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Exploration of Statistics Anxiety Among Doctoral Students in Health Sciences Related Disciplines

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EXPLORATION OF STATISTICS ANXIETY AMONG DOCTORAL STUDENTS IN HEALTH SCIENCES RELATED DISCIPLINES

BY

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ABSTRACT

This study explored the statistical anxiety levels of doctoral students in health sciences related disciplines, i.e. Doctor of Nursing Practice (D.N.P.) and Doctor of Philosophy (Ph.D.). This study also explored the differences in statistics anxiety levels between professional doctoral students (i.e. D.N.P.) and research doctoral student (i.e. Ph.D. in Rehabilitation Sciences, Health Sciences, Nursing, Environmental and Occupational Health, Human Movement Sciences Concentration and Kinesiology & Rehabilitation.) 403 doctoral students responded to the online survey and 312 of them completed 100% of the Statistical Anxiety Rating Scales (STARS) instrument and 100% of the social demographic questions. Statistics anxiety scores achieved internal reliability of 0.86-0.95 and were proved reliable internally. Statistics anxiety scores were statistically different within 3 cohort comparisons of D.N.P. students (p=0.012). These 3 cohorts were the Pre-Statistics cohort (those who have not taken any statistics course in their programs yet), the Current-Statistics cohort (those who were currently taking a statistics course in their programs) and the Post-Statistics cohort (those who have already taken statistics course(s) in their programs). Statistics anxiety scores were also statistically different in comparisons of D.N.P. and Ph.D. students in the Post-Statistics cohort (p=0.0017). Statistics anxiety scores were not statistically different within 3 cohort comparisons of Ph.D. students (p=0.18). Other than the small number of students

recruited in the Pre-Statistics and Current-Statistics cohorts and the inequality between 3 cohorts which may have limited the ability to identify any significant effect, the result may also have suggested that this study could be affected by some dispositional antecedents, e.g. Ph.D. students may feel more comfortable with statistics than D.N.P. students. Implications for students and instructors were discussed such as utilizing the different factors of the STARS instrument to personalize the diagnosis of the statistics anxiety problems.

Keywords: Statistics Anxiety, Health Sciences Related Disciplines, Doctoral Students, STARS Instrument.

DEDICATION

I believe in science and I love statistics. I would like to dedicate this study to all students who are like me. I especially want to dedicate this study to all students who are going to take statistics, are currently taking statistics and have already taken statistics in their programs.

ACKNOWLEDGEMENTS

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CHAPTER I

INTRODUCTION

Background

Statistical skills are a competency, similar to reading, writing or speaking, and it involves two reading skills which are comprehension and interpretation (Schield, 1999). Statistical skills focus on decision making using statistics as evidence, just as reading literacy focuses on using words as evidence (Schield, 1999). Since some health sciences related disciplines doctoral students will continue to be researchers upon graduation, their competency in statistics will still be needed in order to help them analyze their data. There is also a growing need for competency in statistics in a diverse range of jobs and workplaces which have prompted universities to include at least one statistics course as a core component in their degree programs (Onwuegbuzie & Wilson, 2003).

The growing need for the application of statistical techniques in a diverse range of jobs and workplaces has prompted universities to include at least one statistics course as a core component in some degree programs (Onwuegbuzie & Wilson, 2003). However, Ruggeri et al. (2008) reported that only 57.1 percent of students in USA colleges were aware of the statistics element in a psychology program. Additionally, they found that students

often underestimated the extent of statistics in these subjects (Ruggeri et al., 2008). Zeidner (1991) found that a large percentage of students identify statistics courses as the most anxiety-inducing courses in their curriculum In a random survey of students entering a graduate-level education program, students rated the course requirement in statistics as the least desirable of all courses required for their academic major (Dykeman, 2010). These reactions to statistics have been referred to as "statistics anxiety". Consisting of a complex array of emotional reactions, statistical anxiety may induce only a minor discomfort in mild forms or severe forms triggering negative outcomes, such as apprehension, fear, nervousness, panic, and worry (Onwuegbuzie et al., 1997). Statistics anxiety is often regarded as one of the most powerful negative factors of influence on performance in statistics courses (Onwuegbuzie and Wilson, 2003).

Statistics anxiety is believed to be a pervasive problem in many fields of study (Macher et al., 2011). Yet, statistics anxiety is widely spread among students mostly in non-mathematical disciplines such as psychology, education and sociology (Onwuegbuzie & Wilson, 2003; Onwuegbuzie, 2004; Ruggeri et al., 2008). A review of the literature revealed the fact most of the statistics anxiety studies were conducted in social sciences. Limited studies have been conducted on statistical anxiety among health sciences related disciplines students. Only 2 investigations involving health professionals were found in the literature. A 1978 study examined anxiety toward statistics and stereotypical beliefs about statistics among nursing and education students (Wolfe, 1978). It was a pilot study involving 3 graduate students in physical education, 4 were in home economics, 2 in education and the

remainder in nursing. Their statistics anxiety evaluation tools were a work-in-progress. Measures of anxiety toward statistics and belief in selected negative stereotypes about statistics were administered to a sample of graduate students in nursing and education at the beginning and end of a semester course in statistics. Factor analysis showed three dimensions of negative perceptions about statistics, corresponding to age and sex role stereotypes, and belief that quantitative skills must be innate and cannot be learned later on. The results showed that mean anxiety scores decreased significantly from beginning to end of term. There was also a significant shift toward greater disagreement with the belief that statistical skills could not be learned. Implications for curriculum evaluation in the health and social service professions were explored in the study.

In a 2015 study, Welch investigated statistics anxiety among graduate dental hygiene students in the U.S (Welch et al., 2015). The results showed that statistical anxiety rating scale data revealed graduate dental hygiene students experience low to moderate levels of statistics anxiety. Specifically, the level of anxiety on the Interpretation Anxiety factor indicated this population could struggle with making sense of scientific research.

There is no evidence of studies having been done on statistical anxiety among doctoral students in health sciences related disciplines, e.g. Doctor of Nursing Practice (D.N.P.) and Doctor of Philosophy (Ph.D.) students. Since evidence based health sciences research requires the support of statistical analyses, doctoral students in health sciences related disciplines are expected to have a good command of statistics, and to fully understand research articles, and thereby apply scientific evidence to practice or research or both.

Purpose of the Study

To address this gap in the literature, the purpose of this study was to explore the statistical anxiety levels in doctoral students of health sciences related disciplines (i.e. professional doctoral students such as D.N.P. and research doctoral students such as Ph.D. students) according to the following 3 different cohorts:

1. Pre-Statistics cohort - those who have not yet taken any statistics course in their programs;
2. Current-Statistics cohort - those who are currently taking a statistics course in their programs and;
3. Post-Statistics cohort - those who have already taken statistics course(s) in their programs.

This study also explored the differences in statistics anxiety levels/scores between professional doctoral students (i.e. D.N.P.) and research doctoral students (e.g. Ph.D. in Rehabilitation Sciences, Ph.D. in Health Sciences, Ph.D. Nursing, etc.)

Conceptual Framework

Three types of antecedents of statistics anxiety have been identified and are shown in Figure 1 (Baloğlu 2004; Baloğlu and Zelhart 2004; Onwuegbuzie and Wilson 2003):

- Situational antecedents (i.e. the immediate factors surrounding the stimulus events)
- Dispositional antecedents (i.e. perceived task difficulty, personality, etc.)

- Environmental antecedents refer to events that occurred in the past such as gender, ethnicity, and age that "have affected the individual prior to the statistics course" (Onwuegbuzie et al. 1997).

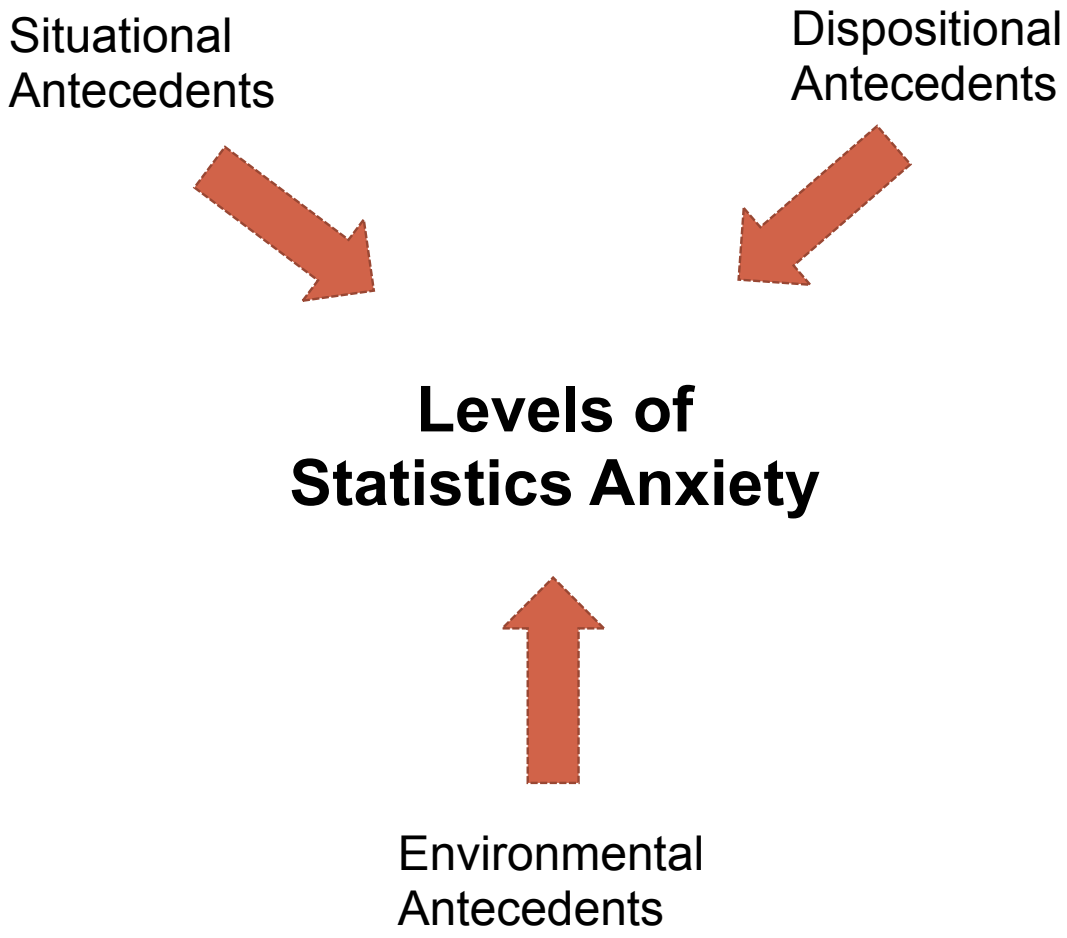

Figure 1. Three types of antecedents of statistics anxiety (Baloğlu 2004; Baloğlu and Zelhart 2004; Onwuegbuzie and Wilson 2003)

The proposed conceptual frame of this study was informed by the State Trait Theory of Anxiety (Spielberger, Gorsuchand Lushene, 1970). Precisely, the trait anxiety can be defined as feelings of stress, worry, discomfort, etc. that one experiences on a day to day basis (Spielberger and Sydeman,1994), whereas the state anxiety refers to "transitory unpleasant feelings of apprehension, tension, nervousness or worry, often accompanied by activation of the autonomic nervous system (McDowell 2006). It is interesting to note that those three types of antecedents of statistics in Figure 1 can influence the amount of trait anxiety brought to the study of statistics by each student as well as the state anxiety each student experiences when responding to stressors in their immediate situation (Dykeman, 2011).

Since no research has been conducted exclusively on doctoral students of health sciences related disciplines, situational antecedents (State Anxiety) influenced by the doctoral programs and the status of the statistics course in the programs were investigated to begin this line of research (Figure 2).

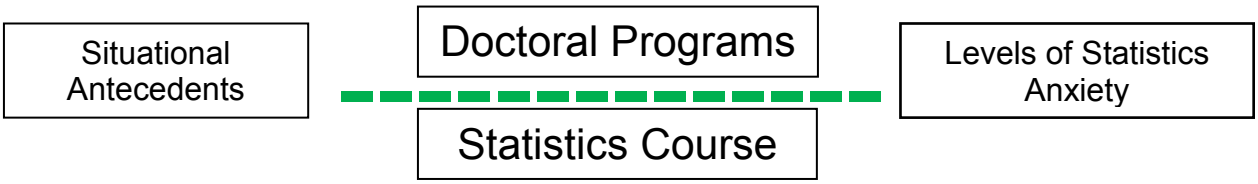

Figure 2. Study conceptual frame.

Research Questions

This study addressed the following research questions:

Research question 1. Is there a statistically significant difference in statistics anxiety scores, as measured by Statistical Anxiety Rating Scale (STARS), between 3 cohorts (i.e. Pre-Statistics, Current-Statistics and Post-Statistics) of professional health sciences doctoral students (i.e. D.N.P.) whose programs require statistics course(s)?

Research question 2. Is there a statistically significant difference in statistics anxiety scores, as measured by Statistical Anxiety Rating Scale (STARS), between 3 cohorts (i.e. Pre-Statistics, Current-Statistics and Post-Statistics) of research health sciences doctoral students (e.g. Ph.D. in Health Sciences related disciplines such as Ph.D. in Rehabilitation Sciences and Ph.D. in Nursing) whose programs require statistics course(s)?

Research question 3. Is there a statistically significant difference in the statistics anxiety scores, as measured by Statistical Anxiety Rating Scale (STARS), between the professional health sciences doctoral students (i.e. D.N.P.) and the research health sciences doctoral students (e.g. Ph.D. in Health Sciences, Ph.D. in Rehabilitation Sciences and Ph.D. in Nursing) in the Pre-Statistics cohort?

Research question 4. Is there a statistically significant difference in the statistics anxiety scores, as measured by Statistical Anxiety Rating Scale (STARS), between the professional health sciences doctoral students (i.e. D.N.P.) and the research health sciences

doctoral students (i.e. Ph.D. in Health Sciences ,Ph.D. in Rehabilitation Sciences and Ph.D. in Nursing) in the Current-Statistics cohort?

Research question 5. Is there a statistically significant difference in the statistics anxiety scores, as measured by Statistical Anxiety Rating Scale (STARS), between the professional health sciences doctoral students (i.e. D.N.P.) and the research health sciences doctoral students (i.e. Ph.D. in Health Sciences, Ph.D. in Rehabilitation Sciences and Ph.D. in Nursing) in the Post-Statistics cohort?

Significance of the Study

A large proportion of students identify statistics courses as the most anxiety- inducing courses in their curriculum (Zeidner, 1991). Evidence reveals that about 80% of graduate students feel some sort of statistics anxiety, which is defined as the apprehension which happens when one encounters statistics in any form and at any level (Onwuegbuzie & Wilson, 2003). This statistics anxiety is a negative state of emotional arousal experienced by individuals as a result of encountering statistics in any form and at any level and this emotional state is preceded by negative attitudes toward statistics and is related to but distinct from mathematics anxiety (Onwuegbuzie et al., 1997). In this initial research on the topic of statistical anxiety among doctoral students in the health sciences, the intent was to describe what the statistical anxiety levels were and if they differed between professional and research doctoral students. This information will be helpful as health sciences doctoral curriculums are developed, as well as, informative to Instructors as they plan their teaching methods.

Significance to doctoral students: This study explored the baseline understanding of and raised the awareness of whether or not the statistics anxiety could be experienced differently among doctoral students in health sciences related disciplines, especially for those who have not taken statistics in their programs yet. Students could also use the results of the STARS survey to understand their personal issues of statistics anxiety.

Significance to educators: One of the factors of the STARS survey is related to the statistics instructors. Several studies have shown that there were some relationships between statistics instructors and statistics anxiety in students. For example, immediacy is the psychological availability of instructors to their students (Williams, 2010). Williams (2010) found that that instructor immediacy was significantly related to statistics anxiety as measured by STARS, with immediacy explaining between 6% and 20% of the variance in students‟ anxiety levels. The study suggested that academic Instructors should attempt to increase their use of immediacy behaviors in order to decrease statistics anxiety (Williams, 2010). Furthermore, statistics instructors could potentially use the results from this study in improving the doctoral students' procrastination problems by changing their teaching approaches (e.g. one-on-one lesson) or by designing special support services (e.g. tutorials after lectures) for those doctoral students who were going to take or were currently taking statistics in their programs.

CHAPTER II

LITERATURE REVIEW

Introduction

Statistical literacy is a competency, similar to reading, writing or speaking, and it involves two reading skills which are comprehension and interpretation (Schield, 1999). Statistical literacy also focuses on making decisions using statistics as evidence, just as reading literacy focuses on using words as evidence (Schield, 1999). To be statistically literate, one must be able to distinguish statements of association from statements of causation, and whether a statement of comparison involves association or causation (Schield, 1999). According to Jordan and Haines (2003), this is an important societal issue because without statistical literacy theories would not be questioned, but, rather, they would be accepted as facts, erroneously or intentionally. Jordan and Haines (2003) believe that foundational abilities in mathematics and statistics are integral parts to the understanding and use of quantitative reasoning. Mathematical skills provide a basis for calculations as well as abstract reasoning, while statistical training teaches students broad applications of quantitative reasoning skills.

Statistics anxiety is a pervasive problem in many fields of study (Macher et al., 2011). A large percentage of students identify statistics courses as the most anxiety-inducing courses in their curriculum (Zeidner 1991). Consisting of a complex array of emotional reactions, statistical anxiety may induce only a minor discomfort in mild forms or severe forms triggering negative outcomes, such as apprehension, fear, nervousness, panic, and worry (Onwuegbuzie et al., 1997). Evidence reveals that about 80% of graduate students feel some sort of statistical anxiety, which is defined as the apprehension which happens when one encounters statistics in any form and at any level (Onwuegbuzie and Wilson, 2003).

The topic of statistics anxiety was explored and reviewed more than a decade ago by Onwuegbuzie & Wilson (2003) and recently by Chew and Dilon (2014). Research on statistics anxiety has been affected by the lack of distinction between statistics anxiety and related variables, such as mathematics anxiety and attitudes toward statistics (Chew and Dillon, 2014). One researcher considered statistics to be a higher mathematics (Wilson. 1927). The substantial use of mathematics and the extensive studies on the mathematics anxiety have made it difficult for the distinction of statistics anxiety. Furthermore, some researchers defined both attitude and anxiety as an affective/non-cognitive construct (Gal & Ginsburg, 1994; Mills, 2004; Rhoads & Hubele, 2000; Roberts & Bilderback, 1980). Hence, it is not uncommon that the terms are used interchangeably. With all these issues, Cruise, Cash, and Bolton (1985) attempted to distinguish between statistics anxiety and mathematics anxiety and subsequently developed the Statistical Anxiety Rating Scale (STARS) to address

this lack of distinction gap. In the next section, theoretical explanations of statistical anxiety and related concepts are considered.

Theoretical Background - State and Trait Anxiety Theory

Psychologically, anxiety disorders are 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 (Diagnostic and Statistical Manual 2013). Anxiety is an unpleasant state of inner turmoil, often accompanied by nervous behavior, such as pacing back and forth, somatic complaints and rumination (Seligman et al.,2001).

In 1970, Spielberger suggested a more clearly defined concept of anxiety in which the disorder should be introduced as multifaceted and with a distinction between trait anxiety and state anxiety (Spielberger, Gorsuchand Lushene, 1970). According to Spielberger (1970), anxiety should be considered as both a temporary emotional state, commonly experienced (state anxiety) and a consistent personality attribute (trait anxiety) (Figure 3). In other words, trait anxiety can be viewed as the person‘s natural default demeanor, whereas state anxiety can be viewed as a person‘s reaction to a specific situation.

Spielberger (1972) believes that people high in trait anxiety respond with higher anxiety to a threat than people with low trait anxiety. Malmo (1966) reached a similar conclusion by means of an experiment measuring arousal levels for psychiatric patients and healthy controls. In his study, he established baseline readings for both groups first. Both groups were then subjected to an unpleasantly loud noise. The arousal level of both groups rose sharply. However, the arousal level of the healthy controls returned to the baseline level

quickly, whereas that of the patients did not resume to baseline during the monitoring period (Malmo, 1966). Therefore, high levels of trait anxiety have a vicious-circle effect that is both physiological and psychological (Highland, 1981).

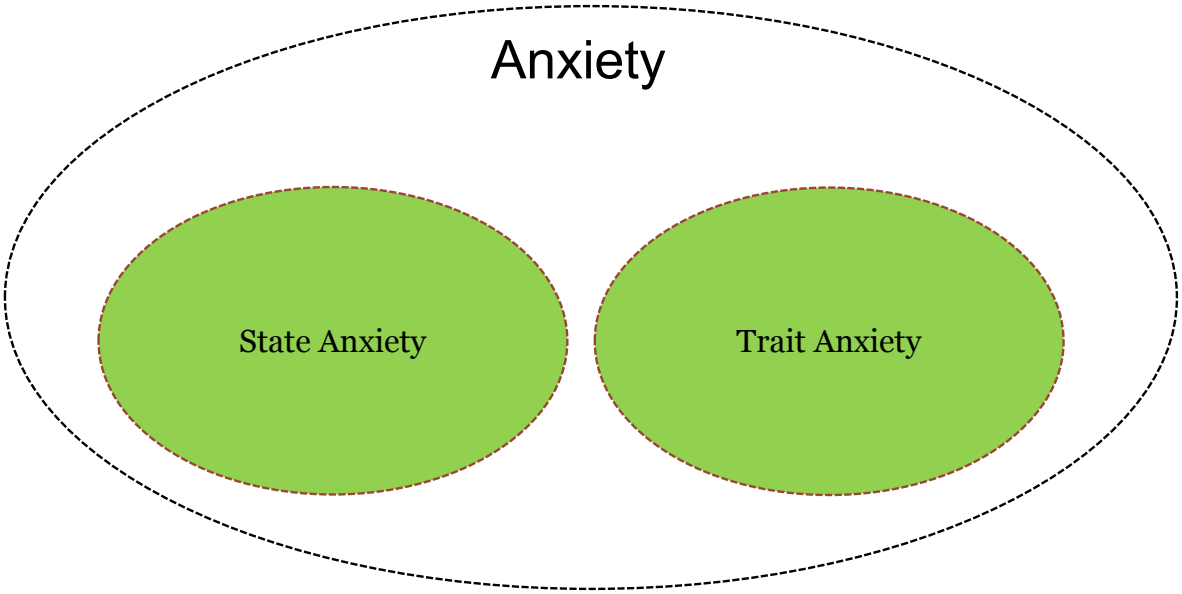

Figure 3. State and trait anxiety theory (Spielberger, Gorsuchand Lushene, 1970).

State Anxiety

State anxiety refers to "transitory unpleasant feelings of apprehension, tension, nervousness or worry, often accompanied by activation of the autonomic nervous system (McDowell 2006). It reflects how threatening a person perceives his environment to be (McDowell 2006). Spielberger referred to this as "a temporal cross-section in the emotional stream-of-life of a person" (Spielberger, 1985). This type of anxiety refers more to how a person is feeling at the time of a perceived threat and the reaction is considered temporary (Spielberger and Sydeman, 1994).

When anxiety happens in brief periods (minutes or hours) or in response to a specific threat and disappears as the threat weakens, it is considered to be state anxiety. Reiss (1997) believes that state anxiety can be classified in terms of observable behaviors, cognitive symptomatology, and physiological events. Similarly, state anxiety has also been argued as multidimensional in which two facets, cognitive-worry and autonomic-emotional (Endler and Kocovski, 2001) are considered. According to Bradley (2016; p.9), "cognitive-worry is commonly perceived as the pervasive thoughts and distorted thinking, whereas autonomic-emotional can be viewed as the psychosomatic symptoms. For example, older adults may develop worry or stress related to perceived cognitive decline and the possible consequences (e.g., loss of driver's license, the development of dementia, the need to depend on their children). Subsequently, they may develop certain behavioral responses". This then becomes either cognitive worry (e.g., keep thinking of ways to improve the recall ability) or autonomic emotional responses (e.g., frustrated when facing a cognitive decline.

