deviations of the observed variables are presented in Table 13. The variables' mean scores were as follows: Examination Anxiety (M = 3.48, SD = 1.14), Interpretation Anxiety (M = 2.79, SD = 1.05), Asking for Help (M = 2.51, SD = 1.11), Value (M = 3.50, SD = 0.89), Cognitive (M = 3.38, SD = 0.83), Affect (M = 3.23, SD = 1.03), Difficulty (M = 2.70, SD = 0.69), Descriptive Statistics Self-Efficacy (M = 3.54, SD = 1.23), and Inferential Statistics Self-Efficacy (M = 2.90, SD = 1.09).

Table 13

Means and Standard Deviations for Measured and Latent Variables

	M	*SD*
Statistics anxiety	2.93	0.98
Examination anxiety	3.48	1.14
Asking for help	2.51	1.11
Interpretation anxiety	2.79	1.05
Attitudes toward statistics	3.22	0.74
Affect	3.23	1.03
Cognitive	3.38	0.83
Difficulty	2.70	0.69
Value	3.50	0.89
Statistics self-efficacy	3.24	1.09
Descriptive	3.54	1.23
Inferential	2.90	1.09

Zero-order correlations among all observed and latent variables were computed and found to be statistically significant ($p < .05$). However, the majority of the correlations were weak to moderate in magnitude, indicating a low level of collinearity among the variables (see Table 14).

Table 14

Measured and Latent Variables Correlation

Variable	SAS	SATS	CSSE	EA	AFH	I	A	D	C	V	DS	IS
SAS		-.639**	-.512**	.859**	.905**	.927**	-.711**	.485**	.598**	.433**	-.524**	-.451**
SATS			.548**	-.571**	-.537**	-.611**	.900**	.795**	.904**	.840**	.586**	.531**
CSSE				-.422**	-.446**	-.513**	.531**	.491**	.549**	.456**	.957**	.947**
EA					.615**	.684**	-.678**	-.472**	-.493**	-.357**	-.425**	-.394**
AFH						.891**	-.678**	-.472**	-.493**	-.357**	-.464**	-.370**
I							-.641**	-.448**	-.585**	-.444**	-.525**	.450**
A								.678**	.814**	.629**	.540**	.484**
D									.731**	.466**	.477**	.465**
C										.636**	.553**	.492**
V											.460**	.406**
DS												.826**

Note: EA: Examination Anxiety, AFH: Asking for Help, I: Interpretation Anxiety, A: Affect, D: Difficulty, C. Cognitive, V: value, DS: Descriptive statistics self-efficacy, IS: Inferential statistics self-efficacy. **These correlations are statistically significant at $p < .01$, $N = 356$.

The Hypothesized Model

The adequacy of the hypothesized model (Figure 4), which examines the relationship between variables and their effect on statistics anxiety, was assessed. Although the model exhibited a statistically significant Chi-square value of 146.010 (38, $n = 356$), $p < .001$, indicating a large value, other fit indices were considered to account for sample size (Schermelleh-Engel et al., 2003). The GFI, NFI, TLI, CFI, and CMIN/DF fit indices showed good fit (GFI = .94, NFI = .94, TLI = .94, CFI = .96, CMIN/DF = 3.84), with values greater than .90 (Meyers et al., 2013). The RMSEA (.08) and SRMR (.04) values were also less than or equal to the optimal fit of .08. Thus, the data confirmed the hypothesized model within an acceptable range. The model explained approximately 53% ($R^2 = .53$) of the variance in statistics anxiety.

All the paths in the model were found to be not significant at $p < .05$: the path from Previous Statistics Experience (PSE) to Statistics Anxiety (SAS) ($\beta = .05$, $p = .877$); the path from Previous Statistics Experience (PSE) to Current Statistics Self-Efficacy (CSSE) ($\beta = .77$, $p = .220$); the path from Current Statistics Self-Efficacy (CSSE) to Statistics Anxiety (SAS) ($\beta = -.17$, $p = .353$); the path from Previous Statistics Experience to Attitudes Toward Statistics (SATS) ($\beta = .41$, $p = .618$); and the path from Current Statistics Self-Efficacy (CSSE) to Attitudes Toward Statistics (SATS) ($\beta = .32$, $p = .616$). However, the path from Attitudes Toward Statistics (SATS) to Statistics Anxiety (SAS) ($\beta = -.58$, $p = <.001$) was significant as reported in Table 15.

Figure 4

The Hypothesized Model (Model 1)

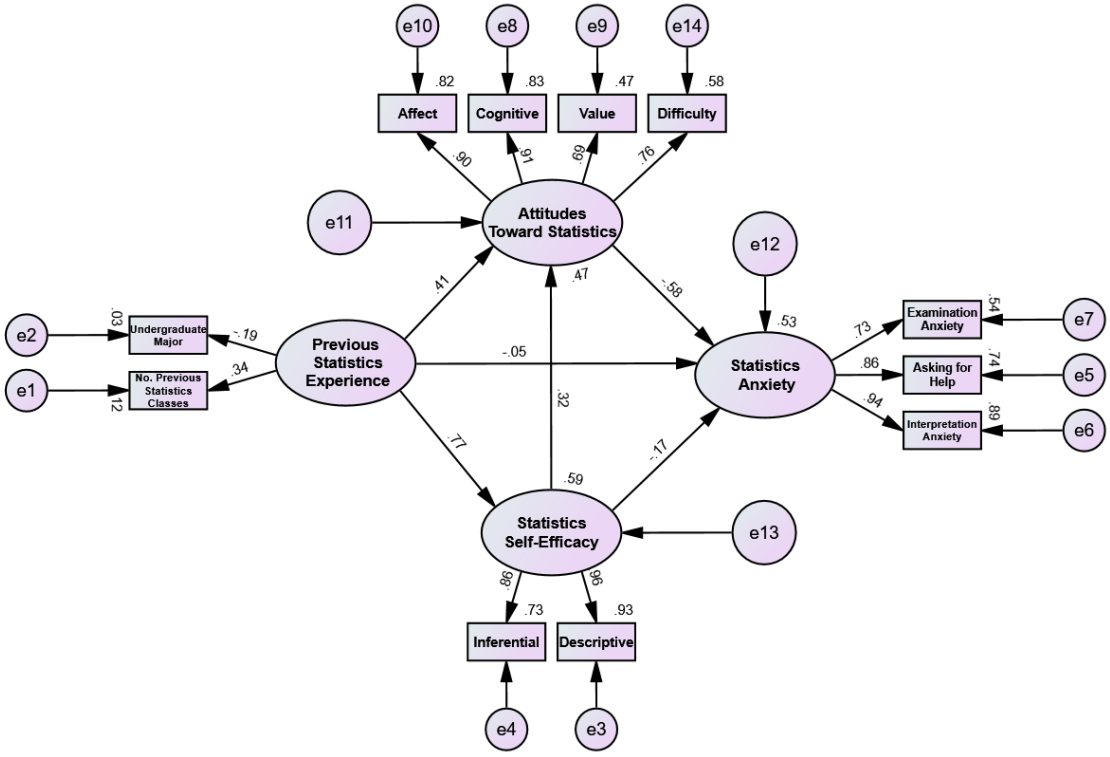

Table 15

Hypothesized Model Estimates (Model 1)

Path	ß	*B*	*S.E.*	*p*
PSE ---> SATS	.41	1.67	3.34	.618
PSE ---> CSSE	.77	3.94	3.21	.220
PSE ---> SAS	.05	-0.19	1.26	.877
SATS ---> SAS	-.58	-0.61	0.11	<.001***
CSSE ---> SAS	-.17	-0.14	0.15	.353
CSSE ---> SATS	.32	0.25	0.49	.616

Note: ***$p < .001$

The Re-specified Model

Several recommendations were provided to improve the fit of the model with the data and significant correlations, such as adding or removing paths or correlations and covarying error terms if they align with theoretical reasoning (Meyers et al., 2016). According to AMOS suggested modifications, two error pairs were identified, and their correlations were incorporated into a re-specified model. In addition, the removal of the relationship between Statistics Self-Efficacy and Attitudes Toward Statistics was found to significantly impact the model's ability to predict Statistics Anxiety (Figure 5). The results indicated that although the Chi-square remained statistically significant, 126.722 (38, n = 356), p < .001, the model had a good fit to the data based on the GFI = .94, NFI = .95, IFI = .96, TLI = .95, CFI = .96, RMSEA = .08, and SRMR = .04 (Meyers et al., 2013). The model configuration explained about 55% (R^2 = .55) of the variance in Statistics Anxiety (see Table 16).