According to Endler, Kantor and Parker (1994), state anxiety is considered an unpleasant emotion which causes many different reactions in interaction with specific situational stressors. A person may try to change the disliking nature of state anxiety by using specific coping responses (Endler et al., 1994). Endler and colleagues have identified three areas of coping responses and they are emotion-focused (person-oriented), problem-focused (task oriented) and avoidance coping strategies (Endler et al., 1994). Coping preferences used by an individual may then impact how that individual will behave under stress (Harrison et al., 2016). Harrison and colleagues (2016) propose that if a person experiences state-based anxiety surrounding public speaking, a person-oriented response may include deep breathing exercises or talk-therapy whereas a task oriented response would be to rehearse the public speaking several times prior or participate; an avoidance coping response would include avoiding all presentations or public speaking engagements. Next, trait anxiety will be considered.

Trait Anxiety

Trait anxiety can be defined as feelings of stress, worry, discomfort, etc. that one experiences on a day-to-day basis (Spielberger and Sydeman, 1994). This is usually perceived as how people feel across typical situations that everyone experiences on a daily basis (Spielberger and Sydeman, 1994). Trait anxiety refers to a more chronic phenomenon that is distinguished from other anxious attacks (Harrison et al., 2016). Moreover, trait anxiety has a longer duration, with symptoms persisting for months to years. And, as such, it has been described as a personality disposition (Bourne, 2005; Teachman, 2006).

Trait based anxiety is evaluated by analyzing the predisposition to experience anxiety in the following situations: social evaluation, physical danger, ambiguous, and daily routines (Endler & Kocovski, 2001). Endler & Kocovski (2001) believe that trait anxiety can be recognized by the following criteria: anxious responses are greater in proportion and experienced in a greater variety of situations; the number and intensity of anxious responses; duration of anxious responses; and the fearfulness evoked in situations. The classical definition of trait anxiety implies a generalized and long-standing predisposition to react to many and most situations in a consistently anxious manner. This assumes that trait anxiety is more inherent in nature, and refers to the rather persistent tendency in an individual to respond with state anxiety to a perceived or potential threat (Spielberger et al., 1970).

Recently, trait anxiety has been described as multidimensional, including the following four facets: social evaluation, physical danger, ambiguity, and daily routines (Endler & Kocovski, 2001). Additionally, Reiss (1997) proposes that trait anxiety is not directly manifested in behavior but can be inferred by how frequently a person experiences state-based anxiety over time. Trait theorists believe in individual differences, meaning that each person will respond and express stress and/or anxiety in unique ways (Endler & Kocovski, 2001). However, while it is not to say that a person will act with absolute consistency (e.g. a person behaves at the same level of anxiety at all times), the notion of relative consistency (e.g., an anxious person will experience symptoms of anxiety across most situations) is more commonly accepted (Endler & Kocovski, 2001). An example of trait anxiety would be when a person has a similar response to all medical appointments (i.e.,

equally afraid of a routine appointment with the primary care physician, the dentist, or a general practitioner) in which the potential threat may be real or imagined (Harrison et al., 2016). The same could be said for fear of certain social situations (e.g. attending a birthday party), or crowded events (e.g. attending a football game) (Harrison et al., 2016). In addition, some people with high levels of trait anxiety may experience anxious feelings in situations that do not evoke anxiety in others; examples include crossing a street intersection or shopping at a grocery store (Harrison et al., 2016). Hence, a trait anxiety could be a life-long expression of worry, as well as a constant stressful response to most situations.

Statistics Anxiety

Students experience statistics with varying degrees of personality dispositions and academic experiences that can either help or hinder their ability to do well. Baloğlu (2001) studied university students and found the following factors serve as antecedents to statistical anxiety: (1) dispositional factors, such as perceived task difficulty and degree of ego threat; (2) situational factors, such as the immediate factors surrounding the stimulus events; and (3) environmental factors, such as age, gender and relevant background experience. These antecedents influence the amount of trait anxiety brought to the study of statistics by each student as well as the state anxiety each student experiences when responding to stressors in their immediate situation. Dispositional and environmental factors interact with situational stressors to produce varying amounts of facilitative and debilitative anxiety (Alpert & Haber, 1960)

Defining Statistics Anxiety

Statistics anxiety is defined as an affective characteristic (Cruise et al., 1985; Onwuegbuzie, Da Ros, & Ryan, 1997; Zeidner, 1991). This affective construct has been defined narrowly as the feelings of anxiety encountered when taking a statistics course or doing statistical analyses (Cruise et al., 1985), or broadly as an anxiety which occurs when a student encounters statistics in any form and at any level (Onwuegbuzie, et al., 1997). Zeidner's definition is "….a performance characterized by extensive worry, intrusive thoughts, mental disorganization, tension, and physiological arousal . . . when exposed to statistics content, problems, instructional situations, or evaluative 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...".

None of the aforementioned definitions of statistics anxiety mention a relationship with mathematics anxiety or attitudes toward statistics or both. Additionally, although there is some evidence for the positive effects of statistics anxiety on statistics achievement, the majority of the literature are about the negative effects of statistics anxiety (Keeley, Zayac, & Correia, 2008). As such, Chew and Dillon (2014) proposed a more inclusive modification on the definition of statistics anxiety based on Dr. Onwuegbuzie's original definition (Onwuegbuzie, 1997). They proposed that statistics anxiety was "a negative state of emotional arousal experienced by individuals as a result of encountering statistics in any form and at any level; this emotional state is preceded by negative attitudes toward statistics and is related to but distinct from mathematics anxiety" (Chew and Dillon, 2014, p.199). This

proposed definition distinguishes statistics anxiety from mathematics anxiety and attitudes toward statistics and can serve as a guide in the selection of measures (Chew and Dillon, 2014).

Measures of Statistics Anxiety

There are currently six measures for assessing statistics anxiety (Chew and Dilion, 2014). They are the STARS (Cruise et al., 1985), the Statistics Anxiety Inventory (Zeidner, 1991), the Statistics Anxiety Scale (Pretorius & Norman, 1992), an unnamed instrument (Zanakis & Valenzi, 1997), the Statistics Anxiety Measure (Earp, 2007), and the Statistical Anxiety Scale (Vigil-Colet, Lorenzo-Seva, & Condon, 2008). These measures and their subscales are summarized in Table 1 (Chew and Dilion, 2014).

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Table 1

Measures and Subscales of Statistics Anxiety (By Date of Publication) (Chew and Dillon, 2014)

Measure	Subscale
51-item STARS (Cruise, Cash, & Bolton, 1985)	Interpretation Anxiety Test and Class Anxiety Fear of Asking for Help Worth of Statistics Computation Self-Concept Fear of Statistics Teachers
40-item Statistics Anxiety Inventory (Zeidner, 1991)	Statistics Test Anxiety Statistics Content Anxiety
10-item Statistics Anxiety Scale (Pretorius & Norman, 1992)	Unidimensional
36-item unnamed instrument (Zanakis & Valenzi, 1997)	Student Interest in and Perceived Worth of Statistics Anxiety When Seeking Help for Interpretation Computer Usefulness and Experience Math Anxiety Understanding Test Anxiety
44-item Statistics Anxiety Measure (Earp, 2007)	Anxiety Attitude Towards Class Fearful Behaviour Attitude Towards Math Performance
24-item Statistical Anxiety Scale (Vigil-Colet, Lorenzo-Seva, & Condon, 2008)	Examination Anxiety Asking for Help Anxiety Interpretation Anxiety

Note: STARS = Statistical Anxiety Rating Scale.

However, Chew and Dillon (2014) noted criticisms of these instruments. They are the following:

1. Two of these measures assume statistics anxiety to be similar to mathematics anxiety and so they are questionable. Precisely, both the Statistics Anxiety Inventory (Zeidner, 1991) and the Statistics Anxiety Scale (Pretorius & Norman, 1992) were developed by replacing words related to mathematics with words related to statistics in the 40-item

version of the MARS (Richardson & Woolfolk, 1980) and the 10-item version of the Mathematics Anxiety Scale (Betz, 1978), respectively.

2. Two measures make no distinction between statistics anxiety and attitudes toward statistics. The unnamed instrument (Zanakis & Valenzi, 1997) and the Statistics Anxiety Measure (Earp, 2007) assess both statistics anxiety and attitude toward statistics.

3. The use of any of these four measures could result in high correlations among statistics anxiety, mathematics anxiety, and attitudes toward statistic (Chew and Dillon, 2014). We might then erroneously assume that all those constructs are similar or even identical.

Chew and Dillon (2014) recommended researchers use either the STARS (Cruise et al., 1985) or the Statistical Anxiety Scale (Vigil-Colet et al., 2008) for measuring statistics anxiety. Currently, the STARS has been extensively utilized by researchers because of the superiority of its reliability and validity data compared with that of other measures (Baloğlu, 2002; Hanna, Shevlin, & Dempster, 2008; Liu, Onwuegbuzie, & Meng, 2011; Mji & Onwuegbuzie, 2004; Papousek et al., 2012). A second option is to use the Statistical Anxiety Scale, a promising instrument that affords researchers a specific measure of statistics anxiety. Nevertheless, this measure seems to be in its early stage, with only one validity study conducted (Chiesi, Primi, & Carmona, 2011). Thus, more studies are needed to confirm its factor structure with diverse samples (Chew and Dillon, 2014).

Types of Antecedents of Statistics Anxiety

Situational Antecedents

Situational antecedents are factors that surround the student, e.g. previous statistics experiences (Sutarso, 1992). Researchers found a negative correlation between the number of completed mathematics courses and statistics anxiety (Auzmendi, 1991; Robert & Saxe, 1982; Zeidner, 1991). Forte (1995) found minimal previous math experience, late introduction to quantitative analysis, anti-quantitative bias, lack of appropriation for the significance of analytical models, and lack of mental imagery were factors contributing to statistics anxiety among social work students. Furthermore, different means of teaching have contributed to the statistics anxiety. For example, students taking accelerated courses experienced higher levels of statistics anxiety than students taking regular courses (Bell, 2005). In addition, students taking an online statistics course had higher levels of statistics anxiety than their counterparts taking a statistics course on campus (DeVaney, 2010). A major limitation of the study was the different characteristics of the groups. For example, students in the on-campus group (n = 27) were predominantly Black (66.7%), whereas students in the online group (n = 93) were predominantly White (74.2%). Overall, those studies were more like observational designs as students were not randomly assigned and special treatments were imposed on a particular group of subjects.

Situational antecedents of statistics anxiety are immediate factors that result from statistics courses themselves and include teacher and teaching related factors (Onwuegbuzie et al., 1997). Common situational antecedents are the following:

- Statistics teachers (Zeidner, 1991)
- The nature of statistics courses (Fenster, 1992a; Kaiser, 1992; Onwuegbuzie et al., 1997; Zeidner, 1991)
- The lack of feedback from statistics instructors (Onwuegbuzie et al., 1997)
- The pace of statistics instruction (Onwuegbuzie et al., 1997)
- The statistical notation/terminology (Onwuegbuzie et al., 1997)
- The complexity of statistics textbooks (Onwuegbuzie et al., 1997)

Dispositional Antecedents

Dispositional antecedents are intrapersonal factors that students bring to the classroom (Onwuegbuzie & Daly, 1999), which include issues such as perfectionism and perception of abilities at developmental stages in life (Pan & Tang, 2004). Walsh and Ugumba-Agwunobi (2002) found evaluation concern, fear of failure, and perfectionism provoked statistics anxiety. Moreover, procrastination has been found to be related to statistics anxiety. Students who procrastinated because of fear of failure and task aversiveness tended to experience higher levels of statistics anxiety. However, procrastination and statistics anxiety might affect each other in a bidirectional manner. Students who procrastinate might experience higher statistics anxiety because of the increasing difficulty and workload of the course. Conversely, students with high levels of statistics anxiety might procrastinate because of task aversiveness (Onwuegbuzie, 2004).

Reading ability and learning strategies have also been implicated in statistics anxiety. Students with poor reading ability tend to experience higher levels of statistics anxiety

(Collins & Onwuegbuzie, 2007). The results provided support for the notion that a well-written statistics textbook might help meet the needs of students and alleviate statistics anxiety (Schact, 1990). With regard to learning strategies, students who used rehearsal, elaboration, organization, critical thinking, and effort regulation strategies experienced lower levels of statistics anxiety (Kesici, Baloğlu, & Deniz, 2011).

Onwuegbuzie et al. (1997) posited that statistics anxiety involves a complex array of emotional reactions that could debilitate statistics achievement. The commonly investigated dispositional antecedents of statistics anxiety are the following:

- Beliefs about statistics (Onwuegbuzie, 1998b)
- Attitudes toward statistics (Harvey, Plake, & Wise, 1985; Zanakis & Valenzi,1997)
- Perceptions (Zanakis & Valenzi, 1997; Zeidner, 1991)
- Avoidance (Onwuegbuzie, 1993)
- Self-concept (Onwuegbuzie, 1993)
- Learning styles (Onwuegbuzie, 1998a)
- Locus of control (Wolfe, 1978)

Environmental Antecedents

Research on the effects of age and gender differences on statistics anxiety has yielded mixed results (Chew and Dillon, 2014). Although some studies reported that older students (i.e., 25 years of age and older) had higher statistics anxiety than younger students (Baloğlu, 2003; Bell, 2003), Bui and Alfaro (2011) found no age differences. With regard to gender

differences, although some researchers reported that women experience higher statistics anxiety than men (Baloğlu, Deniz, & Kesici, 2011; Rodarte-Luna & Sherry, 2008), other researchers found no gender differences (Bui & Alfaro, 2011; Hsiao & Chiang, 2011). Chew and Dillon believed that those mixed results could be due to various sources of inconsistencies, such as type of analysis (e.g., t tests, discriminant function analysis, or multivariate analysis of variance), country (e.g., United States, Turkey, or Taiwan), and the inclusion of other variables in the analysis (e.g., controlling for grade point average or previous mathematics experience) (Chew and Dillon, 2014). Nevertheless, among studies that reported age or gender differences, the effect sizes were mostly small to moderate (e.g., Rodarte-Luna & Sherry, 2008). This suggests that the practical significance of the differences might be negligible (Chew and Dillon, 2014). For example, although women reported higher statistics anxiety than men, it had no impact on the women's statistics achievement because there were no differences in statistics achievement (Bradley & Wygant, 1998). In addition, gender was not related to statistics examination grades (Furnham & Chamorro-Premuzic, 2004). Thus, we should assess the outcomes in conjunction with statistics anxiety, i.e. studies should examine whether age and gender differences in statistics anxiety affect statistics achievement.

Cross-cultural and ethnic differences have also been implicated in statistics anxiety. International students (those who came to US for education only with student visas) in the United States reported higher statistics anxiety than domestic students (Bell, 2008). In addition, college students in the United States reported higher statistics anxiety than Turkish

college students in Turkey (Baloğlu et al., 2011). With regard to race, although no significant differences in statistics anxiety were found between Latino/Hispanics and Caucasians (Bui & Alfaro, 2011), African Americans were found to have higher levels of statistics anxiety than their Caucasian American counterparts (Onwuegbuzie, 1999).

Statistical Anxiety Research Methodologies

We know that high-anxiety students in high stress condition show more emotionality and poorer performance than students in either high anxiety-low stress, low anxiety-high stress or low anxiety-low stress conditions (Deffenbacher, 1978). Similar results are also observed in statistics anxiety. Indeed, a consistent negative relationship has been found between statistics anxiety and statistics achievement in a variety of studies (Bell, 2001; Hanna & Dempster, 2009; Onwuegbuzie, 1995, 2003; Onwuegbuzie & Seaman, 1995; Tremblay, Gardner, & Heipel, 2000; Zanakis & Valenzi, 1997). In other words, students who experience higher levels of statistics anxiety tend to have lower performance on a statistics examination. The negative effects of statistics anxiety have prompted researchers to carry out antecedent research in order to clarify its nature and inform interventions. (Dillon 2014). For example, one research method involved presenting participants with nine short stories and asking them to use statistical analyses to "solve" the puzzle (D'Andrea & Waters, 2002). A pretest–posttest design showed a significant decrease in statistics anxiety scores in the posttest. Another research method required statistics instructors to employ application-oriented teaching methods (applying statistics to real-world problems, critiquing of journal articles, etc.) while being attentive to students' anxiety (humorous teaching style, providing

coping strategies, etc.) in class (Pan & Tang, 2004). Similarly, a pretest–posttest design showed a significant decrease in statistics anxiety scores in the posttest.

The effectiveness of a gender-sensitive and culture sensitive statistics course in alleviating statistics anxiety has also been examined (Davis, 2003) because some research showed that women and minorities had higher statistics anxiety (e.g., Baloğlu et al., 2011). Participants had weekly discussions on the role of women and minorities in research. A pretest–posttest design revealed significant reductions in statistics anxiety at posttest (Davis, 2003).

The role of instructor immediacy in reducing students' levels of statistics anxiety was examined (Williams, 2010). Immediacy refers to a set of behaviors (e.g., addressing students by name) communicated by the instructors to influence the perception of psychological and physical distance. A pretest–posttest control group design revealed a significant decrease in statistics anxiety scores for the treatment group.

There has been an limited use of experimental designs to evaluate interventions of statistics anxiety (Chew and Dillon. 2014). One study included a control group design (Williams, 2010). Others used a one group pretest–posttest design (D'Andrea & Waters, 2002; Davis, 2003; Pan & Tang, 2004). The ethical issue of withholding a potential beneficial intervention from the control/placebo group is often the reason of choosing this kind of study designs without a control/placebo comparator arm (Pan & Tang, 2004). However, the lack of a control group can be problematic because it does not take into account several alternative competing explanations for improvement, such as history,

maturation, testing, and statistical regression (Campbell & Stanley, 1963). For example, there is some evidence that statistics anxiety decreases over time in the absence of interventions (Chew & Dillon, 2012; Keeley et al., 2008). Hence, the effectiveness of the interventions in these studies is questionable.

It is sometimes impractical or not possible to randomly assign students to groups. Instead, some researchers use pre-existing groups, such as students from two comparable classes. Therefore, future researchers should use the non-equivalent control group design, a commonly used quasi-experimental design, to evaluate interventions for statistics anxiety (Chew and Dillon, 2014). The non-equivalent control group design is essentially a pretest–posttest control group design without random assignment.

Research Gaps

Current research on statistics anxiety is limited in several ways. First, there is a limited research on interventions. Antecedent research is not being used to inform interventions. For example, despite procrastination being an antecedent of statistics anxiety (Onwuegbuzie, 2004), no researchers have evaluated the effect of reducing procrastination on the statistics performance or grades as an intervention for statistics anxiety. Thus, this kind of antecedent research has served its main correlational purpose instead of informing researchers about the causality effect by interventions.

Second, although research on the effects of statistics anxiety emphasizes the need for instructors to be aware of this anxiety and for researchers to develop interventions for it, the

research does not explain how statistics anxiety negatively affects statistics performance such as statistics exams.

Third, most of the antecedent studies have assessed statistics in disciplines such as psychology, behavioral, social sciences and business. Very little research on statistical anxiety has been done in health sciences.

Fourth, most of the antecedents cannot be manipulated because of their nature (e.g. gender, age, ethnicity). Previous studies on statistics anxiety have been mostly descriptive and correlational. Hence, most of the multivariate analysis of variance are assessments of correlations.

The gap that this study addresses is to explore statistics anxiety in doctoral programs of health sciences related disciplines.

Summary

This chapter provides a current review of the statistics anxiety literature with the aims of distinguishing statistics anxiety from related variables, understanding the theoretical background, defining statistics anxiety which informs the selection of appropriate measures, introducing measures of statistics anxiety, explaining statistical anxiety research methodologies, discussing study research gaps and three types of antecedents. All of them have paved the way for a new research agenda in this study.

CHAPTER III

RESEARCH METHODS

Introduction

As stated by Creswell (2003), a quantitative approach is suitable when a researcher seeks to understand relationships between variables. Since this study was intended to explore statistics anxiety levels among doctoral students in health sciences disciplines, a quantitative approach was used. This study applied a cross-sectional exploratory survey approach by using online questionnaires. It was exploratory because there was no evidence of studies having been done on statistical anxiety among doctoral students in health sciences related disciplines, e.g. Doctor of Nursing Practice (D.N.P.) and Doctor of Philosophy (Ph.D.) students. Participants were surveyed at only one point in time. The survey method provides an inexpensive way for researchers to have a fast turnaround during data collection (Creswell, 2003). The survey method was designed to provide a descriptive picture of the statistics anxiety of the doctoral students in health sciences related disciplines in universities across the nation.

Since evidence-based health sciences researchers require the support of statistical analyses and health sciences related disciplines' researchers are expected to have possessed a

good command of the statistics knowledge in the interpretation of research results, the purpose of this study was mainly to explore the statistical anxiety among doctoral students in health sciences related disciplines.

Scholarship is an integral part of both professional and research doctoral degrees although they have different focuses and objectives. The D.N.P. degree is a practice doctorate. The Ph.D. degree in Health Sciences related disciplines or in Nursing is a research doctorate. In order to provide D.N.P. students with the skills and tools necessary to assess the evidence gained through nursing research, evaluate the impact of that research on their practice, and, as necessary, make changes to enhance quality of care (retrieved from ttps://nursing.duke.edu/academics/programs/dnp/dnp-phd-program-comparison), knowledge in statistics is understandably crucial. Statistics is also crucial in preparing Ph.D. students in Health Sciences related disciplines or in Nursing in conducting independent research (retrieved from https://nursing.duke.edu/academics/programs/dnp/dnp-phd-program-comparison).

Situational antecedents are factors that surround the students, e.g. previous statistics experiences (Sutarso, 1992). For example, researchers found a negative correlation between the number of completed mathematics courses and statistics anxiety (Auzmendi, 1991; Robert & Saxe, 1982; Zeidner, 1991). In this study, in order to meaningfully investigate the statistics anxiety levels (the dependent variable) experienced by doctoral students who were currently taking a statistics course (the independent variable) in their programs, it was important to control the situational antecedents by measuring the statistics anxiety levels

experienced in all 3 different cohorts of doctoral students. These 3 cohorts were the Pre-Statistics cohort (those who have not taken any statistics course in their programs yet), the Current-Statistics cohort (those who were currently taking a statistics course in their programs) and the Post-Statistics cohort (those who have already taken statistics course(s) in their programs).

Research Design

This study utilized an exploratory cross-sectional survey study where doctoral students were recruited per convenience and purposive sampling methods. This study used purposive sampling because the principle investigator had specific groups of people in mind. Also, this study used convenience sampling because it was a matter of relying on individuals to volunteer for participation in the study. Only doctoral students were recruited for a 1-time only participation.

The online survey had two parts, i.e. Part I STARS and Part II Demographic Survey. The online survey applied to all doctoral student participants in all 3 cohorts. Upon Seton Hall IRB approval (Appendix B), the study solicitation letter was emailed as an attachment to all deans or department chairs or the faculty-in-charge of the participating doctoral programs of Health Sciences related disciplines. The content of the study solicitation letter was posted on Survey Monkey website as well. Participating programs then forwarded the study solicitation letter to their doctoral students during the Fall term 2017. In terms of comparisons, they are presented in Figure 4:

a. There were comparisons in statistics anxiety between 3 different cohorts of professional doctoral students (i.e. Doctor of Nursing Practice students).
b. There were comparisons in statistics anxiety between 3 different cohorts of research doctoral students (i.e. Ph.D. in Health Sciences students and Ph.D. in Nursing students)
c. There were comparisons in statistics anxiety between professional doctoral students and research doctoral students in the pre-statistics cohort, the current-statistics cohort and the post-statistics cohort respectively.

The recruitment period was from 10/9/2017 – 1/1/2018. Two reminder emails were sent to all the participating doctoral programs by the end of Week 2 and Week 6.

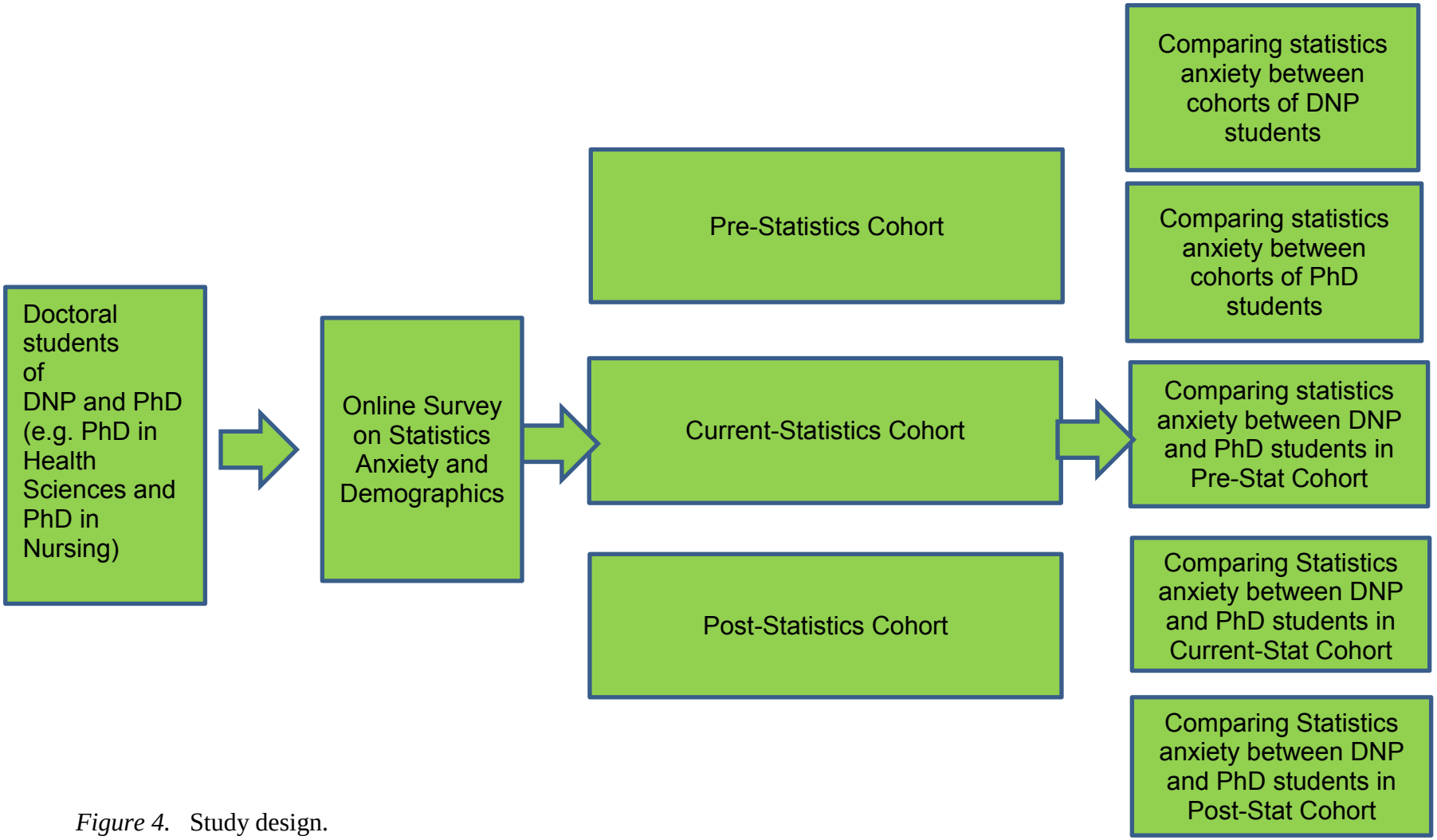

Figure 4. Study design.

Methodology

The following sections provide a detailed description of various aspects of the study design. Topics include the study population, sampling procedures, and procedures for data collection. It also includes a description of the statistics anxiety instrument that was used in this study and the data analyses procedures.

Population

Research participants were doctoral students currently pursuing the professional doctoral degrees (Doctor of Nursing Practice) and research doctoral degrees (Ph.D. in Health Sciences related disciplines and Ph.D. in Nursing), enrolled in different years of their programs from universities across the United States. Table 2 shows the inclusion criterion.

In terms of the sources of the population, doctoral programs were chosen based on the Top 50 Ranking Doctor of Nursing Practice Universities listed on the 2017 US News, their corresponding nursing programs listed in the American Association of Colleges of Nursing (AACN) website and the top 20 Doctoral Degree Programs listed on the 2015 Healthcare Management Degree Guide.

All study participants were only recruited from doctoral programs where deans or department chairs or the faculty-in-charge were initially contacted via emails by the principle investigator regarding this study and they granted site access approval to the study. Confidentiality regarding the names of participating doctoral programs was maintained by the principal investigator..

Table 2

Tables Showing Inclusion and Exclusion Criteria

Inclusion Criteria
1. Research participants are doctoral students in USA currently pursuing either a professional doctoral degree (i.e. D.N.P.) OR a research doctoral degree such as - Ph.D. in Rehabilitation Sciences - Ph.D. in Environmental and Occupational Health - Ph.D. in Health Sciences - Ph.D. in Human Movement Sciences Concentration - Ph.D. in Kinesiology & Rehabilitation - Ph.D. in Nursing
2. A doctoral student is defined as an individual pursuing a professional or research doctoral degree beyond a bachelor's degree.
3. A statistics course in the program is defined as covering at least the descriptive statistics and the inferential statistics
4. Doctoral students who participated in the online survey were one of of the following:

- those who had not taken any statistics course in their programs yet
- those who were currently taking statistics course in their programs
- those who had already completed statistics course(s) in their programs.

5. 18 years of age and above
6. Internet access on a mobile device or a computer
7. Able to read & understand English

Exclusion Criteria

1. Individuals who did not meet the study inclusion criteria were excluded from the study.

Participant Recruitment Procedures

The list of schools granted with deans' or chairs' or the faculty-in-charge site access approvals had to be finalized first. Following the Seton Hall's IRB approval, the online survey website (Survey Monkey) was activated accordingly. The target period for data collections was the Fall term 2017. The study solicitation with a link to the online survey was emailed to all deans or chairs or the faculty-in-charge of the participating doctoral

programs (Appendix C). The study solicitation was assessed by the Flesch-Kincaid Grade Level at 12.5. The deans or chairs or the faculty-in-charge then forwarded the study solicitation to their doctoral students however they saw fit, e.g. they might forward the principle investigator's email or post the online survey website on their universities' internet homepages or Blackboards. Participants were requested to read and convey informed consent in terms of submitting the completed survey. A submission of the online survey conveyed the consent to participate in the study. No follow-up interviews of any kind were included for the study. There was 1 initial invitation email and 2 follow up emails to deans or chairs or the faculty-in-charge. All data were submitted anonymously. The principle investigator did not contact research participants directly. Research participants were told to contact the principle investigator through the principle investigator's department in Seton Hall if needed.

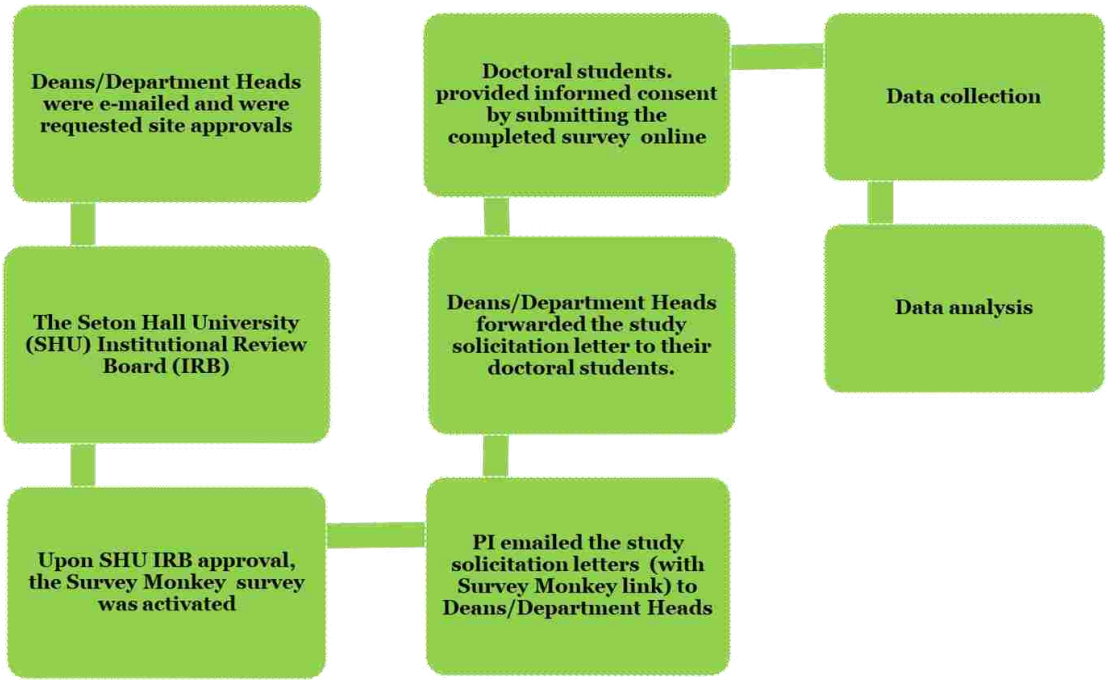

Figure 5. A flowchart of procedures.

Instrumentation

The instrumentation for this research study consisted of a statistics anxiety measure which was used in order to gather data to answer the study's research questions and a demographic questionnaire. The following sections outline the specific instruments used in the study.

Statistical Anxiety Rating Scale (STARS). The Statistics Anxiety Rating Scale (STARS) was developed by Cruise and Wilkins (1980). The STARS was originally developed to assess students' levels of statistics anxiety. It consisted of an initial set of 89 items and was given to 1,150 statistics students (Cruise and Wilkins, 1980). The final form of the instrument consisted of 51 items (Cruise et al., 1985) and six factors described in Table 3. The factors measured by the instrument include worth of statistics (16 items), Interpretation Anxiety (11 Items), test and class anxiety (8 items), computation self-concept (7 items), fear of asking for help (4 items), and fear of statistics Teacher (5 items). The first 23 items indicate how much anxiety a respondent would experience in each situation. The remaining 28 items indicate level of agreement with statements related to statistics. The data collected from the instrument are interval level data where high scores indicated high anxiety levels of the learner in a statistics course (Lodico, Spaulding, & Voegtle, 2010). See Appendix D for a copy of the complete listing of the STARS 51 items. Permission to use and to list all 51 items of the STARS instrument in this study was generously granted by the lead author Dr. Robert Cruise (See Appendix F). See Appendix G for all 51 items of the STARS instrument on Pages 93 and 94 of the original publication by Cruise, Cash and Bolton (1985).

Permission to re-publish Pages 93 and 94 of the original publication by Cruise, Cash and Bolton (1985) was also granted by the publisher American Statistical Association (See Appendix H).

Demographics. A demographic questionnaire was used to collect basic demographic information from each participant. Information included in this questionnaire consisted of the gender, the age range, the highest educational degree, the current educational program and the current statistics course. See Appendix E for a copy of the demographic questionnaire which was created for the purposes of this study by the principle investigator.

Table 3

Statistical Anxiety Rating Scale Factors, Number of Items, Score Ranges and Corresponding Sample Items (Welch, et al. 2015)

Factor	Number of Items	Score Range	Description and Sample Item
Worth of Statistics	16	16 to 80	A person scoring high on this factor sees no value in learning statistics. "I feel statistics is a waste."
Interpretation Anxiety	11	11 to 55	A person scoring high on this factor has difficulty interpreting statistical data. For instance, when "Making an objective decision based on empirical data."
Test and Class Anxiety	8	8 to 40	A person scoring high on this factor is very anxious about being in a statistics course and taking exams. For instance, when "Studying for an examination in a statistics course."

Computation on Self-Concept	7	7 to 35	A person scoring high on this factor has anxiety about statistics because it involves mathematical calculations. "I could enjoy statistics if it weren't so mathematical."
Fear of Asking for Help	4	4 to 20	A person scoring high on this factor experiences anxiety when seeking help from the professor or other students. For instance, when "Asking my statistics teacher for individual help with material I am having difficulty understanding."
Fear of Statistics Teachers	5	5 to 25	A person scoring high on this factor sees statistics teachers as impersonal and intimidating. "Statistics teachers are so abstract they seem inhuman."

Factor one relates to worth of statistics. Responses to these questions relate to the student's perception of the relevance of statistics. Scores will range from 16-80 (16 x 1 through a maximum of 16 items x 5). An individual with a high score sees no purpose in taking or using statistics. In addition, a high score may suggest a negative attitude toward statistics. Included in this group are items 24, 26, 27, 28, 29, 33, 35, 36, 37, 40, 41, 42, 45, 47, 49, and 50.

Factor two suggests interpretation anxiety. Responses to these questions suggest that anxiety is experienced when a student is faced with making a decision from statistical data. Scores will range from 11 - 55. A high score may suggest that a person has difficulty interpreting (and/or analyzing) data and making decision based on data. Included in this group are items 2, 5, 6, 7, 9, 11, 12, 14, 17, 18, and 20.

Factor three is about test and class anxiety. Responses to these questions may indicate the anxiety a person has when taking a statistics class or test. Scores will range from 8 - 40.

A high score may suggest great anxiety. Included in this group are items 1, 4, 8, 10, 13, 15, 21, and 22.

Factor four attempts to measure self-concept and one's anxiety when doing mathematical problems. Scores will range from 7 - 35. A high score suggests a person does not mind taking statistics, but has anxiety because it involves computation and the subject feels inadequate to comprehend statistics. Items included in this group are 25, 31, 34, 38, 39, 48, and 51.

Factor five relates to the fear of asking for help and measures the associated anxiety. Scores will range from 4 - 20. A high score suggests an individual experiences anxiety when asking for help. Items included in this group are 3, 16, 19, and 23.

Factor six measures the fear of statistics teachers. Scores will range from 5 - 25. A high score suggests the participant perceives the statistics teacher as lacking the ability to relate to the student as a human being. Items included in this group are 30, 32, 43, 44, and 46.

Validity. The Statistical Anxiety Rating Scale (STARS) instrument was validated in the following ways. The reviewers consisted of five statistics professors and five doctoral students (Cruise and Wilkins, 1980). Each reviewer was presented with a description of the six factors and a list of possible items for each factor. A coefficient of agreement was determined for each item under each factor. Factor analysis was also conducted to establish construct validity. The original 89-item instrument was given to a sample of 1,265 graduate students of whom 1,150 participants completed the instrument. Principal component analysis was completed and the extracted components were rotated using varimax procedures.

The initial factor analysis determined that a total of 14 possible factors existed; however, the factors were further tested using a new combination of factors and variables because the researchers considered the initial factor structure to be weak (Cruise et al., 1985). The ideal combination was to have each item load only on one factor and items with similar characteristics load on the same factor. The results of the analysis determined that the best solution consisted of six factors and 51 items. This version of STARS has been used the most in terms of measuring statistical anxiety, particularly the fact that STARS has been validated in several validity studies where students were tested (Onwuegbuzie & Wilson, 2003).

Furthermore, researchers can be more confident to state that "reliability generalizability" is achieved if the instrument is conducted in different groups (Onwuegbuzie & Daniel, 2002; Thompson & Vacha-Haase, 2000). For instance, the elements that contribute to the statistical adequacy of STARS have frequently been studied using university students in the United States (Baloğlu, 2002). Yet, it was not sufficient to rely on this US-only evidence. Therefore, a validation study in a total of 196 students on a South African sample of college students (Eastern Cape, South Africa) using STARS could help to determine the validity and reliability of this tool from a different region and to contribute greatly to the database (Mji & Onwuegbuzie, 2004). Results showed that the coefficient alpha indices ranged from .76 to .93, with a median of .77 (Mji & Onwuegbuzie, 2004). Therefore, the evidence of acceptable internal consistency reliability found in this South African study was consistent with that reported in other studies, for the entire scale and the six subscales (Baloğlu, 2002; Cruise et al., 1985; Onwuegbuzie. 1998, 1999).

Reliability. Reliability measures for the STARS (Cruise & Wilkins, 1980) consisted of coefficient alpha, point multi-serial correlations, and test-retest estimates. Coefficient alpha estimates ranged between .678 and .940. Point multi-serial correlations were between .589 and .906. The test-retest estimates fell between .671 and .833.

Administration

Cruise and Wilkins (1980) explained that there were no special qualifications needed to administer the instrument. The instrument can be given individually or in groups. The instructions for taking the instrument are self-explanatory. The authors recommend that students not take too much time on any one question since no grade will be assigned to this particular activity. The entire STARS is a self-diagnosis instrument and should take an average of 15 minutes to complete.

Operationalization of Variables

The key variables of interest within this study were statistics anxiety, the type of doctoral degrees (professional vs research) and statistics course(s) experience in the program. All independent variables and dependent variable are listed below:

Independent Variables

1. Statistics experience
    - Pre-Statistics
    - Current- Statistics
    - Post-Statistics
2. Currently enrolled program

- D.N.P.
- Ph.D. in Health Sciences related disciplines
- Ph.D. Nursing

Dependent Variable

1. Statistics anxiety (STARS scores)

Sample Size

The required sample size for this study was estimated by the G*Power online software (Version 3.1.9.2). The data were ordinal and hence, non-parametric statistics tests were used.

a. For Research Question 1: The chance of correctly accepting the alternative hypothesis in a Kruskal-Wallis Test was improved when we had a Type 1 error (alpha) of 0.05, a medium effect size "f" of 0.25 and a power of 80% . Since there was no Priori Power Analysis sample size calculation for Kruskal-Wallis Test in the G*Power online software , the sample size calculation was conducted via a gold standard method, i.e. via the One way ANOVA, but with 15% more samples (Lehmann, 1998). Hence, a minimum sample size of 183 professional doctoral students (or 61 professional doctoral students from each of the 3 cohorts) (see Figure 6) was needed
b. For Research Question 2: The chance of correctly accepting the alternative hypothesis in a Kruskal-Wallis Test was improved when we had a Type 1 error (alpha) of 0.05, a medium effect size "f" of 0.25 and a power of 80% . Since there

was no Priori Power Analysis sample size calculation for Kruskal-Wallis Test in the G*Power online software , the sample size calculation was conducted via a gold standard method, i.e. via the One way ANOVA, but with 15% more samples (Lehmann, 1998). Hence, a minimum sample size of 183 research doctoral students (or 61 research doctoral students from each of the 3 cohorts) (see Figure 6) was needed.

c. For Research Questions 3, 4 and 5: The chance of correctly accepting the alternative hypothesis in a Mann-Whitney Test was improved when we had a Type 1 error (alpha) of 0.05, a medium effect size "d" of 0.50 and a power of 80% . The minimum sample size of 134 doctoral students (i.e. 67 professional doctoral students and 67 research doctoral students) (see Figure 7) was needed.

d. In order to explore all research questions #1-5 adequately, the total overall sample size was at least 402 doctoral students (see Table 4).

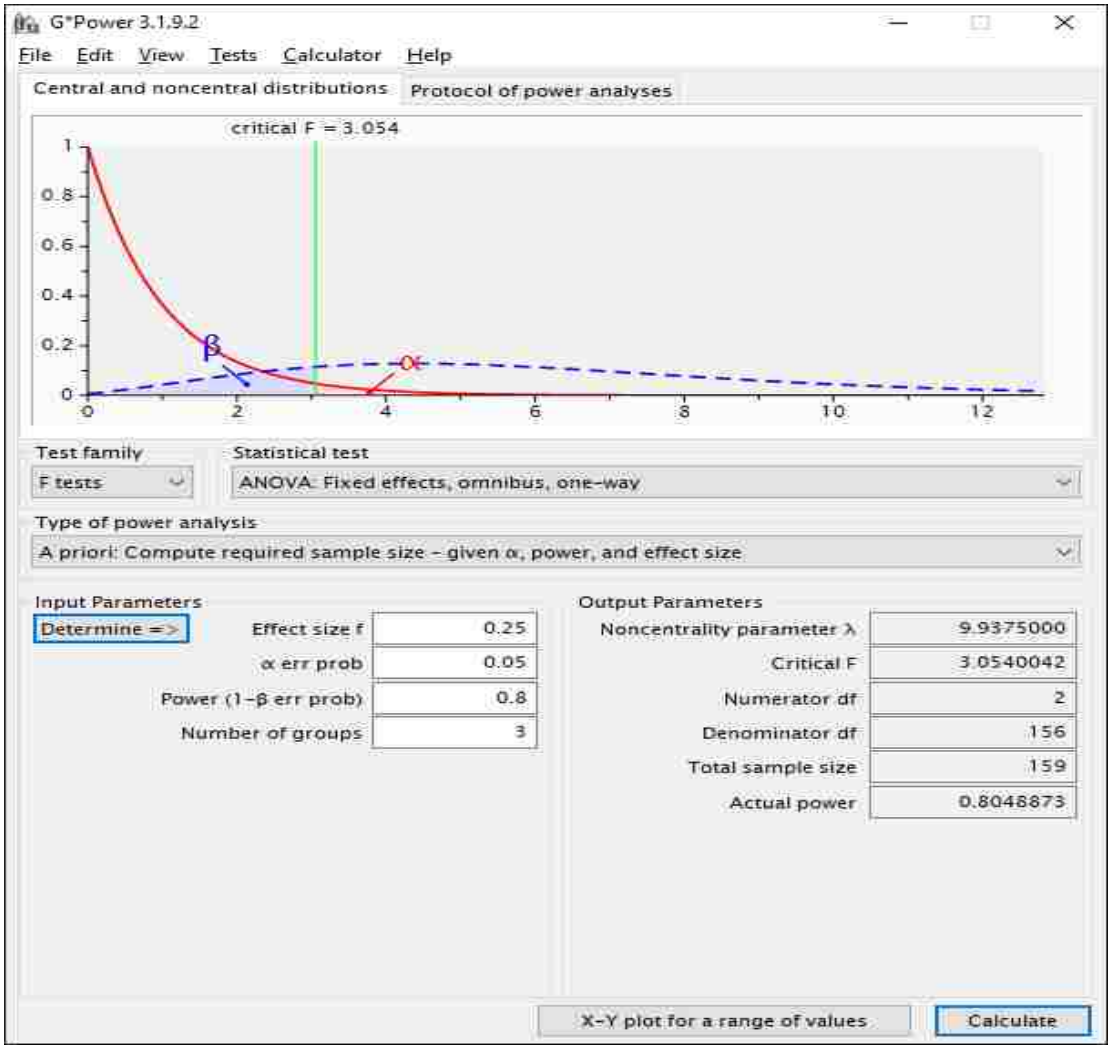

Figure 6. A Priori Power Analysis Sample Size Calculations for Research Questions 1 and 2.