Figure 5

Re-specified Structural Models (Model 2)

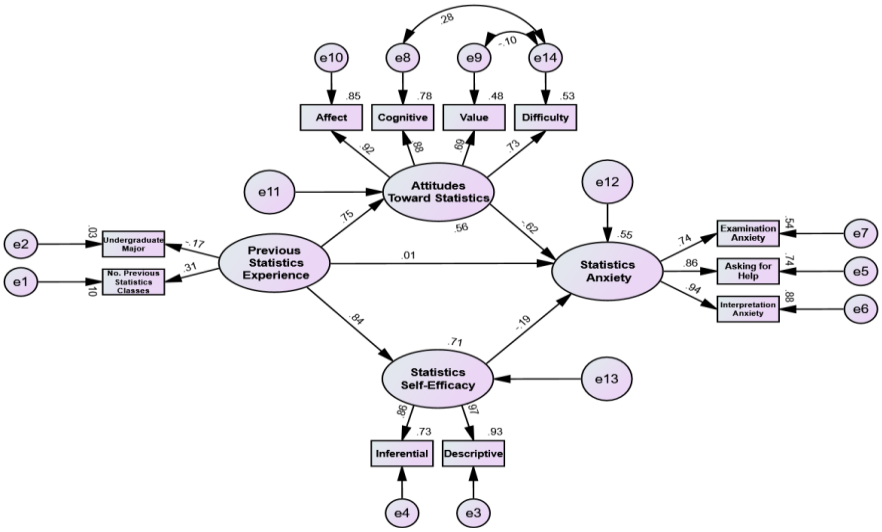

Table 16

Re-specified Model Estimates (Model 2)

Path	ß	*B*	*S.E.*	*p*
PE ---> SATS	.75	3.44	0.71	<.001***
PE ---> CSSE	.84	4.80	1.08	<.001***
PE ---> SAS	.01	0.05	2.45	.985
SATS ---> SAS	-.62	-0.64	0.21	.002**
CSSE ---> SAS	-.19	-0.16	0.27	.563

Note: ** $p < .01$, ***$p < .001$

Four paths were involved in the indirect effects from Previous Statistics Experience to Statistics Anxiety. As Table 17 shows, the path from Previous Statistics Experience to Attitudes Toward Statistics (ß = .75, *B* = 3.44, *SE* = 0.71, *p* = <.001), and the path from Attitudes Toward Statistics to Statistics Anxiety were significant (ß = -.62, *B* = -0.64, *SE* = 0.21, *p* = .002). The path from Previous Experience to Statistics Self-Efficacy (ß = .84, *B* = 4.80, *SE* = 1.08, *p* < .001) was significant, but the path from Statistics Self-Efficacy to Statistics Anxiety (ß = -.19, *B* = -0.16, *SE* = 0.27, *p* = .563) was not significant. Furthermore, the direct path from Previous Statistics Experience to Statistics Anxiety was also not significant (ß =.01, *B* = 0.05, *SE* = 2.45, *p* = .985), suggesting complete mediation. The unmediated model was also analyzed, and it was found that the path from Previous Experience to Statistics Anxiety was not statistically significant in this model (ß = -.60, *B* = -2.49, *SE* = 2.15, *p* = .248)

.

Table 17

Chi-Square and Goodness of Fit for Models

Model	X^2	*df*	GFI	CFI	NFI	TLI	SRMR	RMSEA
Hypothesized	146.01	38	937	.955	.940	.935	.039	.089
Re-specified	126.72	38	.942	.963	.948	.945	.037	.083

$Q_{3.}$ Do attitudes toward statistics and current statistics self-efficacy mediate the relationship between previous statistics experience and statistics anxiety?

The present study examined the mediating role of Attitudes Toward Statistics (SATS) and Current Statistics Self-Efficacy (CSSE) on the association between Previous Statistics Experience (PSE) and Statistics Anxiety (SAS). The findings showed that the indirect effect of PSE on SAS through SATS was significant (ß = -.47, *B* = -2.14, *p* = .031). While the mediating effect of CSSE on the relationship between PSE and SAS was not significant (ß = -.16, *B* = -0.72, *p* = .540), the direct effect of PSE on SAS in the presence of the mediators was not significant (ß = .01, *B* = 0.05, *p* = .985). Therefore, the results indicated that Attitudes Toward Statistics completely mediated the relationship between Previous Statistics Experience and Statistics Anxiety (see Table 18).

Table 18

Summary of Direct and Indirect Effects

Relationship	Direct Effect	Indirect Effect	Confidence Interval		*p*	Decision	Conclusion
			Lower Bound	Upper Bound			
PSE ---> SAS	.01	--	-1.99	1.68	.985	Non-Significant	no Effect
PSE -- > SATS-- > SAS	--	-.47	-8.03	-0.54	.031*	Significant	Full Effect
PSE -- > CSSE-- > SAS	--	-.16	-7.05	6.01	.540	Non-Significant	no Effect

Note: * $p < .05$

Q_4. Are there gender differences in the conceptualized model of statistics anxiety?

A multigroup structural equation modeling analysis was conducted to investigate potential gender differences in the research model. The Chi-square difference test did not reveal a significant difference between males and females ($\chi^2 = 14.60$, $df = 8$, $p = .067$), indicating that the model is equally applicable to both genders. Furthermore, at the individual path level, no significant gender differences were observed in the model (see Table 19). The model explained approximately 58% ($R^2 = .58$) of the variance in Statistics Anxiety for males, and 55% ($R^2 = .55$) for females.

In addition, two indirect paths (Table 20) were tested for multi-group differences: PSE → SATS → SAS and PSE → CSSE → SAS in a structural equation model for Statistics Anxiety, where the predictor variables are Previous Statistics Experience (PSE), Current Statistics Self-Efficacy (CSSE), and Attitudes Toward Statistics (SATS). There were no significant gender differences in the model.

Table 19

Multigroup Analysis for Direct Paths

Path	Gender	Estimates	*B*	*S.E*	*p*	*DF*	CMIN	*P*
PSE→SATS	Male	.81	2.38	0.52	<.001***	1	0.05	.815
	Female	.75	2.38	0.52	<.001***			
PSE→CSSE	Male	.83	4.83	1.10	<.001***	1	0.04	.838
	Female	.84	5.41	1.10	<.001***			
SATS→SAS	Male	-.69	-0.94	0.28	.001**	1	0.62	.431
	Female	-.69	-0.63	0.28	.001**			
CSSE→SAS	Male	-.32	-0.21	0.20	.295	1	1.73	.188
	Female	-.29	0.11	0.20	.295			
PSE→SAS	Male	.20	0.80	1.96	.683	1	1.39	.238
	Female	.19	-2.19	1.96	.683			

Note: * $p < .05$, ** $p < .01$, ***$p < .001$

Table 20

Multigroup Analysis for Indirect Paths

Path		*B*	*p*
PSE→SATS→SAS	Male	-2.21	.038*
	Female	-2.21	.038*
PSE→CSSE→SAS	Male	-1.03	.643
	Female	-1.03	.643

Note: * $p < .05$

Summary of Findings

Based on the findings presented in Chapter 4, it can be concluded that attitudes toward statistics are negatively associated with statistics anxiety. Furthermore, previous statistics experience was found to positively predict attitudes toward statistics and current statistics self-efficacy.

Mediation analysis revealed there was a significant indirect effect between previous statistics experience and statistics anxiety through attitudes toward statistics, suggesting that it significantly mediates the relationship between previous statistics experience and statistics anxiety, resulting in full mediation.

In addition, a multigroup analysis was conducted to examine potential gender differences in the research model. The results indicated that the model was equally applicable to both males and females, and no significant gender differences were observed at the individual path level. However, the model explained approximately 58% of the variance in statistics anxiety for males and 55% for females.

Conclusion

Chapter 4 presented the results of the data analysis. The chapter began by describing the data characteristics and providing an overview of the sample screening and preliminary analysis. The validity and reliability of the current study's instrumentation were also discussed. Next, the study's main findings were presented in relation to each research question. The results indicated that attitudes toward statistics and previous statistics experience were significant predictors of statistics anxiety. Mediation analysis showed that attitudes toward statistics mediates the relationship between previous statistics experience and statistics anxiety. Moreover, the study found no gender differences in the research model. Overall, these findings contribute to a better understanding of the factors that influence statistics anxiety among graduate students.

CHAPTER 5

SUMMARY, CONCLUSIONS, IMPLICATIONS, AND RECOMMENDATIONS

Introduction

This chapter provides an overview of the study's objective, research problem, literature review, importance of the study, research questions, and methodology. Furthermore, the results of the study are presented in this chapter, along with a discussion of the findings based on the literature review. The final section acknowledges the limitations that influenced the findings and provides suggestions for future studies and educational practice.

Research Problem

Graduate students, particularly those pursuing degrees in the humanities and social sciences, must take statistics as a required course. For a large number of graduate students, statistics is seen as a burden and an impediment to obtaining their degree (Dykeman, 2011; Koh & Zawi, 2014). As a result, many students put off taking statistics classes until the very last minute, right before they graduate (Ali, 2020; Chew & Dillon, 2014b; Macher et al., 2013). Many graduate students taking statistics quit because of their fear of statistics, which has both a direct and indirect impact on their academic performance (Onwuegbuzie & Wilson, 2003; Supsopha, 2008).