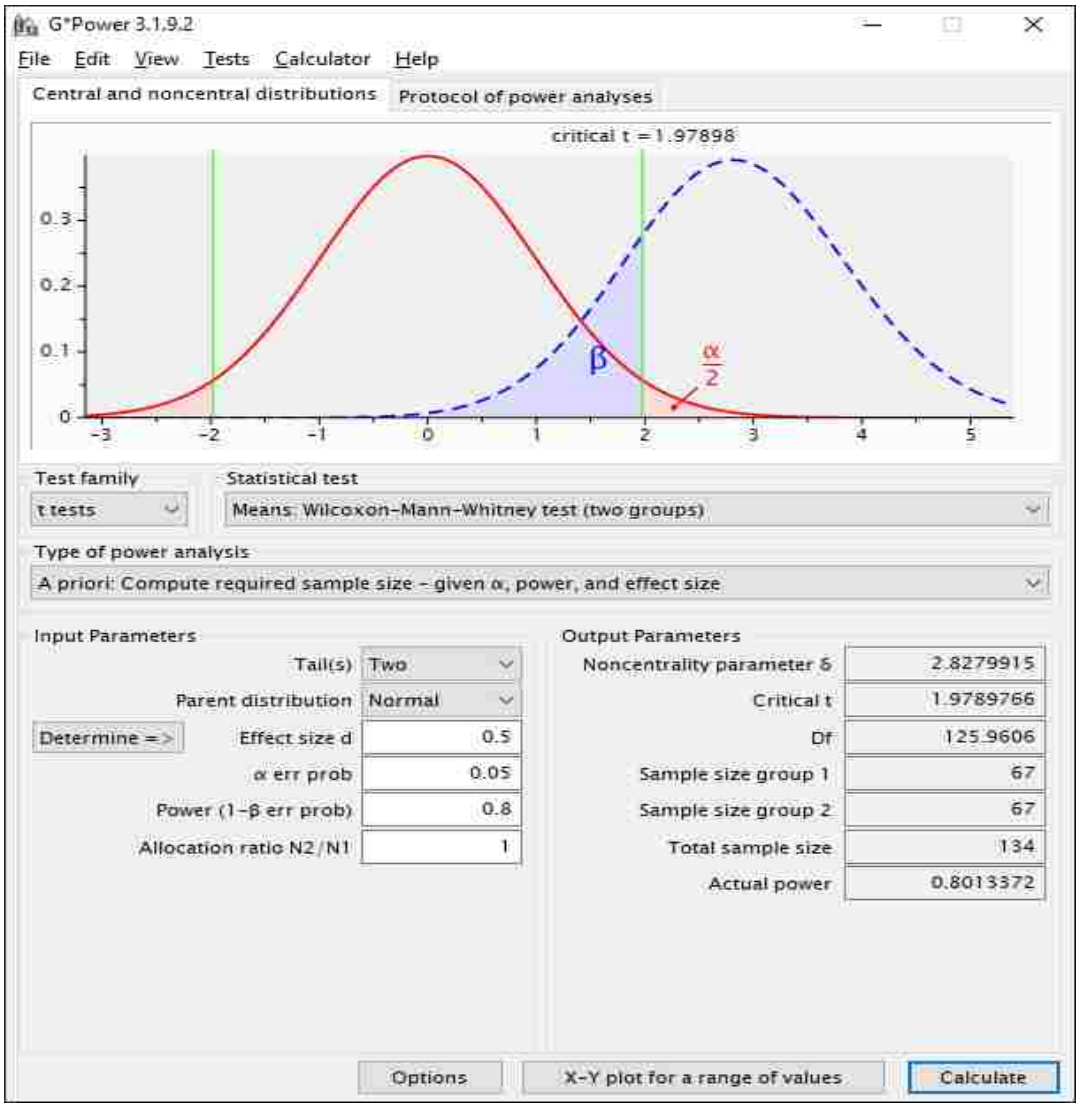

Figure 7. A Priori Power Analysis Sample Size Calculations for Research Questions 3, 4 and 5.

Table 4

Minimum Numbers Needed

Cohorts	Minimum Numbers Needed
Cohort #1: Doctoral students who have not taken any statistics course in their programs yet	• 67 professional doctoral students • 67 research doctoral students
Cohort #2: Doctoral students who were currently taking statistics course in their programs	• 67 professional doctoral students • 67 research doctoral students
Cohort #3: Doctoral students who have already completed statistics course(s) in their programs.	• 67 professional doctoral students • 67 research doctoral students

Hypotheses and Data Analyses

There were 5 research questions explored in this study. Each research question had a corresponding hypothesis and a discussion of the data analysis. All data for this study were analyzed using SPSS Version 24.0 for Windows. Descriptive statistics were first calculated for all demographic variables.

Null Hypothesis ($H1_o$). There will not be a statistically significant difference in the statistics

anxiety scores between all 3 cohorts of D.N.P. students whose programs require statistics course(s).

Alternative Hypothesis ($H1_a$). There is a statistically significant difference in the statistics anxiety scores between at least 2 cohorts of D.N.P. students.

Data Analysis. Kruskal-Wallis Test evaluates whether the STARS median scores are equal between 3 cohorts (pre-, currently-taking and post-statistics). For significant Kruskal-Wallis tests, pairwise comparisons would be conducted using the Mann-Whitney test to confirm whether the differences occurred between 2 cohorts

Null Hypothesis ($H2_o$). There will not be a statistically significant difference in the statistics anxiety scores between all 3 cohorts of Ph.D. students whose programs require statistics course(s).

Alternative Hypothesis ($H2_a$). There is a statistically significant difference in the statistics anxiety scores between at least 2 cohorts of Ph.D. students.

Data Analysis. Kruskal-Wallis Test evaluates whether the STARS median scores are equal between 3 cohorts (pre-, currently-taking and post-statistics). For significant Kruskal-Wallis tests, pairwise comparisons would be conducted using the Mann-Whitney test to confirm whether the differences occurred between 2 cohorts

Null Hypothesis ($H3_o$). There will not be a statistically significant difference in the statistics anxiety scores between D.N.P. and Ph.D. students in the Pre-Statistics cohort.

Alternative Hypothesis ($H3_a$). There is a statistically significant difference in the statistics anxiety scores between D.N.P. and Ph.D. students in the Pre-Statistics cohort.

Data Analysis. The Mann-Whitney Test analyzes whether there is a significant difference of the STARS median scores of the 2 data-sets (between D.N.P. and Ph.D. students).

Null Hypothesis ($H4_o$). There will not be a statistically significant difference in the statistics anxiety scores between D.N.P. and Ph.D. students in the Current-Statistics cohort.

Alternative Hypothesis ($H4_a$). There will be a statistically significant difference in the statistics anxiety scores between D.N.P. and Ph.D. students in the Current-Statistics cohort.

Data Analysis. The Mann-Whitney Test analyzes whether there is a significant difference of the STARS median scores of the 2 data-sets (between D.N.P. and Ph.D. students).

Null Hypothesis ($H5_o$). There will not be a statistically significant difference in the statistics anxiety scores between D.N.P. and Ph.D. students in the post-statistics cohort).

Alternative Hypothesis ($H5_a$). There will be a statistically significant difference in the statistics anxiety scores between D.N.P. and Ph.D. students in the post-statistics cohort).

Data Analysis. The Mann-Whitney Test analyzes whether there is a significant difference of the STARS median scores of the 2 data-sets (between D.N.P. and Ph.D. students).

Confidentiality

Participation was anonymous. Students were not required to provide their names and/or student numbers in the online survey. Survey responses did not include any information that could directly link students to their responses. All data were securely stored on USB thumb drives which were located in a safe locked file cabinet at the principal investigator's home and made available only to the principal investigator (Quincy Chau). In any publications that result from this data, only group results will be reported. Data stored on USB drives will be physically destroyed 3 years after project completion. Records stating what/when/how records were destroyed will be kept.

CHAPTER IV

RESULTS

Introduction

The purpose of this study was to explore the statistical anxiety levels in doctoral students in health sciences related disciplines (i.e. D.N.P. and Ph.D. students) in 3 different cohorts respectively, i.e. the Pre-Statistics cohort, the Current-Statistics cohort and the Post-Statistics cohort. The study also explored the differences in statistics anxiety levels between professional doctoral student (i.e. D.N.P.) and research doctoral student (e.g. Ph.D. in Rehabilitation Sciences, Ph.D. in Health Sciences, Ph.D. Nursing, etc.). This chapter describes the number of responses for participants, demographic characteristics, inferential statistical results, and results of research questions and summary.

Study Participants

During a 12-month period (from 11/15/2016 – 11/4/2017), 408 doctoral programs of Health Sciences related disciplines were solicited from different schools in the nation. 62 programs granted access to their students for participation in this research as listed in Table 5.

The total number of doctoral students participating in this study was 402. The STARS scoring methodology requires 100% completion of the survey. After removing doctoral students who did not provide 100% complete responses to the all online survey items, there were 312 participants left for inclusion in the analysis (see Table 6).

Table 5

Showing Numbers of Programs Being Contacted and Granted Access for Surveys

	Programs Contacted	Programs Granted Students Access
D.N.P.	248	34 (14%)
Ph.D. Health Sciences related Disciplines	55	7 (13%)
Ph.D. in Nursing	105	21 (20%)
Total	408	62 (15%)

Table 6

Showing Numbers of Doctoral Students Responded and Used for Data Analyses

Number of Doctoral students responded	403
Number of Doctoral students used in this data analyses	312
Average time spent	6 min

Reliability Analyses

The results of the reliability analyses are presented in Table 7. The alpha reliability estimates ranged from 0.86 (Fear of Statistics Teachers) to 0.95 (Worth of Statistics) and were consistent with the estimates reported by Cruise et al. (1985).

Table 7

Cronbach's Alpha Reliability Estimates for STARS Factors for Current Study in Comparison with Cruise's Study

Factor	Current study	Cruise et al. (1985)
Interpretation Anxiety	0.92	0.89
Test and class anxiety	0.92	0.91
Fear of asking for help	0.87	0.85
Worth of statistics	0.95	0.94
Computational self-concept	0.88	0.88
Fear of statistics teachers	0.86	0.8

Demographic Characteristics of Participants

Analyses were conducted on the 312 surveys that were included in the study. They were doctoral-level students of health sciences related discipline enrolled in their graduate statistics classes at universities in U.S. during the fall 2017 semester. 312 out of a total of 402 doctoral students completed all of the demographic questionnaire (Part II) found in

Appendix E. There were 268 (85.9%) females and 44 (14.1%) males who participated in the study. These numbers are presented in Figure 8 and Table 8.

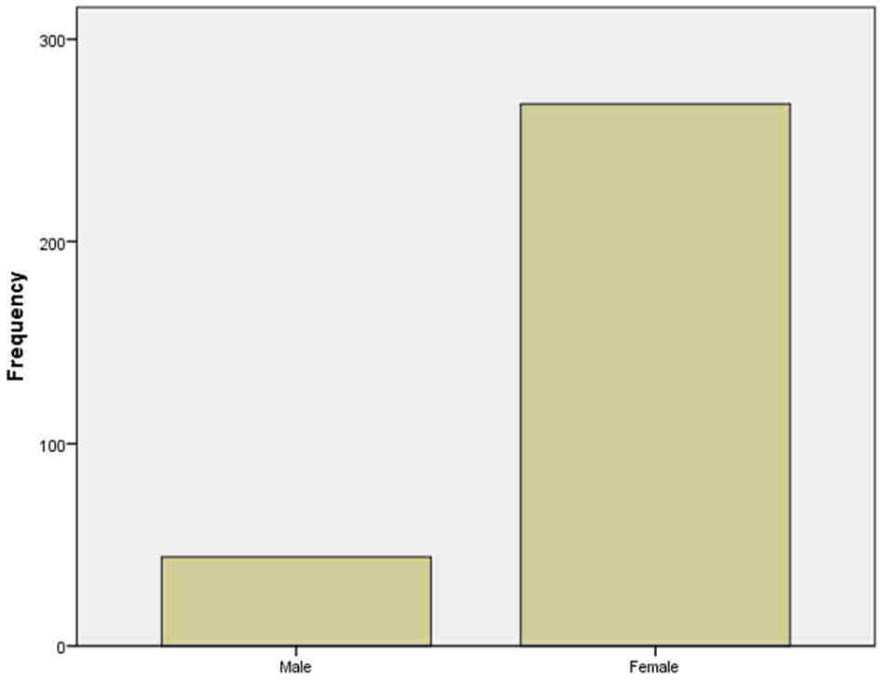

Figure 8. Participants' gender.

Table 8

Numbers of Male and Female

	Frequency	Percentage
Male	44	14.1%
Female	268	85.9%

Race/ethnicity categories were self-selected. The results of this item are shown in Figure 9 and Table 9. Participants were instructed to check their own race/ethnicity as the demographic questionnaire provided pre-identified categories for them to select. 233 participants (74.7%) identified themselves as White/Caucasian and all other race/ethnicities categories were below 10%.

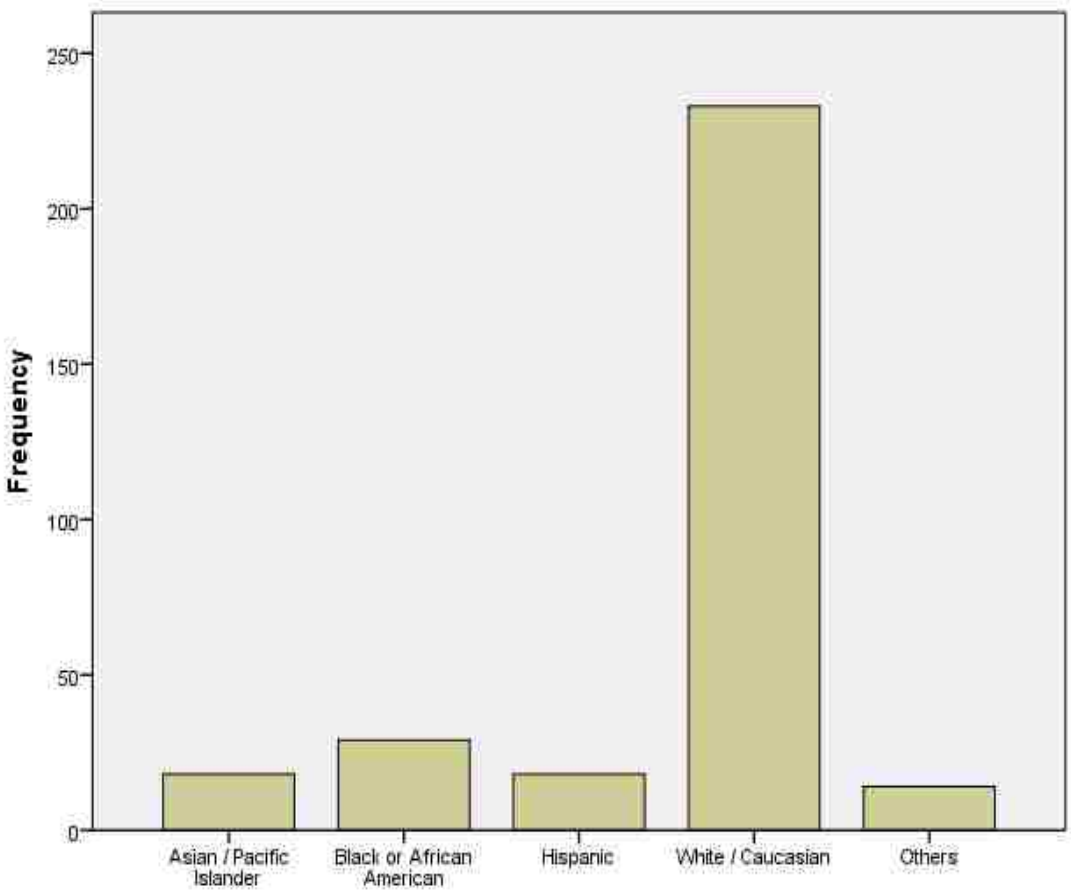

Figure 9. Participants' ethnicities.

Table 9

Distribution of Ethnicities among Participants

	Frequency	Percentage
Asian / Pacific Islander	18	5.8%
Black or African American	29	9.3%
Hispanic	18	5.8%
White / Caucasian	233	74.7%
Others	14	4.5%
Total	312	100%

There were 7 age groups on the survey as shown in Figure 10 and Table 10. Percentage of participants was the 41-49 age group (23.1%). The smallest percentage was the 21-25 year (4.5%).

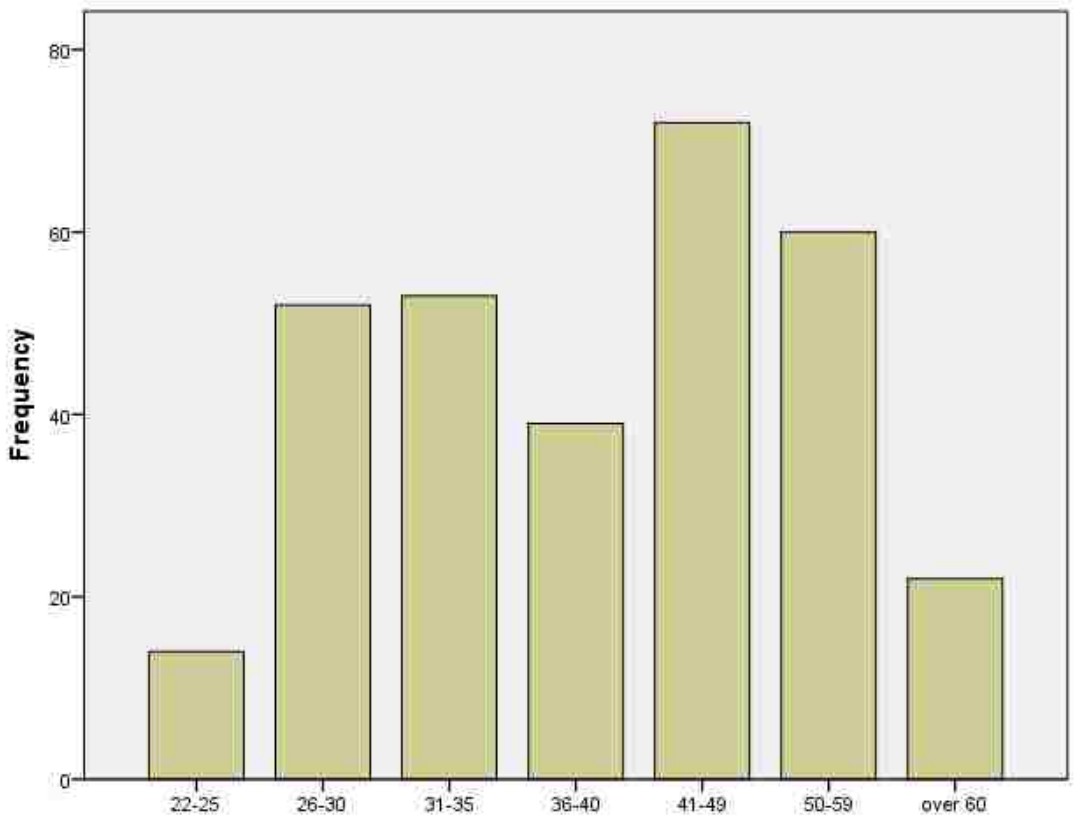

Figure 10. Different age groups.

Table 10

Distribution of Age Groups among Participants

	Frequency	Percentage
22-25	14	4.5%
26-30	52	16.7%
31-35	53	17.0%
36-40	39	12.5%
41-49	72	23.1%
50-59	60	19.2%
over 60	22	7.1%
Total	312	100%

The highest earned academic degrees of participants are shown in Figure 11 and Table 11. Prior to enrolling in the doctoral programs, 82 (26.3%) participants had received a bachelor's degree, 204 (65.4%) had received a master's degree, and 26 (8.3%) had received a doctoral degree.

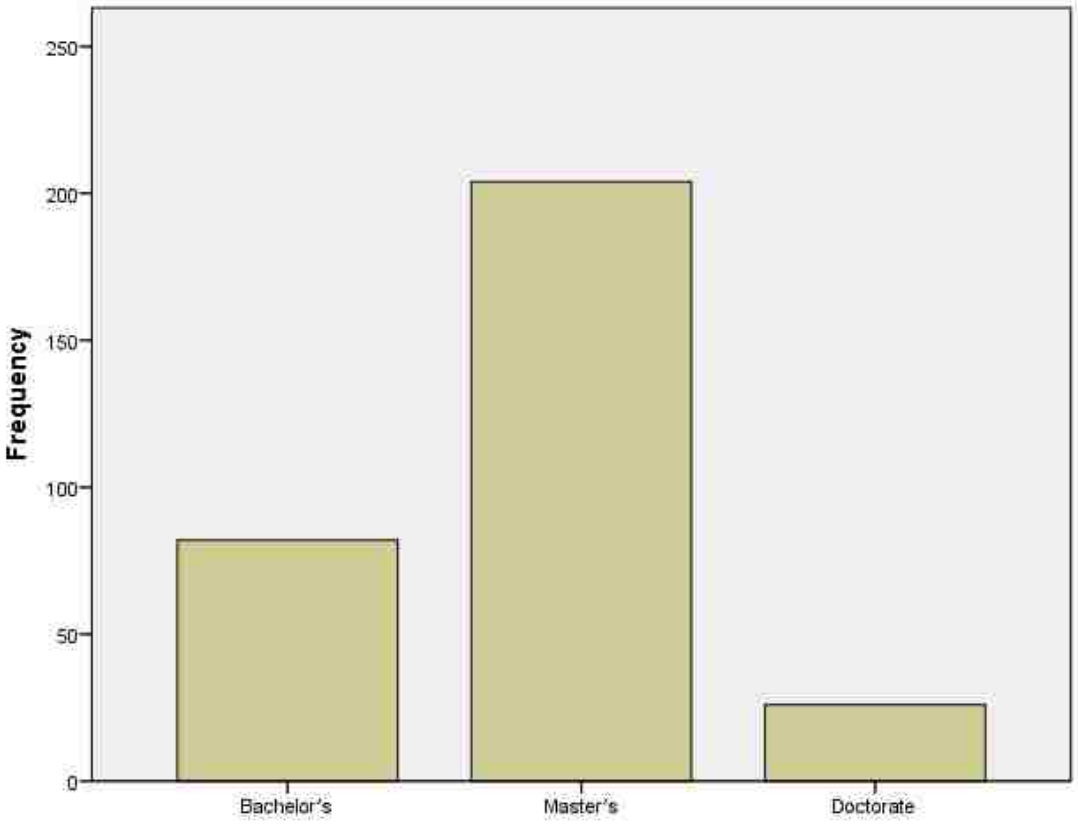

Figure 11. The highest college degree a student has received.

Table 11

Distribution of College Degrees among Participants

	Frequency	Percentage
Bachelor's	82	26.3%
Master's	204	65.4%
Doctorate	26	8.3%
Total	312	100%

Figure 12 depicts the current degree enrollment of participants at the time of the study. 186 students (59.6%) were enrolled as Doctor of Nursing Practice (D.N.P) students, 43 were enrolled as Ph.D. in Health Sciences related disciplines students (13.8%) and 83 were identified as Ph.D. in Nursing students (26.6%) (Table 12).

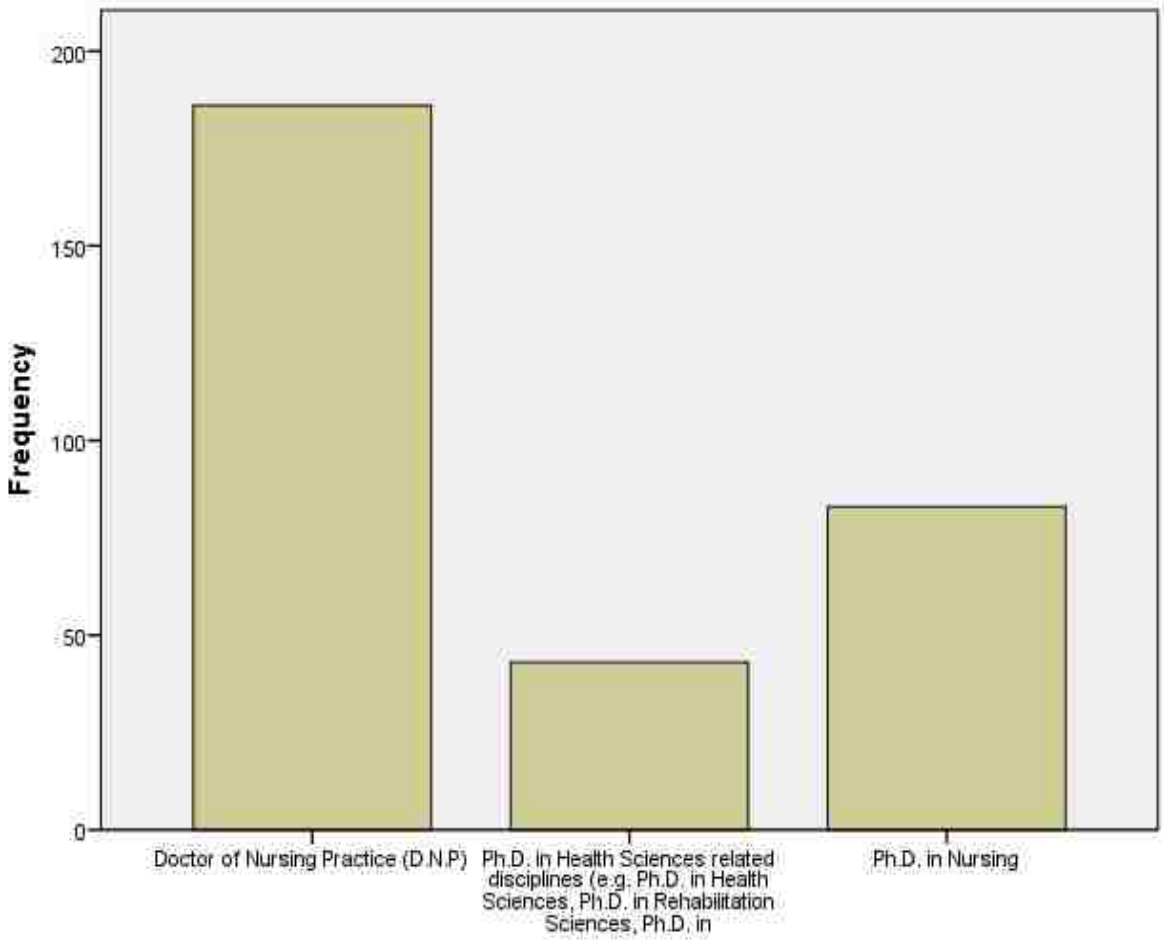

Figure 12. Doctoral students were enrolled in different doctoral programs at the time of the survey.

Table 12

Distribution of Programs among Participants

	Frequency	Percentage
Doctor of Nursing Practice (D.N.P)	186	59.60%
Ph.D. in Health Sciences related disciplines	43	13.80%
Ph.D. in Nursing	83	26.60%
Total	312	100%

Figure 13 depicts the number of doctoral students identified in different cohorts of statistics course at the time of the survey. 20 students (6.4%) were enrolled in the Pre-Statistics cohort, 43 students (13.8%) were enrolled in the Current Statistics cohort and 249 students (79.8%) were enrolled in the Post-Statistics cohort (Table 13).

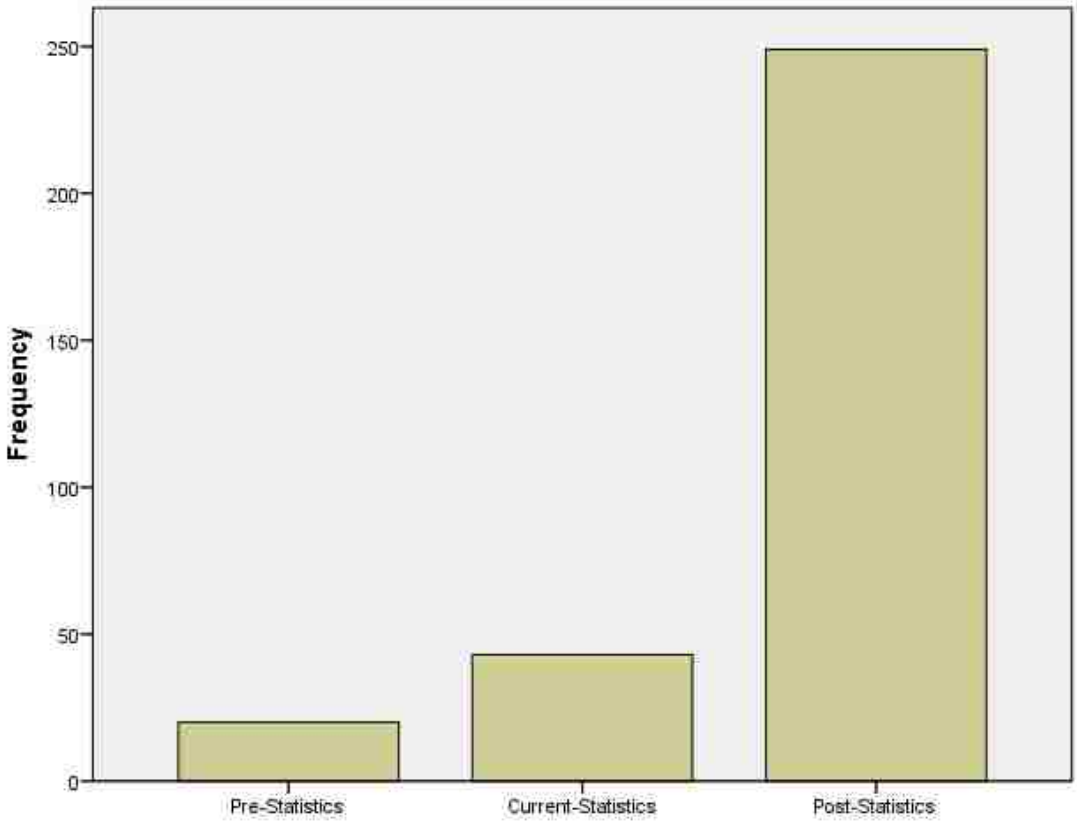

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Figure 13. Doctoral students were enrolled in different cohorts of statistics course at the time of the survey

Table 13

Number of Participants in Different Cohorts

	Frequency	Percentage
Pre-Statistics	20	6.4%
Current-Statistics	43	13.8%
Post-Statistics	249	79.8%
Total	312	100%

Figure 14 depicts the number of doctoral students with and without Bachelor's or Master's statistics course(s) (which covered at least the descriptive statistics and the inferential statistics, e.g. the hypothesis testing, prior to entering in their respective doctoral programs). 287 (92.7%) of doctoral students answered "Yes" and 25 (8.0%) answered "No" (Table 14).

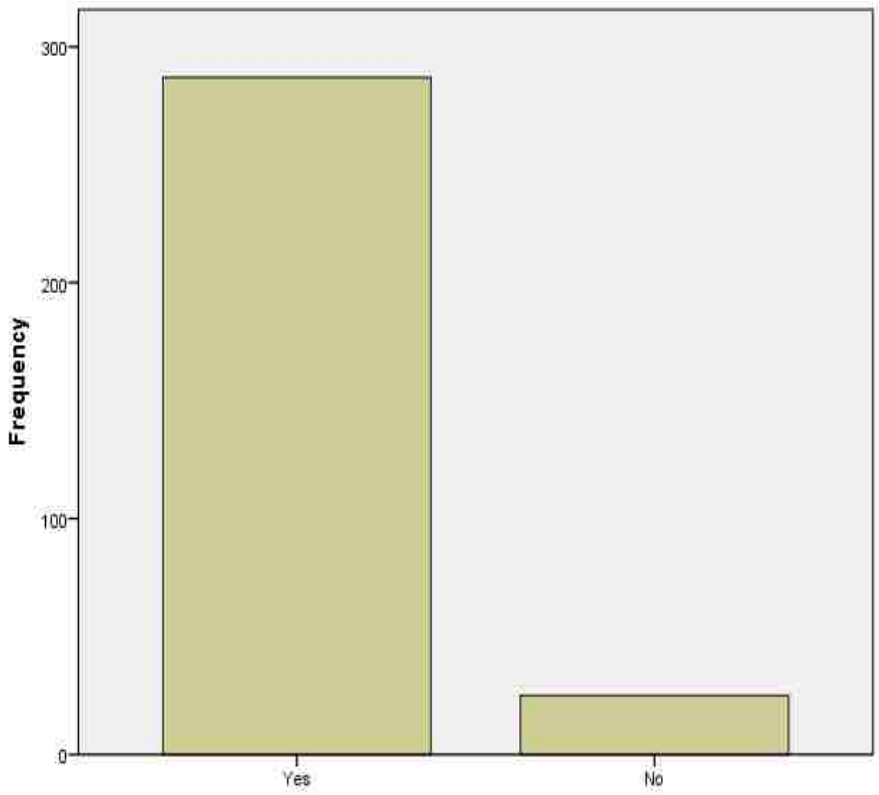

Figure 14. Doctoral students with and without Bachelor's or Master's Statistics Course(s) prior to entering in their respective programs.

Table 14

Number of Participants with Bachelor's or Master's Statistics Course(s) (Which Cover at Least the Descriptive Statistics and the Inferential Statistics e.g. the Hypothesis Testing) Prior to Entering in their Respective Doctoral Program

	Frequency	Percentage
Yes	287	92.0%
No	25	8.0%
Total	312	100%

Inferential Statistics

Research Question 1. Is there a statistically significant difference in statistics anxiety scores, as measured by Statistical Anxiety Rating Scale (STARS), between 3 cohorts of professional doctoral students (i.e. D.N.P.) whose programs require statistics course(s)? These cohorts are:

- Pre-Statistics - those who have not taken any statistics course in their programs yet,
- Current-Statistics - those who are currently taking a statistics course in their programs
- Post-Statistics - those who have already taken statistics course(s) in their programs

Null Hypothesis ($H1_o$). There will not be a statistically significant difference in the statistics anxiety scores between all 3 cohorts of D.N.P. students whose programs require statistics course(s).

Alternative Hypothesis ($H1_a$). There is a statistically significant difference in the statistics anxiety scores between at least 2 cohorts of D.N.P. students.

Data Analysis. A Kruskal-Wallis test was conducted and it showed that the STARS median scores were not equal between 3 cohorts (pre-, currently-taking and post-statistics) (p=0.012) (Figure 15 and Table 15). Hence, the null hypothesis was rejected.

Because of the significant Kruskal-Wallis test, pairwise comparisons were conducted using the Mann-Whitney test. It confirmed that there was no statistical significant difference between the Pre-Statistics and Current-Statistics cohorts (p= 0.991) (Figure 16 and Table 16).

A statistical significant difference occurred between the Current Statistics and Post Statistics cohorts (p= 0.018) (Figure 17 and Table 17). Mann-Whitney Tests in the 6 STARS factors between the Current-Statistics D.N.P. Students and the Post-Statistics D.N.P were conducted. The results revealed that the statistical significant difference occurred between the Current Statistics and Post Statistics cohorts could be explained by 3 of the 6 STARS factors, i.e. Worth of Statistics (p=0.023), Test and Class Anxiety p=0.036) and Fear of Statistics Teachers (p=0.017) (Table 18).

An additional statistical significant difference was found between the Pre-Statistics and Post Statistics cohorts (p= 0.035) (Figure 18 and Table 19). Mann-Whitney Tests in the 6 STARS factors between the Pre-Statistics D.N.P. Students and the Post-Statistics D.N.P were conducted. The results revealed that the statistical significant difference occurred between the Pre-Statistics and Post-Statistics cohorts could be explained by 1 of the 6 STARS factor, i.e. Worth of Statistics (p=0.013) (Table 20).

Summary. The study data provided evidence that among students pursing the D.N.P. degree, there was a difference in statistical anxiety between those who were at different points in the program related to their statistical course(s). The statistics anxiety scores were statistically lower in the Post-Statistics cohorts when compared to the Pre-Statistics and

Current-Statistics cohorts. Their significant results could all be explained by the STARS factors. The following figures and tables provide evidence that supports this finding.

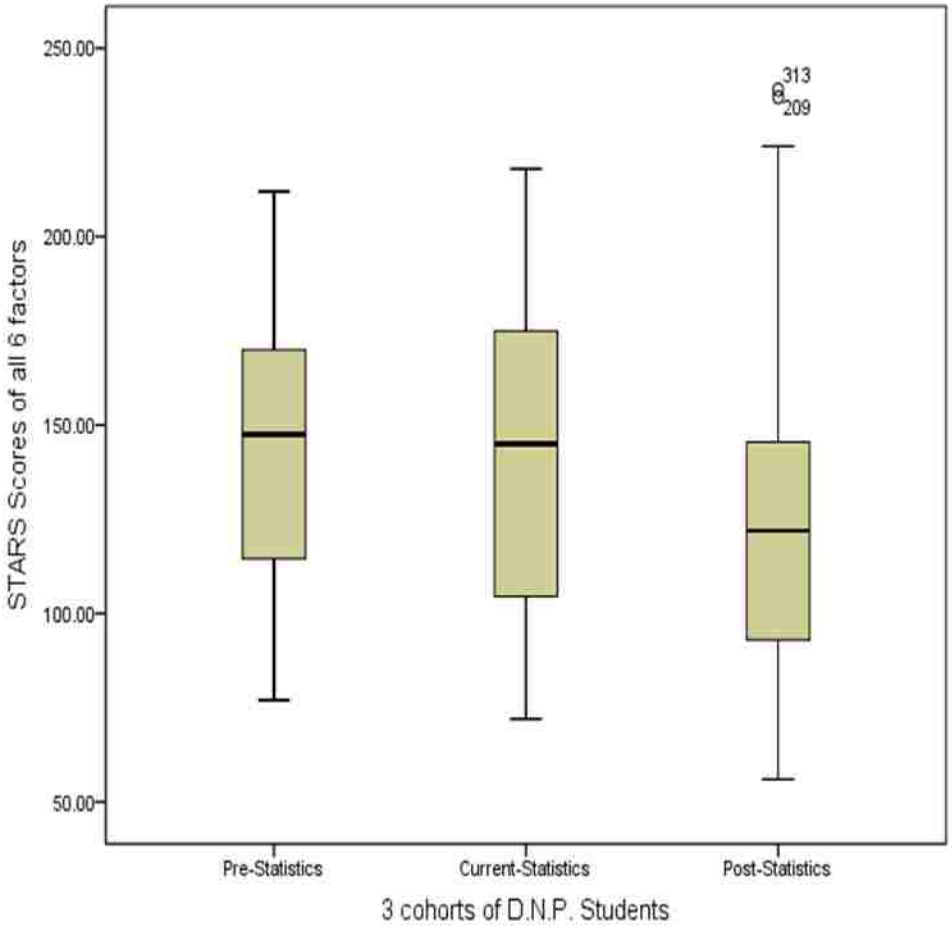

Figure 15. D.N.P. students from 3 different cohorts.

Table 15

Kruskal-Wallis Test

Ranks

	3 cohorts of D.N.P. Students	N	Mean Rank
STARS Scores of all 6 factors	Pre-Statistics	16	115.97
	Current-Statistics	31	112.40
	Post-Statistics	139	86.70
	Total	186	

Test Statistics[a,b]

	STARS Scores of all 6 factors
Chi-Square	8.829
df	2
Asymp. Sig.	.012

a. Kruskal Wallis Test

b. Grouping Variable: 3 cohorts of D.N.P. Students

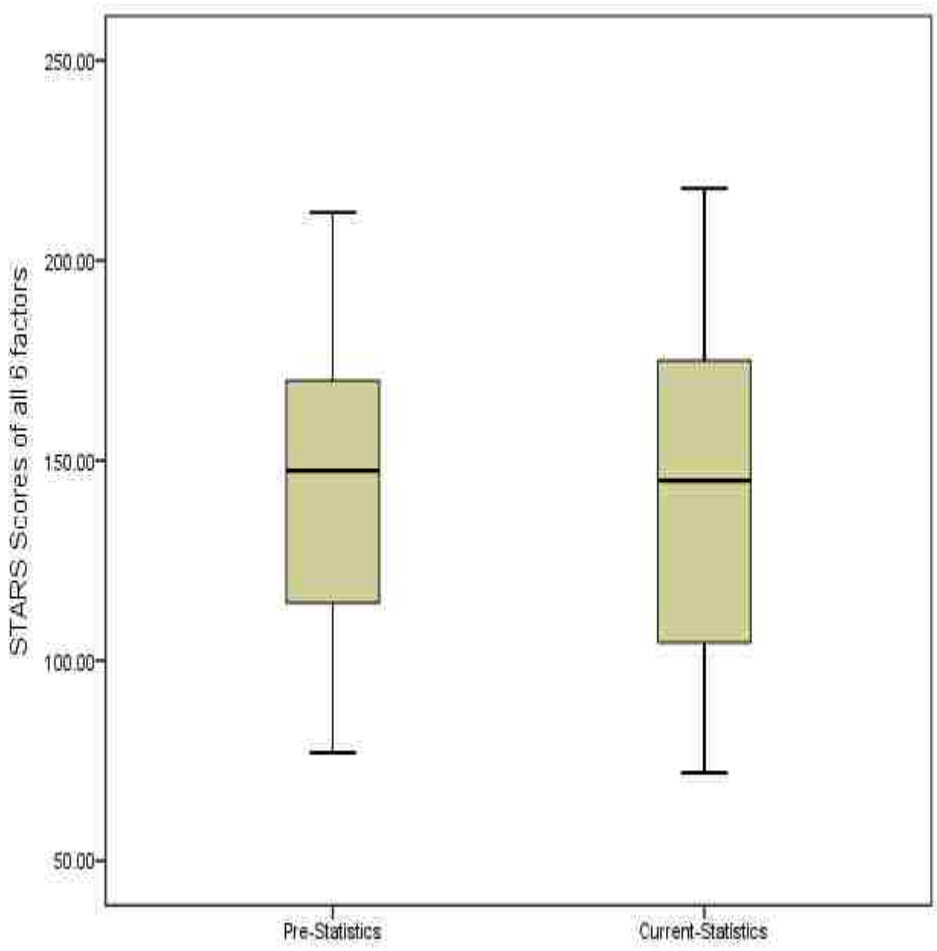

Figure 16. D.N.P. students from 2 different cohorts.

Table 16

Mann-Whitney Test

Ranks

	Pre-Statistics D.N.P. and Current-Statistics D.N.P.	N	Mean Rank	Sum of Ranks
STARS Scores of all 6 factors	Pre-Statistics	16	24.03	384.50
	Current-Statistics	31	23.98	743.50
	Total	47		

Test Statistics[a]

	STARS Scores of all 6 factors
Mann-Whitney U	247.500
Wilcoxon W	743.500
Z	-.011
Asymp. Sig. (2-tailed)	.991

a. Grouping Variable: Pre-Statistics D.N.P. and Current-Statistics D.N.P.

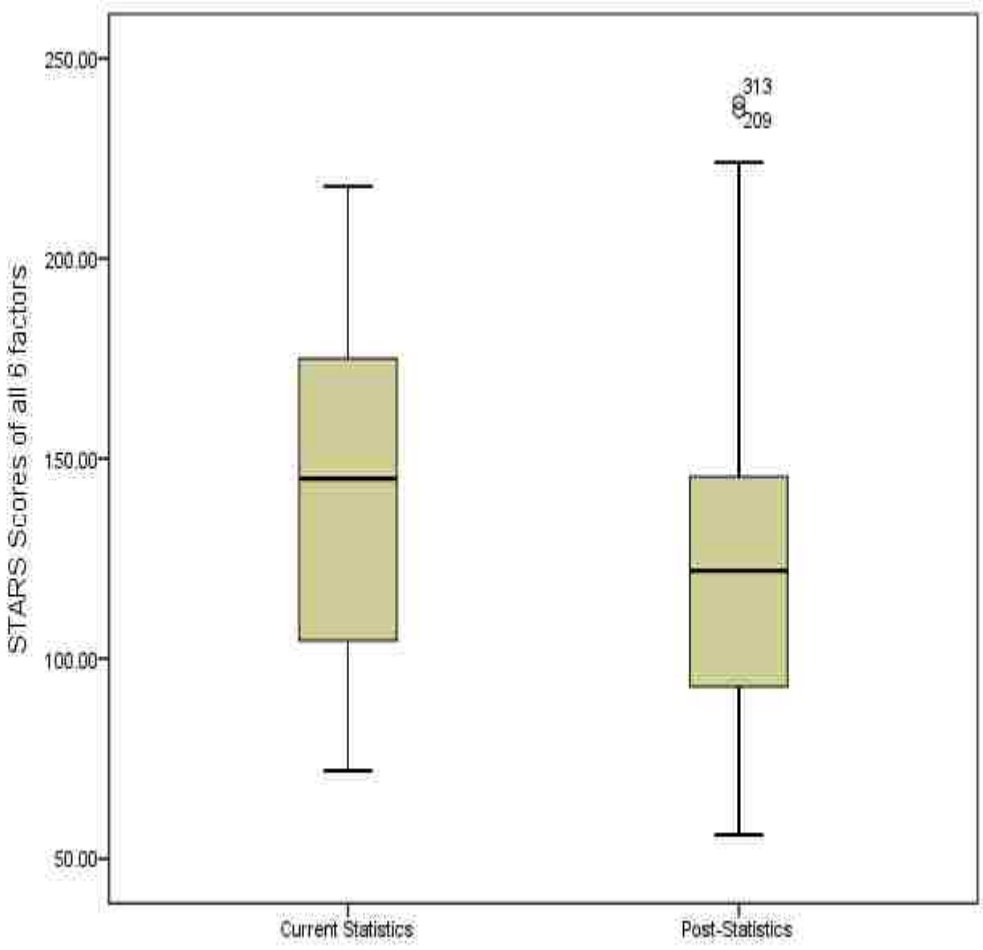

Figure 17. D.N.P. students from 2 different cohorts.

Table 17

Mann-Whitney Test

Ranks

	Current-Statistics D.N.P. and Post-Statistics D.N.P.	N	Mean Rank	Sum of Ranks
STARS Scores of all 6 factors	Current Statistics	31	104.42	3237.00
	Post-Statistics	139	81.28	11298.00
	Total	170		

Test Statistics[a]

	STARS Scores of all 6 factors
Mann-Whitney U	1568.000
Wilcoxon W	11298.000
Z	-2.367
Asymp. Sig. (2-tailed)	.018

a. Grouping Variable: Current-Statistics D.N.P. and Post-Statistics D.N.P.

Table 18

Mann-Whitney Tests in the 6 STARS Factors Between the Current-Statistics D.N.P. Students and the Post-Statistics D.N.P. Students.

Test Statistics[a]

	Worth of Statistics	Interpretation Anxiety	Test and Class Anxiety	Computation Self Concept	Fear of Asking for Help	Fear of Statistics Teachers
Mann-Whitney U	1591.000	1887.000	1635.000	1745.000	1695.500	1564.500
Wilcoxon W	11321.000	11617.000	11365.000	11475.000	11425.500	11294.500
Z	-2.276	-1.080	-2.098	-1.656	-1.861	-2.393
Asymp. Sig. (2-tailed)	.023	.280	.036	.098	.063	.017

a. Grouping Variable: Current-Statistics D.N.P. and Post-Statistics D.N.P.

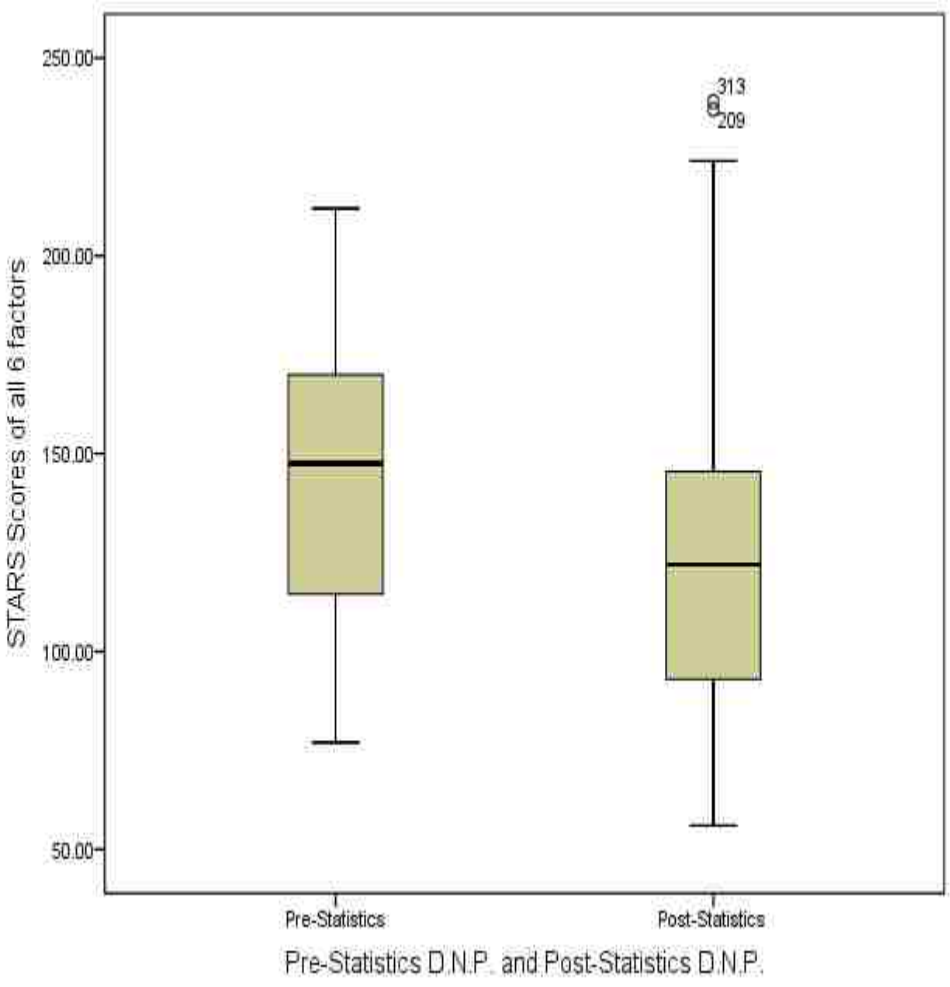

Figure 18. D.N.P. students from 2 different cohorts.