Students who experience statistics anxiety have poorer academic performance than those who do not. According to Onwuegbuzie (2004), statistics anxiety hinders the

performance of around 80% of graduate students. As a result, these students are more likely to drop out of school or take an excessively long time to graduate (De Vink, 2017).

The vast majority of theoretical models of statistics anxiety concentrate on attempting to predict how students will perform in statistics classes. This research aimed to develop and experimentally test a model to discover particular variables that could reduce student anxiety regarding statistics while simultaneously improving positive attitudes toward statistics and high statistics self-efficacy. Statistics anxiety and other variables were included in the development of a conceptual model. However, the model's primary focus was on how independent variables could predict statistics anxiety among graduate students majoring in educational and social science. The use of this approach ought to improve the quality of statistical research and instruction in higher education.

The Purpose of the Study

This study aimed to assess the level of statistics anxiety among graduate students in Saudi Arabia's colleges of education and social sciences taking statistics courses as part of their academic requirements. In this study, a model was developed and tested empirically to predict graduate students' statistics anxiety and assess the impact of relevant factors (previous statistics experience, attitudes toward statistics, and statistics self-efficacy) on this anxiety.

Research Questions

This study carried out an analysis that predicted statistics anxiety among Saudi Arabian graduate students. The hypotheses suggested in the theoretical model were tested using non-experimental methodology; the observed sample covariance matrices were

equal, indicating that the structural model would fit well with the observed data. The following research questions were investigated in light of the hypothesized model:

1. What are the levels of statistics anxiety, attitudes toward statistics, and statistics self-efficacy among graduate students at Umm Al-Qura and King Abdul-Aziz University in Saudi Arabia?

2. To what extent do previous statistics experience, attitudes toward statistics, and statistics self-efficacy explain graduate students' statistics anxiety at Umm Al-Qura and King Abdul-Aziz University in Saudi Arabia?

3. Do attitudes toward statistics and statistics self-efficacy mediate the relationship between previous statistics experience and statistics anxiety?

4. Are there gender differences in the conceptualized model of statistics anxiety?

Significance of the Study

Many graduate students label statistics classes as the most anxiety-inducing classes in their program (Chau, 2018). *Statistics anxiety* is "the apprehension that occurs when a student encounters anxiety in any form and at any level when doing statistics" (Onwuegbuzie et al., 1997, p. 28). Statistics anxiety causes troubling thoughts, nervousness, and panic, affecting student learning (Steinberger, 2020). In addition, students with advanced statistics anxiety are less capable of concentrating and maintaining focus on statistical tasks and instructor instructions, which results in increased academic failure compared to their peers who lack anxiety (Abd Hamid & Sulaiman, 2014).

This study aimed to enhance graduate student statistical achievement by assessing statistics anxiety levels and determining the factors predicting statistics anxiety among

graduate students in Saudi Arabia, such as previous statistics experience, attitudes toward statistics, and statistics self-efficacy. This study also investigated whether the model of statistics anxiety differed between male and female graduate students.

The results of this study will be helpful and deliver multiple benefits to educators and graduate students. First, the study will increase the knowledge about statistics anxiety experienced by graduate students in educational and social sciences programs. This additional knowledge may be informative to statistics instructors as they plan their teaching methods based on a better understanding of student statistics anxiety and the factors that affect their performance in statistics courses. Second, although much research has been done in this area, not enough findings exist for application of the findings to populations not yet examined, such as Saudi Arabian graduate students enrolled in statistics courses. Therefore, the study was important because it documented Saudi graduate student experiences, which may be a springboard for future research and implementation of interventions to reduce statistics anxiety and increase performance in statistics courses, specifically in the Middle East.

Summary of the Literature

This section provides a brief historical overview of the critical variables of this study and continues with a discussion of their interrelationships based on research findings. Statistics anxiety among graduate students contributes to poor academic performance in statistics classes. Student learning could be hindered by a lack of awareness of the elements influencing statistics anxiety. This review explains the theoretical underpinning of statistics anxiety and the elements that drive statistics anxiety and discusses the research gap in this area. In addition, the literature study revealed a

paucity of research on statistics anxiety among graduate students in the Middle East, particularly in Saudi Arabia. Finally, the literature review concluded with the finding of a disagreement in the research that studied gender differences in statistics anxiety.

Statistics Anxiety

Statistics anxiety is prevalent among university students, particularly those majoring in non-mathematics subjects such as psychology, education, and sociology (Onwuegbuzie & Wilson, 2003; Onwuegbuzie, 2004; Ruggeri et al., 2008).

Chew and Dillon (2014c) defined statistics anxiety as "a negative emotional state stimulated from any form of interaction with statistics and exacerbated by negative attitudes toward it; this negative feeling is associated with, but separate from, mathematics anxiety" (p. 199). Many antecedent factors of statistics anxiety have been identified and classified as environmental, situational, and dispositional (Onwuegbuzie & Wilson, 2003). According to previous research, statistics experience moderates symptoms of statistics anxiety, thus previous student statistics experience relates to student self-efficacy and attitudes toward statistics, thereby impacting the degrees of statistics anxiety.

Previous Statistics Experience

According to previous studies, majors of undergraduate degrees contribute to statistics anxiety (Hagen et al., 2013; Zhang et al., 2012). For example, graduate students' mathematics skills significantly impact anxiety in statistics courses (Tutkun, 2019). Furthermore, previous statistics knowledge and earlier mathematics experience in high school are associated with statistics anxiety (Al-Otaibi, 2019). Students with an excellent foundation in mathematics and statistics are typically less anxious than those with limited

knowledge of statistics (Baloğlu, 2003). In other words, students with prior exposure to statistics exhibited less anxiety than those who had never taken a statistics course (Slootmaeckers et al., 2014).

Attitudes Toward Statistics

Attitudes toward statistics include student perspectives on statistics courses and their personal use (Cashin & Elmore, 2005). Attitudes toward statistics comprise four components: affect (student feelings concerning statistics), cognitive competence (student attitudes about their intellectual knowledge and skills as applied to statistics), value (student attitudes about the usefulness, relevance, and worth of statistics in personal and professional life), and difficulty (student attitudes about the difficulty of statistics as a subject) (Schau et al., 1995).

Researchers have determined a significant correlation between statistics anxiety and attitudes toward statistics (Chiesi et al., 2011; Macher et al., 2015). Statistics anxiety is adversely correlated with attitudes toward statistics (Mokhele, 2018). Positive attitudes toward statistics played a crucial role in reducing statistics anxiety (Najmi et al., 2018). Students with a positive attitude toward statistics are more likely to comprehend and convey statistical knowledge (Ashaari et al., 2011; Slootmaeckers et al., 2014). On the other hand, negative attitudes toward statistics may hinder students' ability to comprehend statistical subjects, resulting in statistics anxiety (Aslemand, 2018; Lalayants, 2012).

Statistics Self-Efficacy

Statistics self-efficacy is an individual's confidence in executing particular statistics-related tasks (Ogbogo & Amadi, 2018). In other words, statistical self-efficacy

measures individual beliefs regarding their ability to comprehend, analyze, and interpret statistical data (Blanco, 2011; Finney & Schraw, 2003; Leimer, 2015). Bandura (1997) revealed that the most influential factor in self-efficacy is thought to be previous experience.

Research showed that self-efficacy is one of the essential individual factors influencing statistics anxiety (Chang & Beilock, 2016; McMullan et al., 2010). Statistics self-efficacy motivates students to continue completing simple assignments and lessens their level of statistics anxiety (Finney & Schraw, 2003; Schneider, 2011). Students with strong self-efficacy make more effort and invest more time and perseverance; they also have faith in their capacity to persist in statistics (Ban, 2019). Therefore, students with high levels of perceived self-efficacy and success expectations are more likely to have lower levels of statistics anxiety, resulting in success in statistics courses (Onwuegbuzie, 2003; Pan & Tang, 2005; Papanastasiou & Zembylas, 2008).

Methodology

The factors that predict statistics anxiety, including previous statistics experience, attitudes toward statistics, and statistics self-efficacy, were examined using a quantitative, non-experimental, correlational predictive research design. In particular, a model-testing design was used to evaluate a theoretical model that contends that previous statistics experience, attitudes toward statistics, and statistics self-efficacy predict statistics anxiety among graduate students. In order to answer this research problem and comprehend the correlations between the variables, a quantitative strategy was appropriate based on the study's hypothesis and objectives. This approach produced numerical data and generalized conclusions from a broader sample population (Patten & Newhart, 2017).

In this study, previous statistics experience, attitudes toward statistics, and statistics self-efficacy were the predictor variables; statistics anxiety was the criterion variable. The study made no effort to identify a remedy for statistics anxiety or alter factors that influence it. Instead, the information gathered depicts the environment as seen by a sample of students taking statistics courses. As a result, the data analyses outline elements that affect statistics anxiety and pinpoint the most crucial aspects.