Table 19

Mann-Whitney Test

Ranks

	Pre-Statistics D.N.P. and Post-Statistics D.N.P.	N	Mean Rank	Sum of Ranks
STARS Scores of all 6 factors	Pre-Statistics	16	100.44	1607.00
	Post-Statistics	139	75.42	10483.00
	Total	155		

Test Statistics[a]

	STARS Scores of all 6 factors
Mann-Whitney U	753.000
Wilcoxon W	10483.000
Z	-2.112
Asymp. Sig. (2-tailed)	.035

a. Grouping Variable: Pre-Statistics D.N.P. and Post-Statistics D.N.P.

Table 20

Mann-Whitney Tests in the 6 STARS Factors Between the Pre-Statistics D.N.P. Students and the Post-Statistics D.N.P. Students.

Test Statistics[a]

	Worth of Statistics	Interpretation Anxiety	Test and Class Anxiety	Computation Self Concept	Fear of Asking for Help	Fear of Statistics Teachers
Mann-Whitney U	691.000	963.500	945.000	805.000	887.000	900.000
Wilcoxon W	10421.000	10693.500	10675.000	10535.000	10617.000	10630.000
Z	-2.478	-.874	-.963	-1.809	-1.329	-1.254
Asymp. Sig. (2-tailed)	.013	.382	.326	.070	.184	.210

a. Grouping Variable: Pre-Statistics D.N.P. and Post-Statistics D.N.P.

Research Question 2. Is there a statistically significant difference in statistics anxiety scores, as measured by Statistical Anxiety Rating Scale (STARS), between 3 cohorts of research doctoral students (e.g. Ph.D. in Health Sciences related disciplines such as Ph.D. in Rehabilitation Sciences and Ph.D. in Nursing) whose programs require statistics course(s). These cohorts are:

- Pre-Statistics - those who have not taken any statistics course in their programs yet,
- Current-Statistics - those who are currently taking a statistics course in their programs
- Post-Statistics - those who have already taken statistics course(s) in their programs

Null Hypothesis ($H2_o$). There will not be a statistically significant difference in the statistics anxiety scores between all 3 cohorts of Ph.D. students whose programs require statistics course(s).

Alternative Hypothesis ($H2_a$). There is a statistically significant difference in the statistics anxiety scores between at least 2 cohorts of Ph.D. students.

Data Analysis. A Kruskal-Wallis test was conducted and it showed that the STARS median scores were equal between 3 cohorts (pre-, currently-taking and post-statistics) (p=0.18) (Figure 19 and Table 21). Hence, the null hypothesis was not rejected.

Two additional analyses were also explored. A Kruskal-Wallis test was conducted on Ph.D. students with statistics courses taken prior to entering their doctoral programs (Figure

20 and Table 22). The result showed no statistical significant difference in statistics anxiety scores between 3 cohorts of Ph.D. students (p=0.330). A Man-Whitney test was also conducted on Ph.D. students without statistics courses taken prior to entering their doctoral programs (Figure 21 and Table 23). The result showed that there was no Pre-Cohort Ph.D. students without statistics courses taken prior to entering their doctoral programs and no statistical significant difference in statistics anxiety scores was found between 2 cohorts of Ph.D. students (p=0.513).

Summary. The study data provided no evidence that among students pursing the Ph.D. degrees, there was a difference in statistical anxiety between those who were at different points in the program related to their statistical course(s). The statistics anxiety scores were statistically equal in between all 3 cohorts. Additional analyses on Ph.D. students without statistics courses taken prior to entering their doctoral programs and on Ph.D. students without statistics courses taken prior to entering their doctoral programs resulted in statistically insignificant results respectively. The following tables and figures provide evidence that supports this finding.

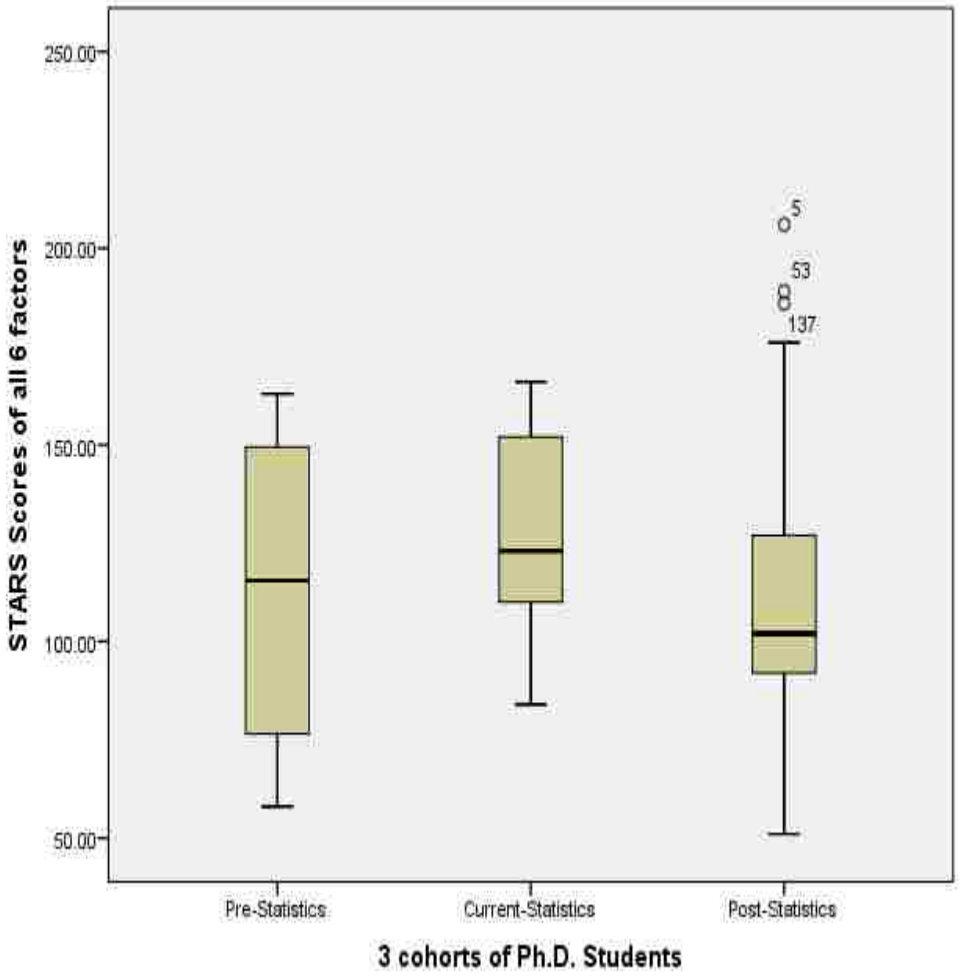

Figure 19. Doctoral students in 2 different cohorts of their statistics course.

Table 21

Kruskal-Wallis Test

Ranks

	3 cohorts of Ph.D. Students	N	Mean Rank
STARS Scores of all 6 factors	Pre-Statistics	4	64.13
	Current-Statistics	12	82.00
	Post-Statistics	110	61.46
	Total	126	

Test Statistics[a,b]

	STARS Scores of all 6 factors
Chi-Square	3.426
df	2
Asymp. Sig.	.180

a. Kruskal Wallis Test

b. Grouping Variable: 3 cohorts of Ph.D. Students

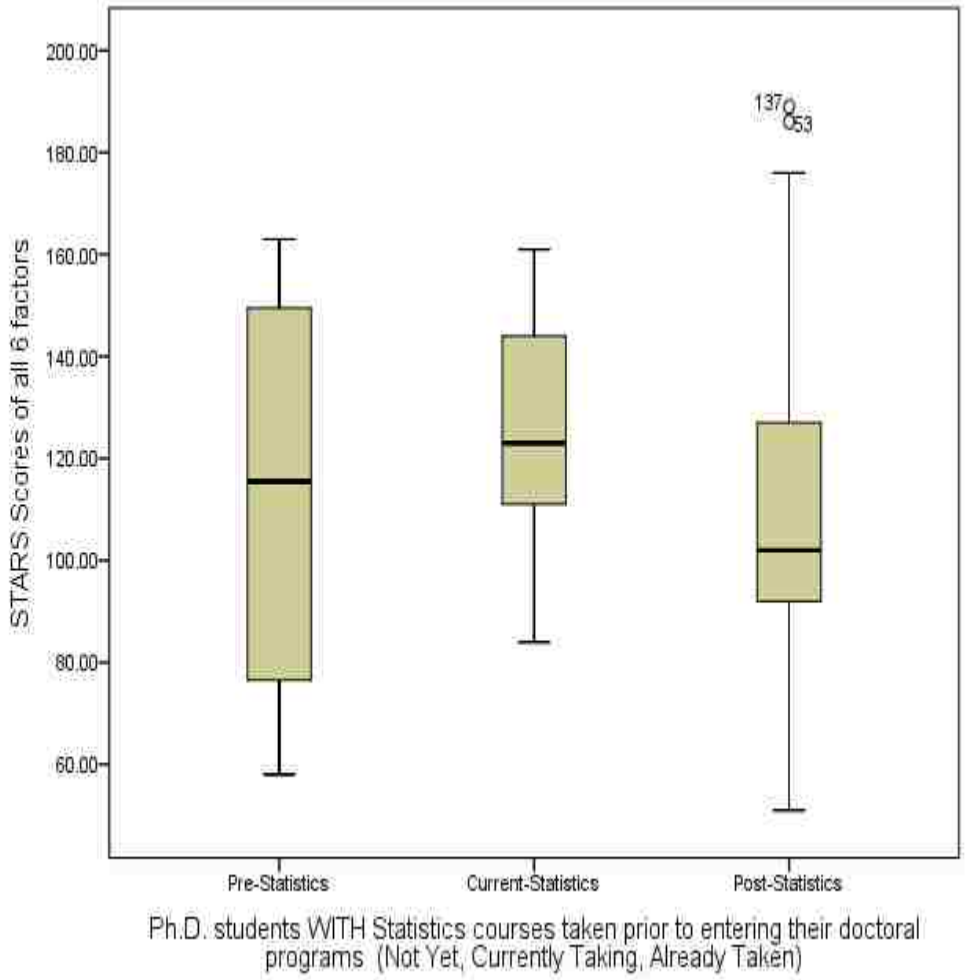

Figure 20. Doctoral students in 3 different cohorts of their statistics course.

Table 22

Kruskal-Wallis Test

Ranks

	Ph.D. students WITH Statistics courses taken prior to entering their doctoral programs. (Not Yet, Currently Taking, Already Taken)	N	Mean Rank
STARS Scores of all 6 factors	Pre-Statistics	4	58.13
	Current-Statistics	10	71.65
	Post-Statistics	99	55.47
	Total	113	

Test Statistics[a,b]

	STARS Scores of all 6 factors
Chi-Square	2.220
df	2
Asymp. Sig.	330

a. Kruskal Wallis Test

b. Grouping Variable: Ph.D. students WITH Statistics courses taken prior to entering their doctoral programs (Not Yet, Currently Taking, Already Taken)

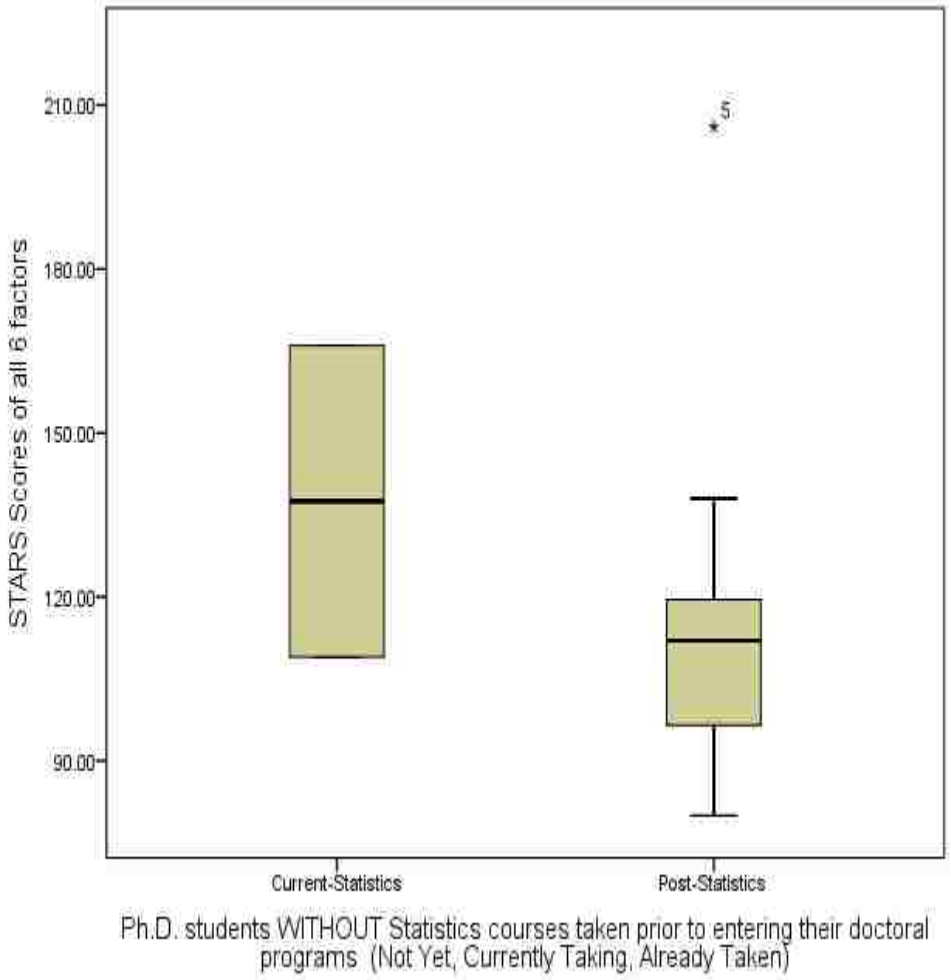

Figure 21. Doctoral students in 2 different cohorts of their statistics course.

Table 23

Mann-Whitney Test

Ranks

	Ph.D. students WITHOUT Statistics courses taken prior to entering their doctoral programs (Not Yet, Currently Taking, Already Taken)	N	Mean Rank	Sum of Ranks
STARS Scores of all 6 factors	Current-Statistics	2	9.00	18.00
	Post-Statistics	11	6.64	73.00
	Total	13		

Test Statistics[a]

	STARS Scores of all 6 factors
Mann-Whitney U	7.000
Wilcoxon W	73.000
Z	-.791
Asymp. Sig. (2-tailed)	.429
Exact Sig. [2*(1-tailed Sig.)]	.513[b]

a. Grouping Variable: Ph.D. students WITHOUT Statistics courses taken prior to entering their doctoral programs (Not Yet, Currently Taking, Already Taken)

b. Not corrected for ties.

Research Question 3. Is there a statistically significant difference in the statistics anxiety scores, as measured by Statistical Anxiety Rating Scale (STARS), between professional doctoral students (i.e. D.N.P.) and research doctoral students (i.e. Ph.D. in Health Sciences related disciplines such as Ph.D. in Rehabilitation Sciences and Ph.D. in Nursing) in the Pre-Statistics cohort?

Null Hypothesis ($H3_o$). There will not be a statistically significant difference in the statistics anxiety scores between D.N.P. and Ph.D. students in the Pre-Statistics cohort.

Alternative Hypothesis ($H3_a$). There is a statistically significant difference in the statistics anxiety scores between D.N.P. and Ph.D. students in the Pre-Statistics cohort.

Data Analysis. A Mann-Whitney test was conducted. There was no significant difference of the STARS median scores of the 2 data-sets between D.N.P. and Ph.D. students (p=0.290). Hence, the null hypothesis was not rejected. The results are shown in Figure 22 and Table 24.

Summary. The study data provided no evidence that among students pursing the D.N.P. and Ph.D. degrees, there was a difference in statistical anxiety between them at the Pre-Statistics cohort. The following tables and figures provide evidence that supports this finding.

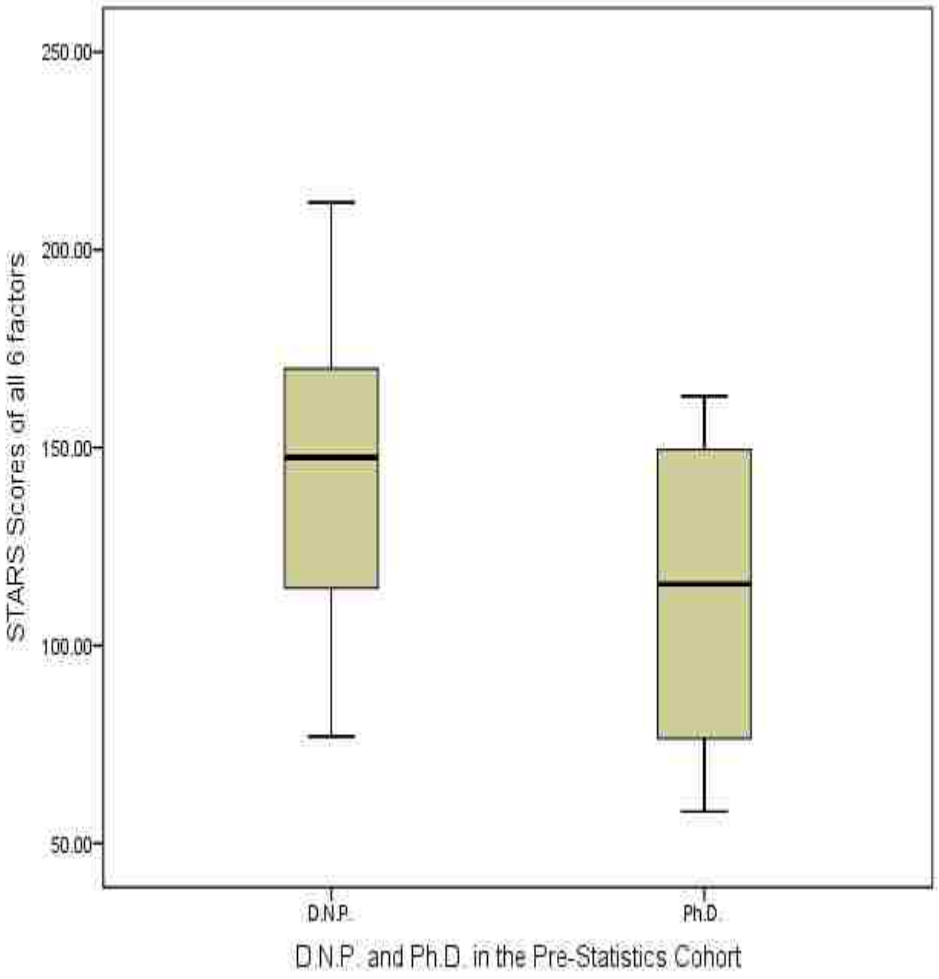

Figure 22. Comparison of D.N.P. and Ph.D. students in the Pre-Statistics Cohort.

Table 24

Mann-Whitney Test.

Ranks

	D.N.P. and Ph.D. in the Pre-Statistics Cohort	N	Mean Rank	Sum of Ranks
STARS Scores of all 6 factors	D.N.P.	16	11.25	180.00
	Ph.D	4	7.50	30.00
	Total	20		

Test Statistics[a]

	STARS Scores of all 6 factors
Mann-Whitney U	20.000
Wilcoxon W	30.000
Z	-1.134
Asymp. Sig. (2-tailed)	.257
Exact Sig. [2*(1-tailed Sig.)]	.290[b]

a. Grouping Variable: D.N.P. and Ph. D. in the Pre-Statistics Cohort

b. Not corrected for ties.

Research Question 4. Is there a statistically significant difference in the statistics anxiety scores, as measured by Statistical Anxiety Rating Scale (STARS), between the professional doctoral students (i.e. D.N.P.) and the research doctoral students (i.e. Ph.D. in

Health Sciences related disciplines such as Ph.D. in Rehabilitation Sciences and Ph.D. in Nursing) in the Current-Statistics cohort?

Null Hypothesis ($H4_o$). There will not be a statistically significant difference in the statistics anxiety scores between D.N.P. and Ph.D. students in the Current-Statistics cohort.

Alternative Hypothesis ($H4_a$). There will be a statistically significant difference in the statistics anxiety scores between D.N.P. and Ph.D. students in the Current-Statistics cohort.

Data Analysis. A Mann-Whitney test found that there was no significant difference of the STARS median scores of the 2 data-sets between D.N.P. and Ph.D. students (p=0.221). Hence, the null hypothesis was not rejected. The results are shown in Figure 23 and Table 25.

Summary: The study data provided no evidence that among students pursing the D.N.P. and Ph.D. degrees, there was a difference in statistical anxiety between them at the Current-Statistics cohort. The following tables and figures provide evidence that supports this finding.

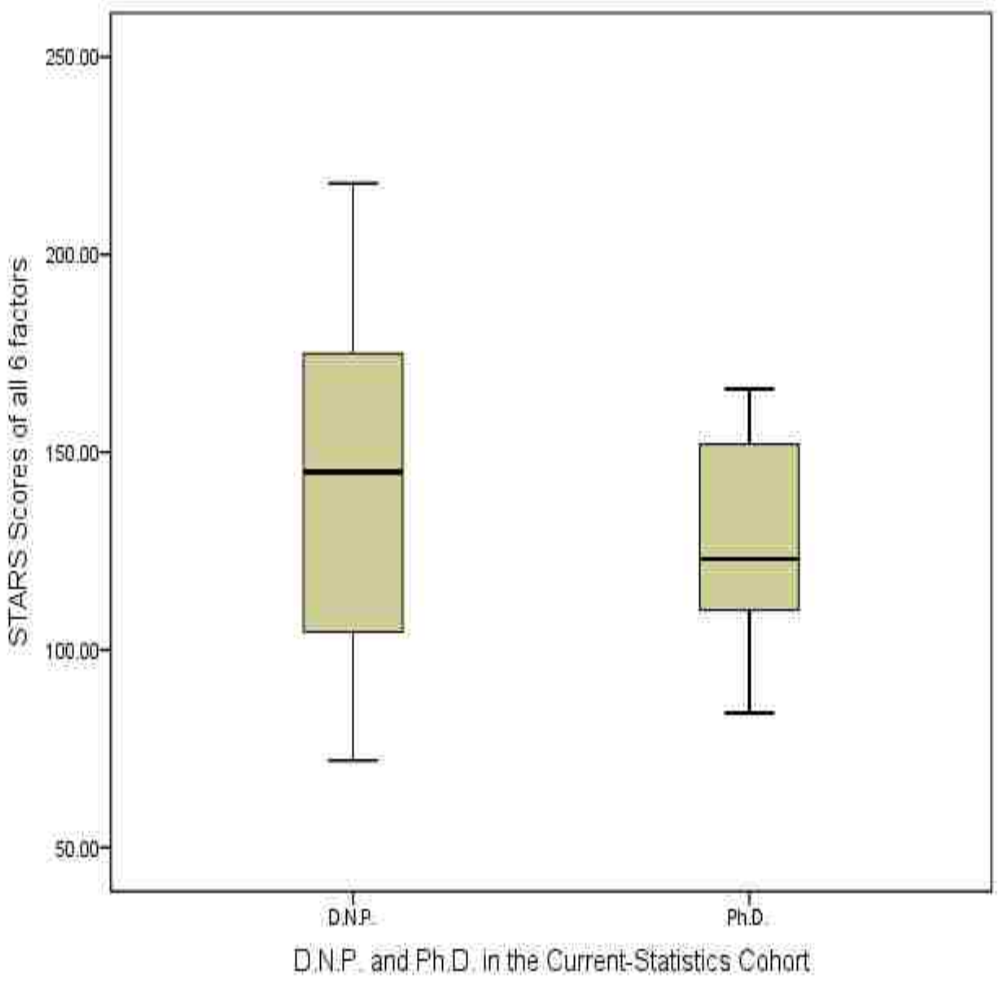

Figure 23. Comparison of D.N.P. and Ph.D. students in the Current-Statistics Cohort.