In the spring of 2022, 365 graduate students were enrolled in statistics courses. Ten classes had male students only, while fifteen classes had female students only. The final sample size, 356, was based on the total number of individuals who filled out the study instruments. The sample was randomized for precision levels, with a confidence level of 95%. The number of students in both genders was divided by the total number of study participants, then multiplied by 356 to determine the appropriate sample size for each gender.

Results and Discussion

Overview of the Sample

A sample of 356 graduate students in Saudi Arabia reported their previous statistics experience, attitudes toward statistics, statistics self-efficacy, and statistics anxiety. Demographic characteristics measured included gender, age, and degree being sought.

Reliability Estimation

The following reliability coefficients were determined: Cronbach's = .96 for statistics anxiety, .94 for attitudes toward statistics, and .95 for statistics self-efficacy. The survey's reliability coefficients were acceptable.

Major Findings

Research Question 1

The first research question in this study aimed to discover the levels of statistics anxiety, attitudes toward statistics, and statistics self-efficacy among graduate students in Saudi Arabia. Calculating means and standard deviations for the three variables to estimate their levels yielded the following results:

Statistics Anxiety

Statistics anxiety refers to the feeling of fear or apprehension that individuals experience when dealing with statistics (Onwuegbuzie, 2004). The finding revealed that graduate students in Saudi Arabia, on average, have a moderate level of statistics anxiety, with a mean score of 2.93 and a standard deviation of 0.98.

The results also indicate that graduate students reported the highest scores on the examination anxiety subscale (M = 3.48, SD = 1.14), which reflects their fear or anxiety about taking exams in statistics. The second-highest subscale score was the interpretation anxiety subscale (M = 2.79, SD = 1.05), which measures the anxiety associated with interpreting statistical results. Finally, graduate students reported the lowest scores on the asking for help subscale (M = 2.51, SD = 1.05), indicating that they may be less likely to seek help when encountering difficulties with statistics.

The finding indicated that statistics anxiety does exist at a moderate level in graduate students and is consistent with previous research that has found that statistics anxiety is a common issue among graduate students in many countries (García-Santillán et al., 2020). For example, university students in Slovenia had moderate levels of statistics anxiety (Levpuek & Cukon, 2022), and postgraduate students in Malaysia had

statistics anxiety in at least one domain (Koh & Zawi, 2014). The results also confirmed the study findings of Rosli et al. (2017) in Malaysia which found that most graduate students exhibit moderate statistics anxiety.

The higher scores on the examination anxiety subscale suggest that students may be particularly anxious about their ability to perform well on statistics exams. This anxiety could be attributed to a lack of confidence in their statistical knowledge and skills or a belief that they will be judged based on their performance. The finding that students reported lower scores on the asking for help subscale suggests that they may be less likely to seek help when encountering difficulties with statistics. This could be due to various factors, such as a fear of appearing incompetent or needing access to appropriate resources for help. Educators and institutions must recognize this issue and create a supportive learning environment to encourage students to seek help.

Overall, the results indicated that graduate students in Saudi Arabia experience statistics anxiety, with higher levels of anxiety associated with taking exams and interpreting statistical results. These findings highlight the importance of providing appropriate support and resources to help students overcome their anxiety and to build their confidence and skills in statistics. However, modern educational technology continues to improve, giving students various learning resources and a wealth of online statistics-related information which can allow students to feel less anxious when learning statistics.

Attitudes Toward Statistics

Attitudes toward statistics refer to individuals' overall positive or negative feelings, beliefs, and opinions about statistics as a discipline. Regarding the attitudes

toward statistics of graduate students in Saudi Arabia, the findings revealed that most students generally have a positive attitude toward statistics, as indicated by the mean score of 3.22 and a standard deviation of 0.74. These results suggest that students generally view statistics as a valuable and relevant subject with potential applications in their personal and professional lives.

More specifically, students had moderate positive attitudes toward the value of statistics, which suggests that they recognize the importance and relevance of statistics in their personal and professional lives ($M = 3.50$, $SD = 0.89$). Students also had moderate positive attitudes toward their cognitive, intellectual knowledge, and skills when applied to statistics, indicating that they feel confident in their abilities to understand and work with statistical concepts ($M = 3.38$, $SD = 0.83$). Moreover, students had moderate positive attitudes toward statistics as a subject, suggesting that they find the topic interesting and engaging ($M = 3.23$, $SD = 1.03$). Finally, students reported a low mean in the difficulty component ($M = 2.70$, $SD = 0.69$). The negative attitudes toward the course's difficulty indicate that students feel challenged by the course but do not find it overly complex or discouraging.

The findings showed that a positive attitude toward statistics was mainly exhibited for the value component, followed by cognitive and affect, then the difficulty among most students in this study. These implied that graduate students valued statistics relevance and perceived it as practical knowledge for their daily life and an essential requirement for their future professions. On the other hand, students were found to show a less positive attitude toward the difficulty component. Students find statistics difficult and are likely more anxious about the struggle to learn statistical information, perform

statistical tasks, and fear potential barriers to comprehending statistics. For example, students had agreed with statements such as: “I will be under stress during statistics classes,” “I will get frustrated going over statistics tests in class,” and “statistics is a complicated subject.”

These findings agree with a study by Rosli et al. (2017) that found a moderate attitude toward statistics among graduate students at the College of Education in Malaysia. Rosli et al. found also that difficulty was the only construct that reflected the students' negative attitudes. Conversely, these results are inconsistent with Ashaari et al. (2011), who found that students displayed a positive attitude toward the effort, interest, and difficulty components. In contrast, Ashaari et al. found a negative attitude regarding statistics was mainly demonstrated toward the affective and value components. Overall, the findings suggest that graduate students in Saudi Arabia have a generally positive attitude toward statistics, which is a good sign for their academic and professional success.

Current Statistics Self-Efficacy

In statistics, self-efficacy reflects students' confidence in understanding and applying statistical concepts. The result found that graduate students in Saudi Arabia have a relatively low to moderate level of statistics self-efficacy, with a mean score of 3.24 and a standard deviation of 1.09, which means students may feel they need more confidence in their ability to perform statistical analyses. Furthermore, the results found that students have lower mean scores in the inferential statistics section ($M = 2.90$, $SD = 1.09$) than in the descriptive section ($M = 3.54$, $SD = 1.23$).

These findings suggest that students have a higher level of self-efficacy in descriptive statistics compared to inferential statistics. In other words, students may feel less confident in their ability to perform inferential statistical analyses than descriptive analyses. This may be because descriptive statistics are more straightforward to understand than inferential statistics, which can be more complex and require a deeper understanding of statistical concepts. Inferential statistics implicates the process of using data obtained from a sample to draw conclusions about a population, while descriptive statistics includes summarizing and describing data (Field, 2013). The lower mean score in inferential statistics indicates that students need more support and instruction in this area. One possible explanation for the difference in mean scores between the descriptive and inferential sections is that students may have had more exposure to descriptive statistics in previous coursework or their professional lives, leading to higher confidence in this area. In contrast, they may have had less exposure to inferential statistics and require additional instruction and practice to build their confidence and skills.

Overall, the results suggest that graduate students in Saudi Arabia generally have moderate statistics self-efficacy. Specifically, students feel less confident in their ability to perform inferential statistics which highlights the importance of providing students with practical instruction and support in this area to build their confidence and skills. This could involve incorporating more real-world examples and case studies into coursework, providing additional practice opportunities, and offering individualized support to students struggling with statistical concepts.

Research Question 2

The second research question sought to discover to what extent do previous statistics experience, attitudes toward statistics, and statistics self-efficacy explain graduate students' statistics anxiety at Umm Al-Qura and King Abdul-Aziz University in Saudi Arabia.

SEM was used to examine whether previous statistics experience, attitudes toward statistics, and statistics self-efficacy could predict statistics anxiety. The researcher also used SEM to identify the relationships among these variables and the direction of those relationships based on data from the 356 participants, as outlined in the hypothesized model.

The model was modified to enhance its appropriateness and detect meaningful correlations. It was observed that the elimination of the association between statistics self-efficacy and attitudes toward statistics substantially impacted the model's ability to predict statistics anxiety. The re-specified model was assessed following these adjustments. It was found that all fit indices were acceptable, indicating that the model was appropriate for the data ($\chi^2 = 126.72$, $df = 38$, $p < .001$, GFI = .94, CFI = .96, RMSEA = .08). Additionally, the results suggest that statistics anxiety is negatively predicted by attitudes toward statistics. This model was found to predict 55% of student statistics anxiety and emphasized the significance of attitudes toward statistics ($\beta = -.62$), as a direct predictor of student statistics anxiety.

Previous Statistics Experience and Attitudes Toward Statistics

The present study suggests that attitudes toward statistics could be viewed as a modifiable risk factor for previous statistics experience. For example, students who earn a

bachelor's degree in a field of science are more likely than those who earn a degree in a field other than science to develop a positive attitude toward statistics during their studies in graduate programs (Koh & Zawi, 2014). Furthermore, students who possess more favorable attitudes toward mathematics and statistics are more inclined to select science-based programs during their undergraduate studies.

One reason for this finding could be that science-based bachelor's degree programs usually involve statistics classes, providing students with more exposure to mathematical material than non-science programs. Consequently, it might be advantageous to concentrate on developing positive attitudes toward statistics, particularly among graduate students with non-science programs, to alleviate statistics anxiety. These results are consistent with other studies that found students who hold a bachelor's degree in a science-related field exhibit more positive attitudes toward their classes and statistics when compared to those who hold a bachelor's degree in a non-science-related field (Koh & Zawi, 2014).

The research findings of Marchis (2011) also suggest that students who performed well in previous mathematics courses had a greater likelihood of being competent in statistics, which in turn led to more positive attitudes toward statistics by course completion. Conversely, students who struggled in mathematics tended to view statistics negatively, which may have impacted their comprehension of the statistical concepts covered in statistics classes (García-Santillán et al., 2013; Suanpang et al., 2004). A good mindset toward mathematics in high school and during an undergraduate degree is essential to help students develop solid problem-solving abilities. An undergraduate degree with mathematics or statistics classes such as science, technology, engineering,

and finance can provide students with a more comprehensive understanding of mathematical concepts and their applications, leading to a stronger foundation in problem-solving skills and a more positive attitude toward statistics.

Attitudes Toward Statistics and Statistics Anxiety

The results indicated that attitudes toward statistics is the most influential direct predictor of statistics anxiety. Students who held a positive attitude toward statistics during their earlier education had the lowest levels of statistics anxiety. This finding aligns with previous research highlighting the impact of attitudes toward statistics on statistics anxiety. Levpušček and Cukon (2022) found that negative attitudes toward statistics and previous experiences contributed to high levels of statistics anxiety. Macher et al. (2013) also observed that students who showed more interest in statistical content had lower levels of statistics anxiety. The results also agree with Najmi et al. (2018), who found that a positive attitude toward statistics could help to mitigate the negative effects of statistics anxiety on students' academic performance.

Overall, these results highlight the significance of early exposure to mathematics and statistics and developing a strong aptitude for statistics in undergraduate degrees to encourage a favorable outlook toward statistics, which can lead to enhanced academic success in statistics-related courses in graduate programs. However, more studies are required to uncover the most effective approaches to help change negative attitudes toward statistics among students with limited statistics backgrounds. Further research is needed to explore the mechanisms underlying the relationship between attitudes toward statistics and statistics anxiety and identify effective strategies for promoting positive attitudes toward statistics.

Previous Statistics Experience and Statistics Self-Efficacy

The results showed that the path from previous experience to statistics self-efficacy was significant, indicating that previous experience alone significantly contributed to students' statistics self-efficacy. Students who have had prior exposure to statistics may be more confident and competent in their ability to perform statistical analyses, leading to higher levels of self-efficacy. This finding is consistent with previous studies that found a positive relationship between prior experience and statistics self-efficacy (Baloğlu et al., 2017; Dempster & McCorry, 2009; Slootmaeckers, 2012).

Baloğlu et al. (2017) examined the relationship between previous experience and statistics self-efficacy among undergraduate students in Turkey. They found that students who had taken a statistics course before had higher levels of self-efficacy in statistics than those who had not. Similarly, Dempster and McCorry (2009) found that previous experience with statistics was positively related to self-efficacy in a sample of high school students in Northern Ireland. Slootmaeckers (2012) studied the relationship between previous experience and self-efficacy in statistics among undergraduate students in Belgium. The study results showed that previous exposure to statistics in high school was positively related to self-efficacy in statistics.

This result underscores the importance of providing students with opportunities to gain experience and practice in statistics. Therefore, educators can help students build confidence and competence in this crucial area, potentially leading to better academic performance and future success in statistics classes.

Statistics Self-Efficacy and Statistics Anxiety

Results indicated that statistics self-efficacy did not predict statistics anxiety among graduate students. In other words, students' statistics self-efficacy was not significantly associated with statistics anxiety. This result is inconsistent with previous studies such as Perepiczka et al. (2011) and Abdul Sadiq (2016), which found that statistical self-efficacy can predict statistics anxiety. These results also did not align with the study by Ali and Gaber (2022), which found a negative relationship between statistical self-efficacy and statistics anxiety among postgraduate students in a College of Education in Saudi Arabia. Nevertheless, these findings suggest that improving students' statistical self-efficacy may help reduce their statistics anxiety.

Overall, the results in the present study highlighted the complexity of the relationship between previous statistics experience, statistics self-efficacy, and statistics anxiety among graduate students. The results suggest that previous experience alone may significantly contribute to self-efficacy in statistics, but having high statistics self-efficacy may not translate into lower levels of statistics anxiety. This indicates that other factors beyond previous experience and self-efficacy may also contribute to statistics anxiety among graduate students.

To conclude, these results highlight the importance of considering not only previous statistics experience but also attitudes toward statistics when addressing statistics anxiety. The findings suggest that developing positive attitudes toward statistics can effectively reduce statistics anxiety among graduate students. Therefore, educators must consider the role of attitudes toward statistics when designing statistics courses and supporting students in their statistical learning. Although the structural equation model only explained 55% of the variance in statistics anxiety, it does provide unique insight

into the interaction of the variables as well as suggestions for future research to understand the specific mechanisms through which these variables influence statistics anxiety and to develop effective interventions to alleviate this problem.

Research Question 3

The third research question examined whether attitudes toward statistics and statistics self-efficacy mediate the relationship between previous statistics experience and statistics anxiety.

The current study assessed the mediating role of attitudes toward statistics and statistics self-efficacy on the relationship between previous statistics experience and statistics anxiety. The findings suggest that attitudes toward statistics significantly mediate the relationship between previous statistics experience and statistics anxiety. Specifically, the relationship between previous statistics experience and statistics anxiety was fully mediated by attitudes toward statistics.

The results revealed a significant indirect effect of previous statistics experience on statistics anxiety through attitudes toward statistics (ß = -.47, B = -2.14, p = .031). This finding is supported by previous research in the field of statistics education. For example, a study by Onwuegbuzie and Wilson (2003) found that students with more positive attitudes toward statistics related to their previous statistics classes tended to have lower levels of statistics anxiety. Similarly, Perepiczka et al. (2011) found that previous positive experiences with statistics were associated with more positive attitudes toward statistics. Furthermore, a study by Zeidner and Matthews (2005) suggested that students' previous experiences with mathematics may impact their attitudes toward statistics and their level of statistics anxiety. In particular, students who had negative

experiences with mathematics may be more likely to experience anxiety when studying statistics. Overall, the finding that previous statistics experience indirectly affects statistics anxiety through attitudes toward statistics is consistent with previous research in the field and underscores the importance of fostering positive attitudes toward statistics among students.

On the other hand, the study found that statistics self-efficacy did not significantly mediate the relationship between previous statistics experience and statistics anxiety (ß = -.16, B = -0.72, p = .540). Although previous statistics experience was found to significantly contribute to statistics self-efficacy; however, statistics self-efficacy did not significantly affect the relationship between previous statistics experience and statistics anxiety. In other words, students with positive experiences in statistics courses and strong beliefs in their ability to perform statistical tasks were not less likely to experience statistics anxiety. These findings suggest that other factors, such as math anxiety, test anxiety, teaching methods, and learning styles, may also affect the relationship between statistics self-efficacy and statistics anxiety among graduate students. Previous studies have shown that these factors can significantly impact students' statistics self-efficacy and statistics anxiety (Paechter et al., 2017; McGrath et al., 2015). Therefore, further research is needed to understand better the complex interplay among previous statistics experience, statistics self-efficacy, and statistics anxiety, as well as other factors that may contribute to the development of statistics self-efficacy and statistics anxiety among graduate students.

Nevertheless, the direct effect of previous statistics experience on statistics anxiety in the presence of the mediators was not significant (ß = .01, B = 0.05, p = .985).

These results are inconsistent with previous research conducted by Baloğlu (2003), which showed that previous mathematics experience was a significant factor in statistics anxiety. The non-significant finding between previous statistics experience and statistics anxiety may be due to the determination of previous statistics experiences in this study by two factors: students' undergraduate majors and the number of previous statistics classes that students had. Therefore, the previous experience could be represented by other factors, such as learning strategies and the quality of previous teaching methods, which may play a more significant role in developing statistics anxiety. Moreover, the small sample size and the use of self-reported measures may lead the subject to response biases, such as social desirability and recall biases, which may have affected the results. Finally, using a cross-sectional design limits the ability to draw causal conclusions about the relationships between the variables.

Research Question 4

The fourth research question aimed to examine the potential gender differences in the research model. The findings indicated that the research model, which examines the relationships among previous statistics experience, attitudes toward statistics, statistics self-efficacy, and statistics anxiety, is equally relevant and applicable to both males and females. However, there were no significant differences across gender for all paths in the model. Therefore, gender is not a significant factor influencing statistics anxiety, and the factors that contribute to statistics anxiety are similar for males and females.