Table 25

Mann-Whitney Test

Ranks

	D.N.P. and Ph.D. in the Current-Statistics Cohort	N	Mean Rank	Sum of Ranks
STARS Scores of all 6 factors	D.N.P.	31	23.48	728.00
	Ph.D.	12	18.17	218.00
	Total	43		

Test Statistics[a]

	STARS Scores of all 6 factors
Mann-Whitney U	140.000
Wilcoxon W	218.000
Z	-1.246
Asymp. Sig. (2-tailed)	.213
Exact Sig. [2*(1-tailed Sig.)]	.221[b]

a. Grouping Variable: D.N.P. and Ph. D. in the Current-Statistics Cohort

b. Not corrected for ties.

Research Question 5. Is there a statistically significant difference in the statistics anxiety scores, as measured by Statistical Anxiety Rating Scale (STARS), between the professional doctoral students (i.e. D.N.P.) and the research doctoral students (i.e. Ph.D. in Health Sciences related disciplines such as Ph.D. in Rehabilitation Sciences and Ph.D. in Nursing) in the Post-Statistics cohort?

Null Hypothesis ($H5_o$). There will not be a statistically significant difference in the statistics anxiety scores between D.N.P. and Ph.D. students in the post-statistics cohort).

Alternative Hypothesis ($H5_a$). There will be a statistically significant difference in the statistics anxiety scores between D.N.P. and Ph.D. students in the post-statistics cohort).

Data Analysis. A Mann-Whitney test found that there was a significant difference of the STARS median scores of the 2 data-sets between D.N.P. and Ph.D. students (p=0.017). Hence, the null hypothesis was rejected. The results are shown in Figure 24 and Table 26.

Additional Mann-Whitney Tests in the 6 STARS factors between D.N.P. and Ph.D. students were also conducted. The results revealed that the statistical significant difference of the STARS median scores of the 2 data-sets between D.N.P. and Ph.D. students could be explained by 2 STARS factor, i.e. Worth of Statistics (p=0.001) and Interpretation Anxiety (p=0.049) (Table 27).

Summary. The study data provided evidence that among students pursing the D.N.P. and Ph.D. degrees, there was a difference in statistical anxiety between them at the Post-Statistics cohort. The statistics anxiety scores were statistically lower in the Ph.D. students

than the D.N.P. students. The significant result could all be explained by the STARS factors. The following tables and figures provide evidence that supports this finding.

With the actual sample size of 249 respondents (139 D.N.P. students and 110 Ph.D. students), a Post Hoc analysis of D.N.P. vs Ph.D. in the post-statistics cohort showed 97% power which was greater than the original assumed power of 80% (Figure 25).

Additional Exploratory and Retrospective Research Questions: The statistical power was sufficient for D.N.P. vs Ph.D. comparison in the post-statistics cohort. The recruitment of D.N.P. students in the Post-Statistics cohort was surprisingly greater than all other cohorts. Hence, it was of exploratory interest to explore the D.N.P. students recruited in the Post-Statistics cohort and additional analyses were done

1. Figure 26 and Table 28 show that there was no statistically significant difference by a Kruskal-Wallis test in the statistics anxiety scores, as measured by Statistical Anxiety Rating Scale (STARS), between different ethnicities of the professional doctoral students (i.e. D.N.P.) in the Post-Statistics cohort (p=0.169).
2. Figure 27 and Table 29 show that there was no statistically significant difference by a Kruskal-Wallis test in the statistics anxiety scores, as measured by Statistical Anxiety Rating Scale (STARS), between different age groups of the professional doctoral students (i.e. D.N.P.) in the Post-Statistics cohort (p=0.166).

3. Figure 28 and Table 30 show that there was no statistically significant difference by a Mann-Whitney test in the statistics anxiety scores, as measured by Statistical Anxiety Rating Scale (STARS), between men and women of the professional doctoral students (i.e. D.N.P.) in the Post-Statistics cohort (p=0.152).

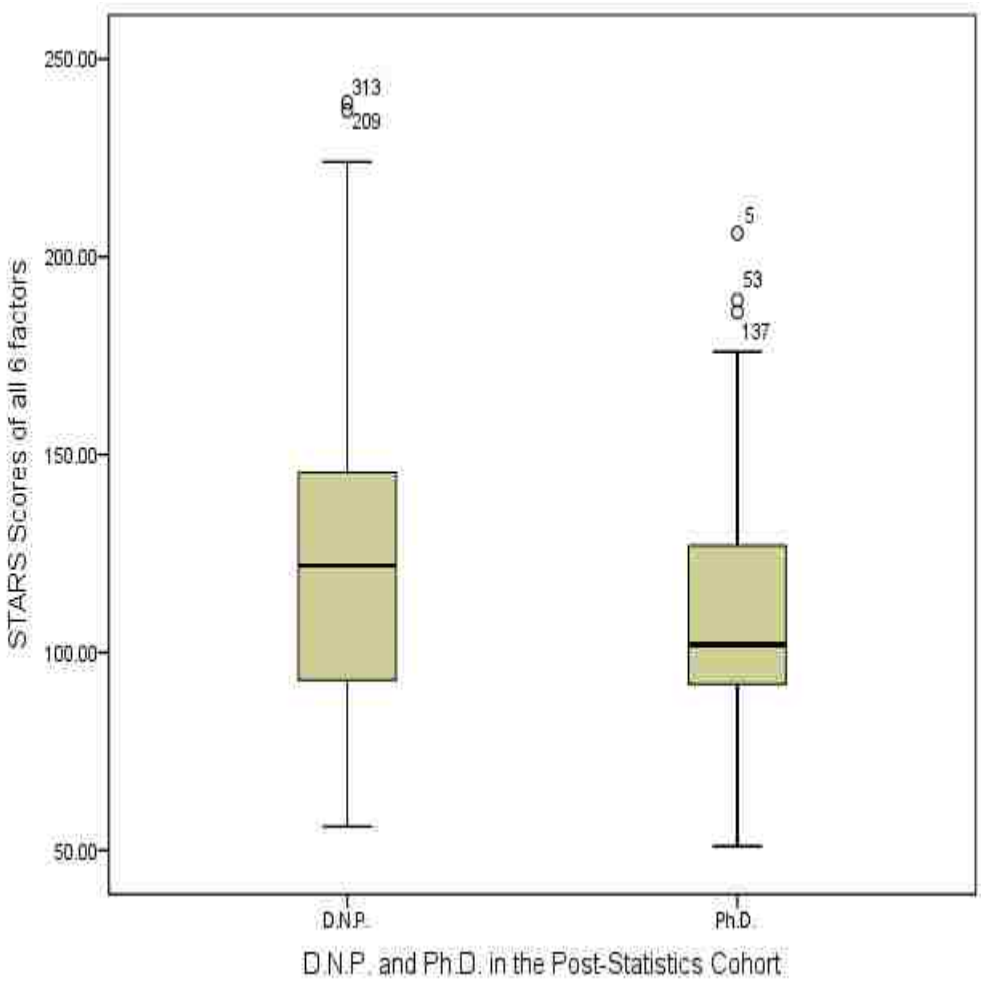

Figure 24. Comparison of D.N.P. and Ph.D. students in the Post-Statistics Cohort.

Table 26

Mann-Whitney Test

Ranks

	D.N.P. and Ph.D. in the Post-Statistics Cohort	N	Mean Rank	Sum of Ranks
STARS Scores of all 6 factors	D.N.P.	139	134.69	18722.00
	Ph.D	110	112.75	12403.00
	Total	249		

Test Statistics[a]

	STARS Scores of all 6 factors
Mann-Whitney U	6298.000
Wilcoxon W	12403.000
Z	-2.387
Asymp. Sig. (2-tailed)	.017

a. Grouping Variable: D.N.P. and Ph.D. in the Post-Statistics Cohort

Table 27

Mann-Whitney Tests in the 6 STARS Factors Between D.N.P. Students and Ph.D. Students in the Post-Statistics Cohort

Test Statistics[a]

	Worth of Statistics	Interpretation Anxiety	Test and Class Anxiety	Computation Self Concept	Fear of Asking for Help	Fear of Statistics Teachers
Mann-Whitney U	5812.000	6535.500	6704.000	6761.000	7360.000	7103.000
Wilcoxon W	11917.000	12640.500	12809.000	12866.000	13465.000	16833.000
Z	-3.252	-1.967	-1.669	-1.570	-.507	-.965
Asymp. Sig. (2-tailed)	.001	.049	.095	.116	.612	.335

a. Grouping Variable: D.N.P. and Ph.D. in the Post-Statistics Cohort

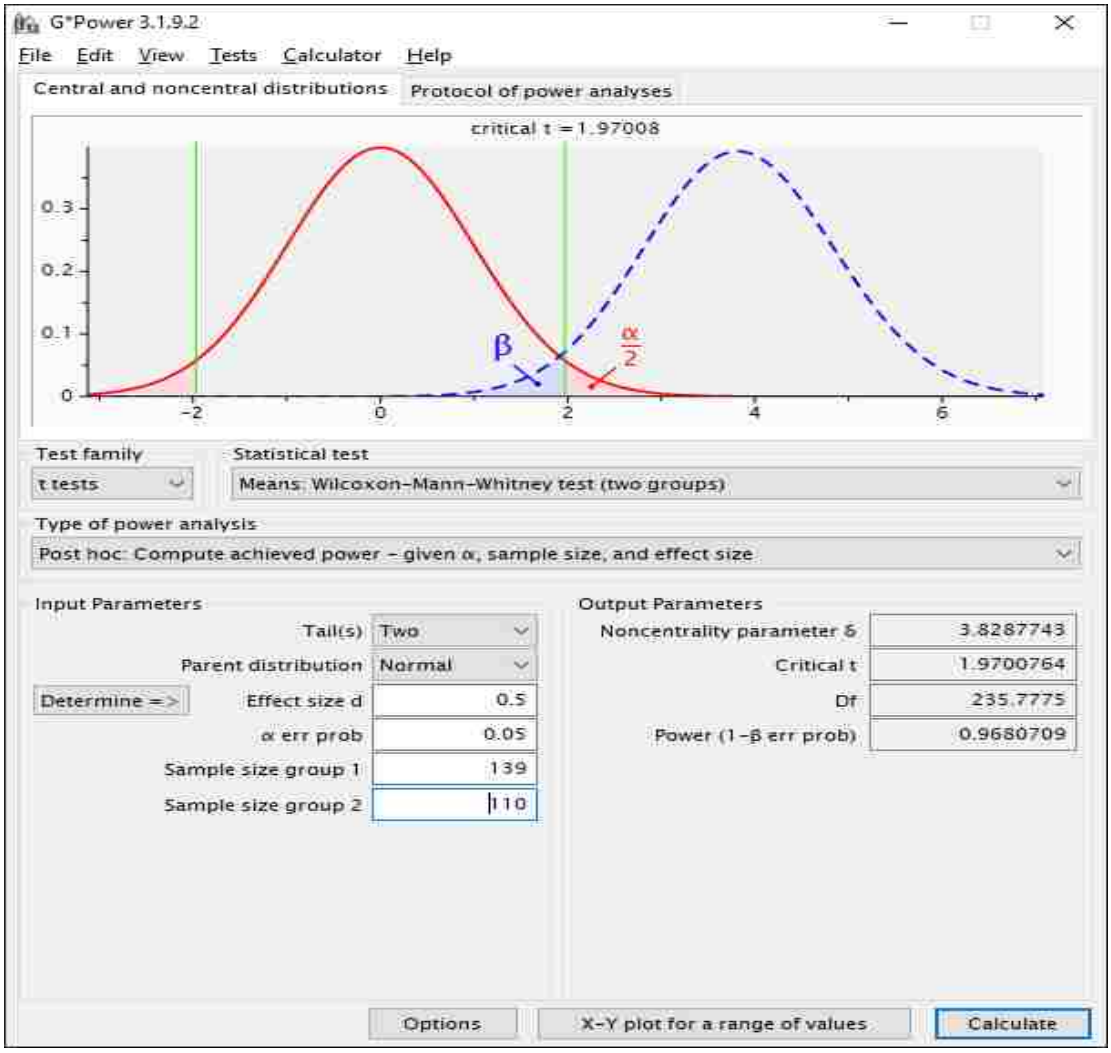

Figure 25. A Post Hoc analysis of D.N.P. vs Ph.D. in the post-statistics cohort.

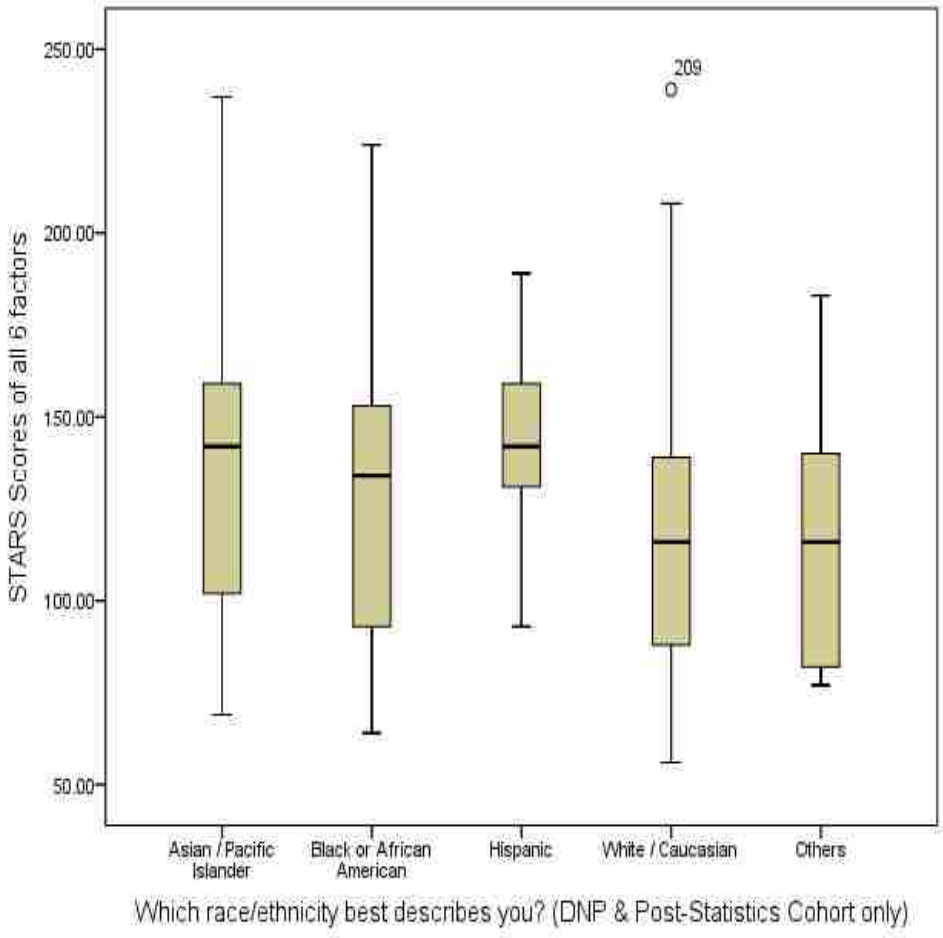

Figure 26. Statistics anxiety and ethnicities.

Table 28

Kruskal-Wallis Test

Ranks

	Which race/ethnicity best describes you? (DNP & Post-Statistics Cohort only)	N	Mean Rank
STARS Scores of all 6 factors	Asian / Pacific Islander	9	85.67
	Black or African American	17	75.97
	Hispanic	9	94.78
	White / Caucasian	98	65.43
	Others	6	67.08
	Total	139	

Test Statistics[a,b]

	STARS Scores of all 6 factors
Chi-Square	6.439
df	4
Asymp. Sig.	.169

a. Kruskal Wallis Test

b. Grouping Variable: Which race/ethnicity best describes you? (DNP & Post-Statistics Cohort only)

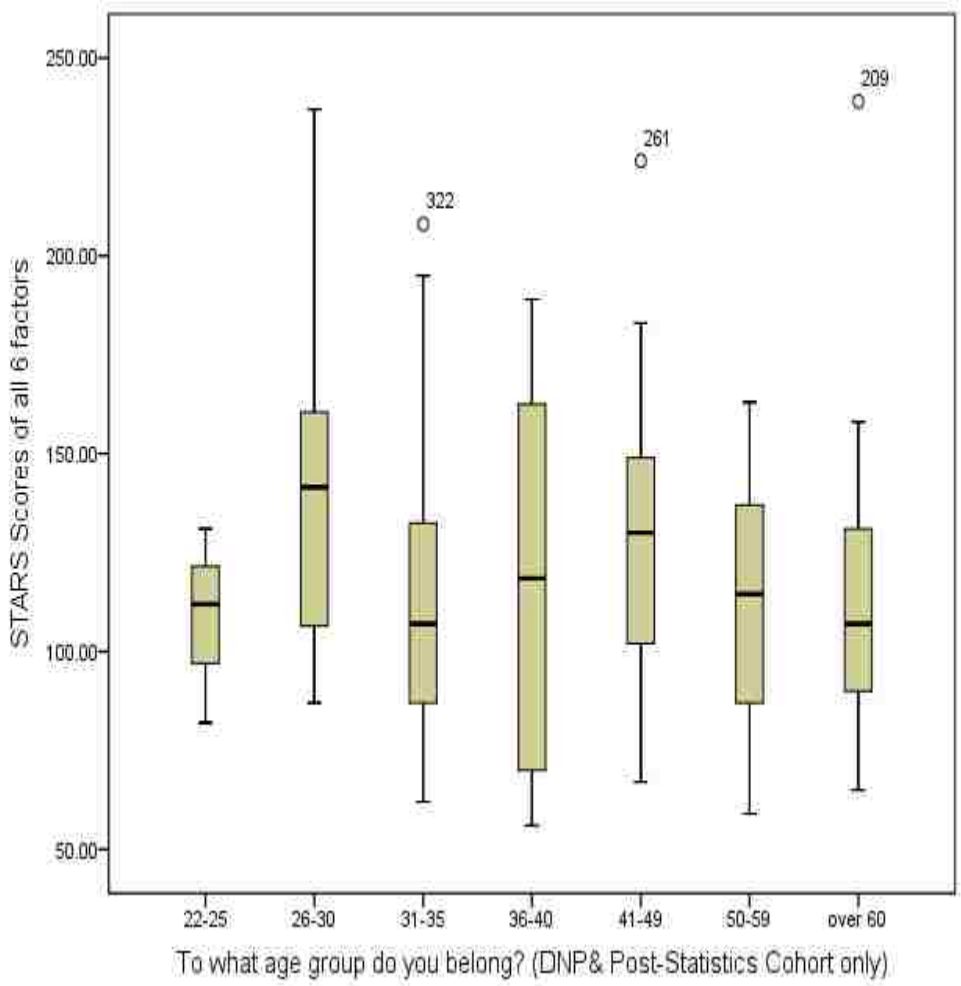

Figure 27. Statistics anxiety and age groups.

Table 29

Kruskal-Wallis Test

Ranks

	To what age group do you belong? (DNP& Post-Statistics Cohort only)	N	Mean Rank
STARS Scores of all 6 factors	22-25	3	56.33
	26-30	20	90.55
	31-35	23	61.02
	36-40	16	66.41
	41-49	34	76.31
	50-59	30	62.22
	over 60	13	63.31
	Total	139	

Test Statistics[a,b]

	STARS Scores of all 6 factors
Chi-Square	9.141
df	6
Asymp. Sig	.166

a. Kruskal Wallis Test

b. Grouping Variable: To what age group do you belong? (DNP& Post-Statistics Cohort only)

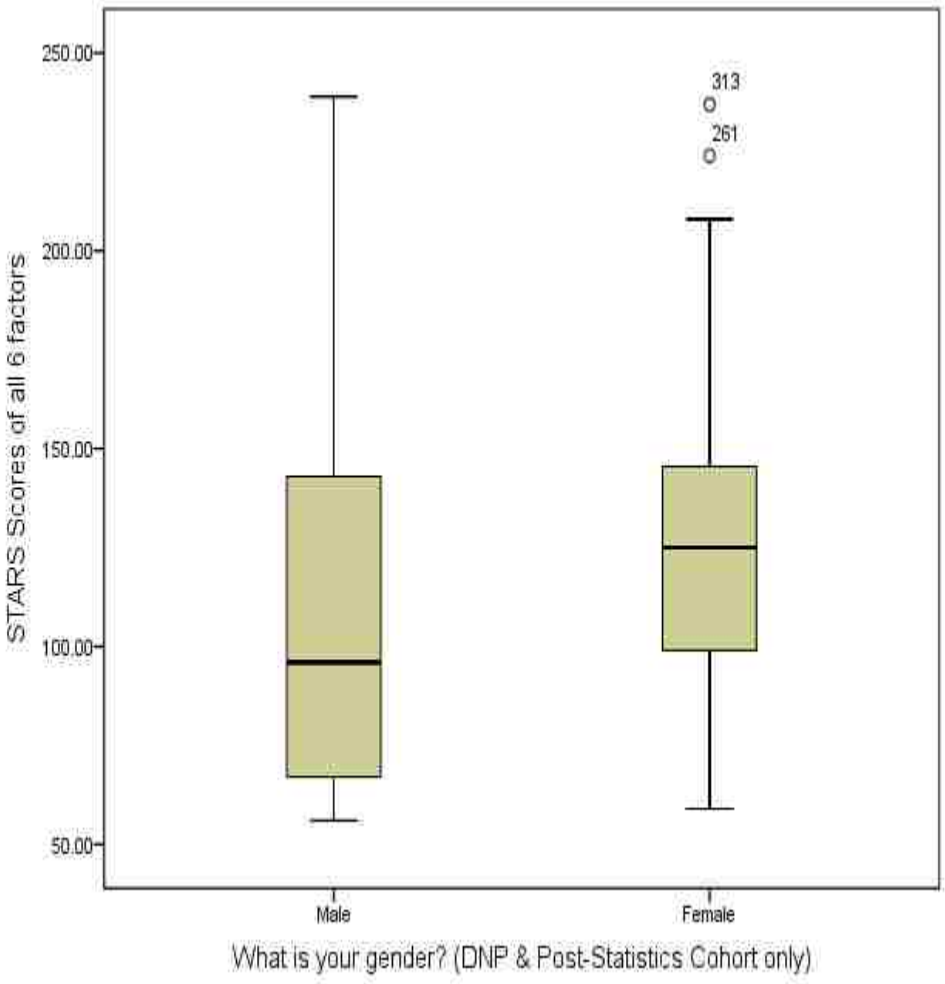

Figure 28. Statistics anxiety and gender.

Table 30

Mann-Whitney Test

Ranks

	What is your gender? (DNP & Post-Statistics Cohort only)	N	Mean Rank	Sum of Ranks
STARS Scores of all 6 factors	Male	12	54.08	649.00
	Female	127	71.50	9081.00
	Total	139		

Test Statistics[a]

	STARS Scores of all 6 factors
Mann-Whitney U	571.000
Wilcoxon W	649.000
Z	-1.433
Asymp. Sig. (2-tailed)	.152

a. Grouping Variable: What is your gender? (DNP & Post-Statistics Cohort only)

Summary

The results of the statistical data analysis were presented to answer all 5 research questions (Table 31).

Table 31

Summary of the Statistical Findings for All Research Questions

Research Question	The Null Hypothesis	*p* value	Finding
#1	Rejected	0.012	The statistics anxiety scores were statistically lower in the Post-Statistics cohorts when compared to the Pre-Statistics and Current-Statistics cohorts of D.N.P. students. Their significant results could be explained by the STARS factors, i.e. Worth of Statistics (p=0.023), Test and Class Anxiety p=0.036) and Fear of Statistics Teachers (p=0.017) for Current-Statistics and Post-Statistics cohort comparisons and Worth of Statistics (p=0.013) for Pre-Statistics and Post-Statistics cohort comparison respectively.
#2	Not Rejected	0.18	The statistics anxiety scores were not statistically different between 3 cohort comparisons of Ph.D. students.
#3	Not Rejected	0.29	The statistics anxiety scores were not statistically different between D.N.P. and Ph.D. students in the Pre-Statistics cohort
#4	Not Rejected	0.221	The statistics anxiety scores were not statistically different between D.N.P. and Ph.D. students in the Current-Statistics cohort
#5	Rejected	0.017	The statistics anxiety scores were not statistically different between D.N.P. and Ph.D. students in the Post-Statistics cohort. The significant result could be explained by the STARS factors, i.e. Worth of Statistics (p=0.001) and Interpretation Anxiety (p=0.049).