These findings are consistent with previous research that found no significant differences in statistics anxiety and previous statistics experience between males and females (Chew & Dillon, 2014b; Hsiao & Chiang, 2011; Macher et al., 2013;

Onwuegbuzie & Wilson, 2003). In addition, research has shown that self-efficacy and attitudes toward statistics are important predictors of statistics anxiety for both males and females (Koh & Zawi, 2014; Perepiczka et al., 2011).

Overall, results indicated considering gender in future research; since it is not a significant factor in the current research model. Moreover, it is important to continue exploring gender differences in other areas of statistics education. Results also provide valuable insights for educators and researchers in statistics education. They suggest that interventions designed to improve attitudes toward statistics, statistics self-efficacy, and statistics experience may be effective for both male and female students.

Conclusion

This study investigated the relationship among students' previous statistics experience, attitudes toward statistics, statistics self-efficacy, and statistics anxiety among graduate students in two universities in Saudi Arabia. The results showed that statistics anxiety was negatively correlated with attitudes toward statistics. Students who had positive attitudes were less likely to experience statistics anxiety. Furthermore, previous experience in statistics played an indirect role in statistics anxiety through attitudes toward statistics. In other words, a positive cycle may exist between previous experience, attitudes toward statistics, and statistics anxiety. Students with positive experiences with statistics are more likely to develop positive attitudes, leading to lower statistics anxiety levels. These findings suggest that changes in students' attitudes toward statistics can account for changes in their statistics anxiety. Results have important implications for educators and counselors who work with students experiencing statistics anxiety, such as

promising positive attitudes toward statistics and enhancing students' experience with mathematics and statistics.

Limitations

This research should be evaluated with an understanding of its limitations, which stem from convenience sampling. The sample used in this study was drawn from Saudi Arabian graduate students at Umm Al-Qura and King Abdulaziz Universities studying statistics in the educational and social sciences colleges during the Spring of 2022. Additionally, the sample size was small and limited to graduate students at the two universities. The sampling method and size are not representative of the broader population and may limit the generalizability of the findings. Results may differ for students at other universities or in other countries.

In addition, a one-time survey was administered during the data collection stage in the middle of the semester. Therefore, it is possible that students had not fully completed the course, and their attitudes and self-efficacy may have changed by the end of the semester. They may have felt less confident in their abilities and reported higher levels of statistics anxiety and lower self-efficacy. Therefore, the timing of the survey influenced the students' responses and should be considered when interpreting the study results.

Furthermore, this study relied on self-report questionnaires and a Likert scale to measure all the research variables. Consequently, response bias may influence self-report questionnaires, including social desirability and recall bias. Similarly, a Likert scale may only partially capture the complexity of students' self-efficacy and attitudes toward

statistics. Finally, this study used a non-experimental research design, which limits the ability to make causal claims.

Recommendations and Implications

The study results indicated that students' previous statistics experience significantly predicted their attitudes toward statistics, statistics self-efficacy, and their statistics anxiety while attending a statistics course. Students who reported a good previous statistics experience had high competence in doing statistics, positive feelings toward statistics, and high statistics self-efficacy leading to low levels of statistics anxiety. This suggests that exposing students to statistics early on and providing opportunities for practice can be beneficial (Davis & Mirick, 2015). Thus, the implications that can be drawn from this study pertain to the programs, instructors, counselors, and students.

Programs

Programs offering statistics courses should design a preparatory course that reviews statistics concepts, such as dealing with numbers, operations, and algebraic expressions, to build students' competency in conducting statistics before taking a statistics course (Williams, 2014). In addition, these statistics topics should utilize data from the education and social sciences to demonstrate the value, relevance, and usability of learning statistics for these students (Althubaiti, 2021). Consequently, students might develop positive attitudes toward statistics, become interested in learning the subject, and exert the necessary effort to master statistics (Dykeman, 2011). Furthermore, program administrators should integrate quantitative literacy throughout the educational and social sciences curriculum. The graduate students in these programs need to realize the

usefulness of statistics not only in their statistics classes but also in other classes in their programs (Huang, 2018; Ruggeri et al., 2008).

Instructors

Statistics instructors should be aware that students with limited previous statistics experience might encounter more difficulties in statistics courses. These struggles might be present in perceiving statistics as less critical, interpreting their attitudes toward statistics class, or evaluating their statistics abilities. Therefore, educators need to recognize the impact of previous experience and attitudes on students' ability to learn statistics.

Educators can help create a more supportive and effective learning environment by addressing any negative perceptions or experiences that students may have had. For example, instructors can provide opportunities for students to practice their skills and receive appropriate feedback (Chiou et al., 2014; Egodawatte, 2019). In addition, instructors can recommend that their students review the statistics topics that constitute adequate preparation for the course knowledge before taking a statistics course. Professors should also stimulate students' interest in statistics by drawing attention to the subject's relevance to the student's future careers and everyday life, which helps students experience less statistics anxiety (Souza et al., 2020). In addition, instructors ought to incorporate practical teaching and learning approaches to make statistics more engaging and relevant for students, such as technology-based resources (Baharun & Porter, 2009), guided project-based learning (Bayer, 2016), computer-based tools for statistic instruction (Ciftci et al., 2014; Park & Kondrat, 2022), immediacy (Tonsing, 2018), and one-minute strategies (Hu et al., 2017).

Counselors

The key recommendation for counseling professionals is to work with students to develop a positive mindset and a willingness to learn and practice statistics by addressing negative feelings and anxiety, building competence and confidence, and providing effective support and resources that may help reduce anxiety levels. Counselors can help students to improve their perceptions of statistics and build confidence in their ability to do statistics (Ruggeri et al., 2008). Counselors can work with students to identify and address statistics-related negative attitudes or anxiety, such as exploring the sources of these feelings, providing coping strategies, or referring students to additional resources. Counselors can also help students build positive feelings toward statistics by exploring the real-world applications of statistics and understanding how it can be used to solve problems in various fields which leads students to be more motivated to learn and apply statistical concepts (Sockol et al., 2021). Counselors can also work with students to identify and develop effective learning strategies that work best for them, such as breaking down complex concepts into smaller pieces, using visual aids, or practicing with real-world examples to reduce their anxiety and improve their attitudes toward statistics courses (Fayomi et al., 2022).

Students

Based on the study results, students should:

1. Seek opportunities to gain previous statistics experience, including taking a statistics course, participating in research projects, or working on data analysis projects.

2. Focus on building competence in statistics by regularly practicing and applying statistical concepts to help them feel more confident in their statistics ability and reduce their anxiety levels.
3. Develop positive attitudes toward statistics by exploring the real-world applications of statistics and understanding how it can be used to solve problems in various fields.
4. Use techniques and strategies that help them to manage their negative attitudes and anxiety, such as seeking support from peers or instructors, using tutoring or counseling services, and practicing relaxation techniques and self-regulation strategies (Kesici et al., 2011).

Future Research

Future research could provide a more comprehensive understanding of this issue that could help better recognize the factors that influence students' success in statistics and develop effective strategies for teaching and learning statistics. Some future research directions that could be explored:

1. Further investigate the causal relationships among previous statistics experience, attitudes, self-efficacy, and anxiety. For example, longitudinal studies could examine how these factors influence each other over time.
2. Examine the role of different factors of previous statistics experience, such as coursework, research experience, or industry experience, and how they may influence attitudes, self-efficacy, and anxiety.

3. Explore the role of different teaching strategies in improving students' attitudes toward statistics, for example, investigating the impact of active learning approaches or online resources on graduate student attitudes.
4. Design interventions to address statistics anxiety and reduce its negative impact on statistics performance.
5. Investigate how students' attitudes, self-efficacy, and anxiety toward statistics vary across different demographic groups, such as socioeconomic status, to identify disparities in statistics education and improve equity.
6. Adopt qualitative and experimental research to understand better the factors related to statistics anxiety and identify potential causes of statistics anxiety among graduate students.
7. Compare the graduate students in this study to those in other universities with comparable classifications to broaden the scope of this study.
8. Determine if there are differences in statistics anxiety and related factors between graduate students attending in-person and online to determine effective strategies for teaching and learning statistics in both contexts.
9. Examine the role of other factors, such as learning strategies, perfectionism, and mathematics anxiety, to better understand the complex factors that contribute to statistics anxiety.

APPENDIX

APPENDIX A

STATISTICS ANXIETY SCALE (Vigil-Colet et al., 2008)

	Statement	No anxiety				Considerable anxiety
		1	2	3	4	5
1	Studying for an examination in a statistics course.*					
2	Interpreting the meaning of a table in a journal article.*					
3	Going to ask my statistics teacher for individual help with material I am having difficulty understanding.*					
4	Realizing the day before an exam that I cannot do some problems that I thought were going to be easy.					
5	Asking a private teacher to explain a topic that I have not understood at all.					
6	Reading a journal article that includes some statistical analyses.*					
7	Asking the teacher how to use a probability table.					
8	Trying to understand a mathematical demonstration.					
9	Doing the final examination in a statistics course.*					
10	Reading an advertisement for an automobile which includes figures on gas mileage, compliance with population regulations, etc.*					
11	Walking into the classroom to take a statistics test.*					
12	Asking the teacher about how to do an exercise.					
13	Getting to the day before an exam without having had time to revise the syllabus.					
14	Waking up in the morning on the day of a statistics test.*					
15	Realizing, just before you go into the exam, that I have not prepared a particular exercise.					
16	Copying a mathematical demonstration from the blackboard while the teacher is explaining it.					

Statistics Anxiety Scale, continued

	Statement	No anxiety				Considerable anxiety
		1	2	3	4	5
17	Asking one of your teachers for help in understanding a printout.*					
18	Trying to understand the odds in a lottery.*					
19	Seeing a classmate carefully studying the results table of a problem he has solved					
20	Going to a statistics exam without having had enough time to revise.					
21	Asking a teacher for help when trying to interpret a results table.					
22	Trying to understand the statistical analyses described in the abstract of a journal article.*					
23	Going to the teacher's office to ask questions.					
24	Asking a private teacher to tell me how to do an exercise.					

APPENDIX B

SURVEY OF ATTITUDES TOWARD STATISTICS (Schau, 2003)

Mark the one response that most clearly represents your degree of agreement or disagreement with that statement.

	Statement	strongly disagree	disagree	neutral	agree	strongly agree
1	I will like statistics.					
2	I will feel insecure when I have to do statistics problems.*					
3	I will have trouble understanding statistics because of how I think.*					
4	Statistics formulas are easy to understand.					
5	Statistics is worthless.*					
6	Statistics is a complicated subject.*					
7	Statistics should be a required part of my professional training.					
8	Statistical skills will make me more employable.					
9	I will have no idea of what's going on in statistics.*					
10	Statistics is not useful to the typical professional.*					
11	will get frustrated going over statistics tests in class.*					
12	Statistical thinking is not applicable in my life outside my job.*					
13	I use statistics in my everyday life.					

Survey of Attitudes Toward Statistics, continued

	Statement	Strongly disagree	disagree	neutral	agree	Strongly agree
14	I will be under stress during statistics classes.*					
15	I will enjoy taking statistics courses.					
16	Statistics conclusions are rarely presented in everyday life.*					
17	Statistics is a subject quickly learned by most people.					
18	Learning statistics requires a great deal of discipline.*					
19	I will have no application for statistics in my profession.*					
20	I will make a lot of math errors in statistics.*					
21	I am scared by statistics.*					
22	Statistics involves massive computations.*					
23	I can learn statistics					
24	I will understand statistics equations.					
25	Statistics is irrelevant in my life.*					
26	Statistics is highly technical.*					
27	I will find it difficult to understand statistics concepts.*					
28	Most people have to learn a new way of thinking to do statistics.*					

Note. *These items reverse scored.

APPENDIX C

CURRENT STATISTICS SELF-EFFICACY SCALE

(Finney & Schraw, 2003)

For each task, please mark the one response that represents your confidence in your current ability to successfully complete each task.

	Statement	no confidence at all	a little confidence	a fair amount of confidence	much confidence	very much confidence	complete confidence
1	Identify the scale of measurement for a variable.						
2	Interpret the probability value (*p*-value) from a statistical procedure.						
3	Identify if a distribution is skewed when given the values of three measures of central tendency.						
4	Select the correct statistical procedure to be used to answer a research question.						
5	Interpret the results of a statistical procedure in terms of the research question.						
6	Identify the factors that influence power.						
7	Explain what the value of the standard deviation means in terms of the variable being measured.						
8	Distinguish between a Type I error and a Type II error in hypothesis testing.						

Current Statistics Self-Efficacy Scale (Finney & Schraw, 2003), continued

	Statement	no confidence at all	a little confidence	a fair amount of confidence	much confidence	very much confidence	complete confidence
9	Explain what the numeric value of the standard error is measuring.						
10	Distinguish between the objectives of descriptive versus inferential statistical procedures.						
12	Distinguish between a population parameter and a sample statistic.						
13	Identify when the mean, median and mode should be used as a measure of central tendency.						
14	Explain the difference between a sampling distribution and a population distribution.						

APPENDIX D

DEMOGRAPHIC QUESTIONNAIRE

Gender: Male __ Female __

To What Age Group do you belong:

□ 21- 30
□ 31- 40
□ 41- 50
□ 51-60

What is the highest college degree you have received?

□ Bachelor's
□ Master's
□ Doctorate/Professional

Please indicate if you are degree seeking and in which program you are currently enrolled:

□ Enrolled in Master's degree program
□ Enrolled in Doctoral degree program
□ Enrolled in Diploma degree program

Please indicate if you have taken a Bachelor's or Master's level statistics course prior to this one:

□ Yes, please indicate number of classes completed _____
□ No

APPENDIX E

DEFINITION OF VARIABLE AND INSTRUMENTS TABLE

Variable	Conceptual Definition	Instrumental Definition	Operational Definition
Statistics anxiety	The specific feelings of anxiety students experience when they encounter statistics, for example, gathering, processing and interpreting data (Cruise et al.; 1985; Onwuegbuzie et al, 1997).	Statistical Anxiety Scale (SAS) (Vigil-Colet et al., 2008): 24 -item instrument to measure the score of statistics anxiety. For example: 1. Studying for an examination in a statistics course. 2. Interpreting the meaning of a table in a journal article. 3. Going to ask my statistics teacher for individual help with material I am having difficulty understanding. 4. Realizing the day before an exam that I cannot do some problems that I thought were going to be easy. 5. Asking a private teacher to explain a topic that I have not understood at all. 6. Reading a journal article that includes some statistical analyses. 7. Asking the teacher how to use a probability table. 8. Trying to understand a mathematical demonstration. 9. Doing the final examination in a statistics course. 10. Reading an advertisement for an automobile which includes figures on gas mileage, compliance with population regulations, etc. 11. Walking into the classroom to take a statistics test. 12. Asking the teacher about how to do an exercise.	Appropriate item scores are summed for each factor, with higher scores indicating higher levels of statistics anxiety. Item format is Five-point Likert-type scale. For the number selected by the participant. 1 = No Anxiety to 5 = Considerable Anxiety. the scores are: 1 = 1 2 = 2 3 = 3 4 = 4 5 = 5 In order to clarify the level of statistical anxiety, each individual scale will be calculated to forming an interval scale. The higher statistical anxiety level would be correlated with a higher score on the scale. Highest statistical anxiety level is 120; lowest level is 24.

Definition of Variables and Instruments Table, continued

Variable	Conceptual Definition	Instrumental Definition	Operational Definition
		13. Getting to the day before an exam without having had time to revise the syllabus.	
		14. Waking up in the morning on the day of a statistics test.	
		15. Realizing, just before you go into the exam, that I have not prepared a particular exercise.	
		16. Copying a mathematical demonstration from the blackboard while the teacher is explaining it.	
		17. Asking one of your teachers for help in understanding a printout.	
		18. Trying to understand the odds in a lottery.	
		20. Going to a statistics exam without having had enough time to revise.	
		21. Asking a teacher for help when trying to interpret a results table.	
		22. Trying to understand the statistical analyses described in the abstract of a journal article.	
		23. Going to the teacher's office to ask questions.	
		24. Asking a private teacher to tell me how to do an exercise.	

Definition of Variables and Instruments Table, continued

Variable	Conceptual Definition	Instrumental Definition	Operational Definition
Examination anxiety	Anxiety when taking statistic exams.	8 items (1, 4, 9, 11, 13, 14, 15, 20).	
Asking for help	Anxiety when asking the course teacher or other student for help in understanding a printout.	8 items (3, 5, 7, 12, 17, 21, 23, 24).	
Interpretation anxiety	Anxiety when students have to interpret statistics data and understand the formulation used in statistics.	8 items (2, 6, 8, 10, 16, 18, 19, 22).	

Definition of Variables and Instruments Table, continued

Variable	Conceptual Definition	Instrumental Definition	Operational Definition
Attitudes toward statistics	"not directly observable, inferred aspects, consisting of beliefs, feelings, and behavioural predispositions towards the object to which they are directed." (Auzmendi, 1992, p. 17, cited in Mondejar-Jimenez & Vargas-Vargas, 2010).	The ATS will be measured by the Survey of Attitudes Toward Statistics (SATS-28) (Schau, 2003), which is a 28-item instrument designed to assess tfour aspects of an individual's attitudes toward statistics. 1. I will like statistics. 2.* I will feel insecure when I have to do statistics problems. 3.* I will have trouble understanding statistics because of how I think. 4. Statistics formulas are easy to understand. 5.* Statistics is worthless. 6.* Statistics is a complicated subject. Statistics should be a required part of my professional training. 7. Statistical skills will make me more employable. 8. Statistical skills will make me more employable. 9.* I will have no idea of what's going on in statistics. 10.* Statistics is not useful to the typical professional. 11.* I will get frustrated going over statistics tests in class. 12.* Statistical thinking is not applicable in my life outside my job. 13. I use statistics in my everyday life. 14.* I will be under stress during statistics classes. 15. I will enjoy taking statistics courses. 16.* Statistics conclusions are rarely presented in everyday life.	Responses are made on a five-point Likert scale that ranges from 1 = Strongly Disagree to 5 = Strongly Agree. nineteen negatively worded items are reverse scored and the appropriate item scores are summed for each factor and for the total scale. Higher scores indicate higher levels of positive attitudes toward statistics.

Definition of Variables and Instruments Table, continued

Variable	Conceptual Definition	Instrumental Definition	Operational Definition
		17. Statistics is a subject quickly learned by most people.	
		18.* Learning statistics requires a great deal of discipline.	
		19.* I will have no application for statistics in my profession.	
		20.* I will make a lot of math errors in statistics. 21.* I am scared by statistics	
		22.* Statistics involves massive computations.	
		23. I can learn statistics.	
		24. I will understand statistics equations.	
		25.* Statistics is irrelevant in my life.	
		26. * Statistics is highly technical.	
		27.* I will find it difficult to understand statistics concepts.	
		28* Most people have to learn a new way of thinking to do statistics.	
Affect		6 items (1, 2, 11, 14, 15, 21).	
Cognitive Competence		6 items (3, 9, 20, 23, 24, 27).	
Difficulty		7 items (4, 6, 17, 18, 22, 26, 28).	
Value		9 items (5, 7, 8, 10, 12, 13, 16, 19, 25).	

Definition of Variables and Instruments Table, continued

Variable	Conceptual Definition	Instrumental Definition	Operational Definition
Statistics self-efficacy	Self-efficacy refers to an individual's perceived capability in performing necessary tasks to achieve goals (Bandura, 1997)	The Current statistics self-efficacy scale (CSSES) developed by finny & Schraw (2003): 14 -item instrument to measure the score of self-efficacy. 1. Identify the scale of measurement for a variable. 2. Interpret the probability value (*p*-value) from a statistical procedure. 3. Identify if a distribution is skewed when given the values of three measures of central tendency. 4. Select the correct statistical procedure to be used to answer a research question. 5. Interpret the results of a statistical procedure in terms of the research question. 6. Identify the factors that influence power. 7. Explain what the value of the standard deviation means in terms of the variable being measured. 8. Distinguish between a Type I error and a Type II error in hypothesis testing. 9. Explain what the numeric value of the standard error is measuring. 10. Distinguish between the objectives of descriptive versus inferential statistical procedures. 11. Distinguish between the information given by the three measures of central tendency. 12. Distinguish between a population parameter and a sample statistic.	An instrument to assess a student's confidence in his/her current ability to solve specific statistics related tasks. Item format is a six-point Likert-type scale. For the number selected by the participant. The scale ranging from 1 (no confidence all) to 6 (complete confidence) the scores are: 1 = no confidence all 2 = a little confidence 3 = a fair amount of confidence 4 = much confidence 5 = very much confidence 6 = complete confidence In order to clarify the score of self-efficacy, each individual scale will be calculated to forming an interval scale. The higher self-efficacy score would be correlated with a higher score on the scale. Higher self-efficacy score is 84; lower score is 14.

Definition of Variables and Instruments Table, continued

Variable	Conceptual Definition	Instrumental Definition	Operational Definition
		13. Identify when the mean, median and mode should be used as a measure of central tendency.	
		14. Explain the difference between a sampling distribution and a population distribution.	
	Summarizes data using indexes such as central tendency (Mishra et al., 2019).		

APPENDIX F

IRB APPROVAL

Andrews University
Office of Research & Creative Scholarship

February 11, 2022

Rabab Abdulghani
Tel. 805-267-6458
Email: abdulghani@andrews.edu

RE: APPLICATION FOR APPROVAL OF RESEARCH INVOLVING HUMAN SUBJECTS
IRB Protocol #:22-008 **Application Type:** Original **Dept.:** Graduate Psychology & Counseling **Review Category:** Exempt **Action Taken**: Approved **Advisor:** Nadia Nosworthy
Title: Factors of statistic anxiety among graduate students in Saudi Arabia.

Your IRB application for approval of research involving human subjects entitled: "*Factors of statistic anxiety among graduate students in Saudi Arabia"* IRB protocol # 22-008 has been evaluated and determined Exempt from IRB review under regulation CFR 46.104 (2)(i): Research that includes survey procedures in which information obtained is recorded by the investigator in such a manner that the identity of the human subjects cannot readily be ascertained, directly or through identifiers linked to the subject. You may now proceed with your research.

Please note that any future changes made to the study design and/or informed consent form require prior approval from the IRB before such changes can be implemented. Incase you need to make changes please use the attached report form.

While there appears to be no more than minimum risks with your study, should an incidence occur that results in a research-related adverse reaction and/or physical injury, this must be reported immediately in writing to the IRB. Any research-related physical injury must also be reported immediately to the University Physician, Dr. Katherine, by calling (269) 473-2222.

We ask that you reference the protocol number in any future correspondence regarding this study for easy retrieval of information.

Best wishes in your research.

Sincerely,

Mordekai Ongo, PhD.
Research Integrity and Compliance Officer

Institutional Review Board – 8488 E Campus Circle Dr Room 234 - Berrien Springs, MI 49104-0355
Tel: (269) 471-6361 E-mail: irb@andrews.edu

APPENDIX G

Andrews University

Online Survey Informed Consent Form for Students

You are being invited to participate in a research study titled "Factors of Statistics Anxiety Among Graduate Students in Saudi Arabia". This study is being done by Rabab Abdulghani from Andrews University. You were selected to participate in this study because:

You are a graduate student who is currently studying statistics in an educational or social sciences programs in Saudi Arabia.

The purpose of this research study is to examine graduate student's levels of statisticas anxiety who are enrolled in statistics courses in their academic program in educational and social sciences in Saudi Arabia. The study aims to investigate also factors that predict statisticas anxiety in the sample.

If you agree to take part in this study, you will be asked to complete an online survey. This survey will ask about your demographic background, level of statistics anxiety, attitude towards statistics, and your level of statistics self-efficacy.

It will take you approximately 30 minutes to complete the survey. You may not directly benefit from this research; however, the researcher hopes that your participation in the study may assist improve future learning process for graduate students' statistics performance. This research seeks to provide additional data and teaching suggestions for statistics instructors about teaching statistics methods and factors related to students' statistics anxiety.

There are no known risks associated with this research study; however, as with any online related activity the risk of a breach of confidentiality is always possible. The risk will be minimized by having the survey filled anonymously. You will not be asked to provide personal information except for gender and age. All data collected will be securely saved in a password protected folder on the researcher's personal computer.

Your participation in this study is completely voluntary and you can withdraw at any time. If you have questions about this project or if you have a research-related problem, you may contact the researcher's advisor Nadia Nosworthy, Ph.D., email: Nosworthy@andrews.edu or the researcher(s), Rabab Abdulghani, email: Abdulghani@andrews.edu If you have any questions concerning your rights as a research subject, you may contact the Andrews University IRB Office at (269) 471-6361, or irb@andrews.edu.

By clicking "Next" below you are indicating that you are at least 18 years old, have read and understood this consent form and agree to participate in this research study. Please print a copy of this page for your records.

Next Cancel

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EDUCATION

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PROFESSIONAL EXPERIENCE

Graduate Psychology & Counseling Andrews University, Berrien Springs	2018-2020	Online quality specialist
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SELECTED PUBLICATIONS

Abdulghani, R. (2022, October). Predictors of statistics anxiety among graduate students in Saudi Arabia. [Poster Presentation] Celebration of Research and Creative Scholarship. Andrews University, Berrien Springs, MI, United States.

Abdulghani, R. (2022, May). The relationship between test item format and gender performance gaps on statistics tests among graduate students. [Poster Presentation] APS Convention, Chicago, IL, United States.

Abdulghani, R. (2022, January). Statistics anxiety and attitudes toward statistics among online and on-campus graduate students. [Conference Presentation]. Hawaii International Conference on Education 2022 Convention, Waikoloa, HI, United States.

Abdulghani, R. (2021, April). The Relationship between Attitude to Statistic and Statistic Anxiety Among Graduate Students at Umm Al-Qura University in Saudi Arabia. [Poster Presentation]. MPA 2021 Convention, Chicago, IL, United States.

Kijai, J., Abdulghani, R., & Hamzah, A. (2019, April). Factors Related to At-Risk Behaviors Among 12-18-year-old. [Conference Presentation]. MPA 2019 Convention, Chicago, IL, United States.