In the next chapter these findings will be discussed, along with theoretical considerations. Additionally, implications for students and academics, limitations and future research possibilities will be considered.

CHAPTER V

DISCUSSION

The purpose of this research study was to measure levels of statistical anxiety associated with and without the situational antecedent, i.e. the enrolment of a doctoral level statistics course in different doctoral programs. The sections of this chapter are a brief summary of the study, the discussion, implications for students, implications for instructors, limitations and future research.

Brief Summary

Limited studies have been found to be conducted on statistical anxiety among doctoral students in health sciences related disciplines. The perception could be that these doctoral students do not struggle with statistics because they have the necessary level of personal self-efficacy and knowledge to achieve at the required level. The antecedents of statistics anxiety can be categorized as situational, dispositional and environmental (Onwuegbuzie and Wilson, 2003). Situational antecedents can be referred to as factors that surround the stimulus, whereas dispositional antecedents refer to factors which an individual brings to the setting. Environmental antecedents refer to events which occurred in the past (Onwuegbuzie and Wilson, 2003). Situational antecedents can include the following

variables that have been found to be related statistically significantly to statistics anxiety: statistics prior knowledge, statistics course grade, the status of the course (i.e. required or elective), major (statistics vs. non-statistics) attitudes towards calculators, course and instructor evaluation, and satisfaction with the statistics course (Morris et al., 1978; Sells, 1978; Roberts & Saxe, 1982; Hunsley, 1987; Trimarco, 1997). Since no research has been conducted exclusively on doctoral students of health sciences related disciplines, situational antecedents influenced by the doctoral programs and the status of the statistics course in the programs are the main focus of this study.

The research questions identified for this study included:

Research question 1. Is there a statistically significant difference in statistics anxiety scores, as measured by Statistical Anxiety Rating Scale (STARS), between 3 cohorts of professional doctoral students (i.e. D.N.P.) whose programs require statistics course(s)?

Research question 2. Is there a statistically significant difference in statistics anxiety scores, as measured by Statistical Anxiety Rating Scale (STARS), between 3 cohorts of research doctoral students (e.g. Ph.D. in Health Sciences related disciplines such as Ph.D. in Rehabilitation Sciences and Ph.D. in Nursing) whose programs require statistics course(s)?

Research question 3. Is there a statistically significant difference in the statistics anxiety scores, as measured by Statistical Anxiety Rating Scale (STARS), between the professional doctoral students (i.e. D.N.P.) and the research doctoral students (i.e. Ph.D. in Health Sciences related disciplines such as Ph.D. in Rehabilitation Sciences and Ph.D. in Nursing) in the Pre-Statistics cohort?

Research question 4. Is there a statistically significant difference in the statistics anxiety scores, as measured by Statistical Anxiety Rating Scale (STARS), between the professional doctoral students (i.e. D.N.P.) and the research doctoral students (i.e. Ph.D. in Health Sciences related disciplines such as Ph.D. in Rehabilitation Sciences and Ph.D. in Nursing) in the Current-Statistics cohort?

Research question 5. Is there a statistically significant difference in the statistics anxiety scores, as measured by Statistical Anxiety Rating Scale (STARS), between the professional doctoral students (i.e. D.N.P.) and the research doctoral students (i.e. Ph.D. in Health Sciences related disciplines such as Ph.D. in Rehabilitation Sciences and Ph.D. in Nursing) in the Post-Statistics cohort?

The research design tested statistics anxiety scores between 3 cohorts of professional doctoral students (i.e. D.N.P.), between 3 cohorts of research doctoral students (e.g. Ph.D. in Health Sciences related disciplines such as Ph.D. in Rehabilitation Sciences and Ph.D. in Nursing), between the professional doctoral students (i.e. D.N.P.) and the research doctoral students (i.e. Ph.D. in Health Sciences related disciplines such as Ph.D. in Rehabilitation Sciences and Ph.D. in Nursing) in the Pre-Statistics cohort, the Current-Statistics cohort and the Post-Statistics cohort.

During the Fall of 2017, the online survey was assessed by 402 doctoral students from 62 programs of different (private and State-run; major academic and church-run) universities in the US. After removing doctoral students who did not complete the survey

items, the study was left with 312 doctoral students. A demographic questionnaire was included to assess the sample such as age group, gender, and race/ethnicity and to identify prior statistics course experiences as well as the program being sought.

The instrument plus the demographic questionnaire were combined into one online survey on the Survey Monkey for administration to participants. The dependent variable, statistics anxiety scores, was measured by using the Statistics Anxiety Rating Scales (STARS).

The study results demonstrated a statistical significant difference in statistics anxiety scores between 3 cohorts of professional doctoral students (i.e. D.N.P.), precisely that they were between the Current-Statistics and the Post-Statistics cohorts and between the Pre-Statistics and the Post-Statistics cohorts. The study also found a statistically significant difference in statistics anxiety scores between the professional doctoral students (i.e. D.N.P.) and the research doctoral students (i.e. Ph.D. in Health Sciences related disciplines such as Ph.D. in Rehabilitation Sciences and Ph.D. in Nursing) in the Post-Statistics cohort.

Discussion

Limited Numbers

Unlike what the study was originally planned for and expected, it was surprising to experience imbalanced cohorts in this study. Reasons could be that there was a timing issue, i.e. the data collection during the summer may have more Pre-Statistics doctoral students. Also, not everyone answered all survey items. Therefore, some surveys (91) were not able to be included in the analyses. As such, there was a reduced statistical power in statistics

analyses. It reduced the ability to find a difference if it was indeed true. However, because this study was exploratory in nature, the findings still have value in guiding future recruitment efforts and sampling methods. The lessons learnt for future recruitment are:

1. Over-sampling the minority cohorts (the Pre- and Current- Statistics cohorts) and down-sizing or even capping the majority cohort (the Post-Statistics cohort) in dealing with cohort imbalance problems (Japkowicz, 2000)
2. Keep the survey open longer with IRB approval

Findings Compared to Literature

This study's findings were in agreement with a study by Bui and Alfaro (2011) that there was no statistically significant difference between Hispanics and Caucasians in terms of statistics anxiety scores, although African Americans were found to have higher levels of statistics anxiety than their Caucasian American counterparts (Onwuegbuzie, 1999). This study's findings were also in agreement with Bui and Alfaro (2011) that there was no statistically significant difference in age groups in terms of statistics anxiety scores, although other studies reported that older students (i.e., 25 years of age and older) had higher statistics anxiety than younger students (Baloğlu, 2003; Bell, 2003). Furthermore, this study's findings were in agreement with some studies (Baloğlu, 2003; Bui & Alfaro, 2011; Hsiao & Chiang, 2011) that there was no statistically significant difference in gender in terms of statistics anxiety scores, although other researchers reported that women experience higher statistics anxiety than men (Baloğlu, Deniz, & Kesici, 2011; Rodarte-Luna & Sherry, 2008)

Situational Antecedents

This study is the first to focus on doctoral students of health science related disciplines concerning the concept of statistic anxiety. Situational antecedents refer to factors that surround the stimulus/stimuli (Onwuegbuzie and Wilson, 2003). Given that statistics anxiety is only experienced when learning or using statistics (i.e. a situation-specific anxiety; Cruise et al., 1985; Onwuegbuzie et al., 1997; Zeidner, 1991), it may explain why there was a statistically significant lower statistics anxiety scores in the post-statistics cohort for D.N.P. students. However, it was surprising to find that there were no statistically significant differences in statistics anxiety for Ph.D. students across 3 cohorts. The results could be due to the small number of students recruited in the Pre-Statistics and Current-Statistics cohorts. Or, the inequality in numbers between 3 cohorts may have resulted in a false negative result and limited the ability to identify a significant effect.

Additionally, other antecedents might have also affected the statistics anxiety for Ph.D. students. A recent study with undergraduate students found no statistically significant difference of statistics anxiety in all 3 cohorts (NeverTakenStats vs. TakingStats, vs. TakenStats) (Chew, et al. 2017). The authors suggested that their students might have experienced a type of a dispositional antecedent called "anticipatory anxiety" before enrolling in a statistics course. Chew's study suggested that this study could also be affected by some sorts of dispositional antecedents, e.g. PhD students may feel more comfortable with statistics.

Lower Statistic Anxiety in Ph.D. Students.

It was interesting to find that Ph.D. students had a statistically significant lower statistic anxiety than D.N.P. in the post-statistics cohort. One of the reasons could be the possibility that Ph.D. students entering a Ph.D. program may be more inclined to statistics than D.N.P. students. This kind of dispositional effects has been demonstrated in a study where there was some evidence to suggest a relationship between personality characteristics and nursing specialty choice (Kennedy et al., 2014).

From the curriculum point of view, a Ph.D. Nursing program prepares nurses to conduct research whereas a D.N.P. program prepares nurse leaders at the highest level of nursing practice to improve patient outcomes and translate research into practice according to the American Association of Colleges in Nursing. As such, it is possible that Ph.D. nursing students would need to understand and use different methods of inferential statistics more often than D.N.P. students who need to understand how data could be explained and applied to patients in clinical settings when necessary.

Implications for Doctoral Students

This study initiates consideration of the concept of statistical anxiety in an under-represented population because this study has attempted to gather information on doctoral students in health sciences. It raises the awareness to doctoral students who need to understand their statistics anxiety. It can be done in terms of the STARS' 6 factors. The value of the STARS' 6 factors can help quantify their statistics anxiety issues, focus on their specific problems and take remedial actions, e.g. studying in teams or with a partner if "Fear

of statistics teacher" or "Fear of Asking for Help" is an issue. Realizing that doctoral students of health sciences related disciplines also have statistics anxiety, the study gives some ideas to doctoral students what and how they can take actions in overcoming their statistics anxiety instead of relying on their statistics instructors completely.

Implications for Instructors

Regarding instructors in health sciences' doctoral programs, the awareness of this study may change the way they teach. First, instructors can use the STARS survey to assess graduate students' statistics anxiety level at the beginning and the end of the semester. Since this study found that all of the participants in this study experienced some levels of statistical anxiety, instructors can work closely with those students with relatively higher statistics anxiety (as assessed at the beginning) and re-assess them again at the end of the semester to assess learning outcomes in relation to different teaching methods..

With a better appreciation of students' statistical anxiety, instructors may utilize strategies that have been found to reduce statistical anxiety (Chew and Dillon, 2014). These tactics include the use of humor in teaching (Schact & Stuart, 1990), applying statistics to real-world situations (Wilson, 1999a), encouraging students to work in co-operative groups (Wilson, 1999a), open book tests (Wilson, 1999b) and exhibiting immediacy behaviors (Williams, 2010).

Limitations

The research design of this study was limited to participants who were doctoral students of health sciences related disciplines from 62 doctoral-degree granting programs.

These doctoral students could not be interpreted as being representative of doctoral students health science related disciplines at all universities. Moreover, a one-time cross-sectional research via the convenience sampling makes the generalizability of the results impossible. Other limitations including the following:

1. Small samples collected in the Pre-Statistics and Current-Statistics cohorts.
2. Anonymous online survey causing the prevention of repeated participations impossible
3. Potential variations in teaching materials and methods between schools
4. Statistics course achievement was not considered. Therefore, a relationship between the impact of a lower statistics anxiety and Statistics course achievement outcome was not studied.

Future Research

Further research could be conducted with a larger sample size using the same instrument by inviting other professional doctoral students such as medical students and pharmacy students. The online survey could be conducted earlier in the summer and keep the online survey open until the enrolment goal is reached. Another possibility for future research might be to conduct a longitudinal research study to measure if there is a change in statistics anxiety of doctoral students as they advance through their programs. It could begin as they enter their programs early in the summer and continue until the Fall or the end of recruitment (whichever comes first).

Additionally, a mixed method research study could be utilized with a combination of a set of open-ended questions and the current online survey. Questions would focus on the thoughts and feelings of participants as they relate to statistics and statistics anxiety. These qualitative open-ended questions may give more contexts to how the participants respond to the STARS questions. Lastly, research in dispositional antecedents (e.g. personality and learning styles) and the inclusion of statistics course achievements should also be attempted in future studies.

Conclusion

There is more to becoming statistically literate than just taking a few introductory statistics courses. However, one of the weakening factors to statistical skills is the statistical anxiety. Hence, it would also be insightful to understand our basic learning processes such as Bloom's Taxonomy, statistical learning, how different domains of statistical learning are related to Bloom's Taxonomies and how our learning styles play a role in statistical learning. Believing that there could be some sorts of associations between individual learning styles and statistical anxiety, we should attempt to personalize the diagnosis of statistics anxiety on an individual basis if we intend to mitigate or even eradicate the statistical anxiety.

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APPENDIX A

A Certificate of Completion for the NIH Web-based training course "Protecting Human Research Participants" is listed on the next page.

Certificate of Completion

The National Institutes of Health (NIH) Office of Extramural Research certifies that **Quincy Chau** successfully completed the NIH Web-based training course "Protecting Human Research Participants".

Date of completion: 06/17/2016.

Certification Number: 2097391.

APPENDIX B

The Seton Hall IRB Approval Letter is listed on the next page

SETON HALL UNIVERSITY

1 8 5 6

September 27, 2017

Quincy Chau
[redacted]

Dear Mr. Chau,

The Seton Hall University Institutional Review Board has reviewed your research proposal entitled "Exploration of Statistics Anxiety Among Doctoral Students in Health Sciences Related Disciplines Using the Statistical Anxiety Rating Scale" and has categorized it as exempt.

Enclosed for your records is the signed Request for Approval form.

Please note that, where applicable, subjects must sign and must be given a copy of the Seton Hall University current stamped Letter of Solicitation or Consent Form before the subjects' participation. All data, as well as the investigator's copies of the signed Consent Forms, must be retained by the principal investigator for a period of at least three years following the termination of the project.

Should you wish to make changes to the IRB approved procedures, the following materials must be submitted for IRB review and be approved by the IRB prior to being instituted:

- Description of proposed revisions;
- *If applicable*, any new or revised materials, such as recruitment fliers, letters to subjects, or consent documents; and
- *If applicable*, updated letters of approval from cooperating institutions and IRBs.

At the present time, there is no need for further action on your part with the IRB.

In harmony with federal regulations, none of the investigators or research staff involved in the study took part in the final decision.

Sincerely,

Mary F. Ruzicka, Ph.D.

Mary F. Ruzicka, Ph.D.
Professor
Director, Institutional Review Board

cc: Dr. Terrance Cahill

REQUEST FOR APPROVAL OF RESEARCH, DEMONSTRATION OR RELATED ACTIVITIES INVOLVING HUMAN SUBJECTS

All material must be typed.

PROJECT TITLE: *Exploration of statistics anxiety among doctoral students in health sciences related disciplines using the Statistical Anxiety Rating Scale*

CERTIFICATION STATEMENT:

In making this application, I(we) certify that I(we) have read and understand the University's policies and procedures governing research, development, and related activities involving human subjects. I (we) shall comply with the letter and spirit of those policies. I(we) further acknowledge my(our) obligation to (1) obtain written approval of significant deviations from the originally-approved protocol BEFORE making those deviations, and (2) report immediately all adverse effects of the study on the subjects to the Director of the Institutional Review Board, Seton Hall University, South Orange, NJ 07079.

[redacted] 8/30/2017

RESEARCHER(S) Quincy Chau Ph.D. Candidate DATE

Please print or type out names of all researchers below signature. Use separate sheet of paper, if necessary.

My signature indicates that I have reviewed the attached materials of my student advisee and consider them to meet IRB standards.

Terrance F. Cahill 8/30/2017

RESEARCHER'S FACULTY ADVISOR Terrance F. Cahill Ed.D., FACHE DATE

Please print or type out name below signature

The request for approval submitted by the above researcher(s) was considered by the IRB for Research Involving Human Subjects Research at the Sept 2017 meeting.

The application was approved ✓ not approved ___ by the Committee. Special conditions were ___ were not ✓ set by the IRB. (Any special conditions are described on the reverse side.)

Mary J. Renzulla Ph.D. 9/27/17

DIRECTOR, DATE
SETON HALL UNIVERSITY INSTITUTIONAL
REVIEW BOARD FOR HUMAN SUBJECTS RESEARCH

APPENDIX C

A LETTER OF SOLICITATION OF THE ONLINE SURVEY

Researcher: You are being asked to participate in a research study that is being conducted by the principle investigator Quincy Chau, a doctoral candidate at the Department of Interprofessional Health Sciences and Health Administration, Seton Hall University.

Purpose: The purpose of this research study is to measure levels of statistical anxiety associated with the enrolment of a doctoral level statistics course. An online survey of health sciences related disciplines doctoral students is needed for this research study.

Duration: This one time online participation will be limited to the completion of the Part I - statistic anxiety survey and Part II - a short demographic survey that should take only 10-15 minutes to complete.

Procedure: You click the web-link at the end of this Welcome page below to proceed to the online survey called Survey Monkey.

Survey: The survey is called the Statistics Anxiety Rating Scale (STARS) which has 51 items. The first 23 items indicate how much anxiety (from 1-No Anxiety to 5-Very High Anxiety) you would experience in each situation, e.g. studying for an examination in a statistics course. The remaining 28 items indicate level of agreement (from 1-Strongly Disagree to 5-Strongly Agree) with statements related to statistics, e.g. I feel statistics is a waste. High scores indicate high anxiety levels of the learner in a statistics course.

Voluntary Participation: Participation in this online survey is voluntary. You may refuse to

participate or withdraw from this study at any time without penalty. To ensure the most accurate information, you are encouraged to respond to all items on the surveys. However, if you do not want to respond to a particular item on the survey, you may leave it blank. Once completed, please do not discuss this online survey with other potential participants.

Confidentiality: There is always a chance of hacking of online material. However, your participation is anonymous. We do not need to know your name or any data that would identify you. Your survey responses cannot be deleted once they are submitted because your submission will not include any information that could link you directly to your survey responses.

Record Keeping: All data will be securely stored on USB thumb drives which are located in the safe locked file cabinet at the principal investigator's home and made available only to the principal investigator. Data stored on USB thumb drives will be physically destroyed 3 years after project completion. Records stating what/when/how data were destroyed will be kept.

Risks and Benefits: You will not be terminated or negatively affected if you do not want to join this study. There are no foreseeable risks associated with the participation in this survey. There are also no direct benefits associated with participation except for raising awareness of anxiety towards studying statistics.

Publications: In any publications that result from these data, only group results will be reported.

Compensation: None

Alternative procedures: You are free to discuss the topic of statistics anxiety with your instructor.

Access: All data will be securely stored and made available only to the principal investigator.

Contact information: The principle investigator Quincy Chau will not contact you directly. You can contact the principle investigator or his Advisory Committee Chair Terrence Cahill Ed.D. (through the principle investigator's department) or the Institutional Review Board (IRB) in Seton Hall

University if further study details are needed. Their addresses are:

(1) Department of Interprofessional Health Sciences and Health Administration

Seton Hall University

School of Health and Medical Sciences

400 South Orange Avenue

Alfieri Hall, Lower Level

South Orange, NJ 07079

(973) 275-2076

(2) Mary F. Ruzicka, Ph.D.

Professor

Seton Hall University

Office of the Institutional Review Board

Presidents Hall – 3rd Floor

400 South Orange Avenue

South Orange, NJ 07079

(973) 313-6314

Consent: You have read the information above and understand what will be expected of your participation. You further understand that your consent to participate in this research is indicated by the submission of the online survey.

Thank you for your participation.

Quincy Chau

Please click or copy/paste the web-link below to proceed to the survey.

http://www.surveymonkey.com/r/C8L3GXJ

APPENDIX D

PART I: STATISTICAL ANXIETY RATING SCALE (STARS)

Part 1a. This section identifies situations that are commonly associated with statistical anxiety. Please respond to each of the following situations by indicating the level of anxiety you would experience in each situation.

No Anxiety Very High Anxiety

1 2 3 4 5

1. Studying for an examination in a statistics course

1 2 3 4 5

2. Interpreting the meaning of a table in a journal article

1 2 3 4 5

3. Going to ask my statistics teacher for individual help with material I am having difficulty understanding 1 2 3 4 5

4. Doing the homework for a statistics course

1 2 3 4 5

5. Making an objective decision based on empirical data

1 2 3 4 5

6. Reading a journal article that includes some statistical analyses

1 2 3 4 5

7. Trying to decide which analysis is appropriate for your research project

1 2 3 4 5

8. Doing the final examination in a statistics course

1 2 3 4 5

9. Reading an advertisement for an automobile which includes figures on gas mileage, compliance with population regulations, etc.

1 2 3 4 5

10. Walking into the classroom to take a statistics test

1 2 3 4 5

11. Interpreting the meaning of a probability value once I have found it.

1 2 3 4 5

12. Arranging to have a body of data put into the computer

1 2 3 4 5

13. Finding that another student in class got a different answer than you did to a statistical problem

1 2 3 4 5

14. Figuring out whether to reject or retain the null hypothesis

1 2 3 4 5

15. Waking up in the morning on the day of a statistics test

1 2 3 4 5

16. Asking one of your professors for help in understanding a printout

1 2 3 4 5

17. Trying to understand the odds in a lottery

1 2 3 4 5

18. Seeing a student poring over the computer printouts related to his/her research

1 2 3 4 5

19. Asking someone in the computer center for help in understanding a printout

1 2 3 4 5

20. Trying to understand the statistical analyses described in the abstract of a journal article

1 2 3 4 5

21. Enrolling in a statistics course

1 2 3 4 5

22. Going over a final examination in statistics after it has been graded

1 2 3 4 5

23. Asking a fellow student for help in understanding a printout

1 2 3 4 5

Part Ib. Please respond to the following statements related to statistics. For each statement, indicate you level of agreement on a scale from Strongly Disagree to Strongly Agree.

Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
1	2	3	4	5

24. Since I am by nature a subjective person, the objectivity of statistics is inappropriate for me.

1 2 3 4 5

25. I haven't had math for a long time. I know I'll have problems getting through statistics

1 2 3 4 5

26. I wonder why I have to do all these things in statistics when in actual life I'll never use them.

1 2 3 4 5

27. Statistics is worthless to me since it's empirical and my area of specialization is philosophical.

1 2 3 4 5

28. Statistics takes more time than it's worth.

1 2 3 4 5

29. I feel statistics is a waste.

1 2 3 4 5

30. Statistics teachers are so abstract they seem inhuman.

1 2 3 4 5

31. I can't even understand seventh- and eighth-grade math; how can I possibly do statistics

1 2 3 4 5

32. Most statistics teachers are not human.

1 2 3 4 5

33. I lived this long without knowing statistics, why should I learn it now?

1 2 3 4 5

34. Since I've never enjoyed math, I don't see how I can enjoy statistics.

1 2 3 4 5

35. I don't want to learn to like statistics.

1 2 3 4 5

36. Statistics is for people, who have a natural leaning toward math.

1 2 3 4 5

37. Statistics is a grind, a pain I could do without.

1 2 3 4 5

38. I don't have enough brains to get through statistics.

1 2 3 4 5

39. I could enjoy statistics if it weren't so mathematical

1 2 3 4 5

40. I wish the statistics requirement would be removed from my academic program.

1 2 3 4 5

41. I don't understand why someone in my field needs statistics.

1 2 3 4 5

42. I don't see why I have to clutter up my head with statistics. It has no significance to my life work.

1 2 3 4 5

43. Statistics teachers talk a different language.

1 2 3 4 5

44. Statisticians are more number oriented than they are people oriented.

1 2 3 4 5

45. I can't tell you why, but I just don't like statistics.

1 2 3 4 5

46. Statistics teachers talk so fast you cannot logically follow them.

1 2 3 4 5

47. Statistical figures are not fit for human consumption.

1 2 3 4 5

48. Statistics isn't really bad. It's just too mathematical.

1 2 3 4 5

49. Affective skills are so important in my profession that I don't want to clutter my thinking with something as cognitive as statistics. 1 2 3 4 5

50. I'm never going to use statistics so why should I have to take it?

1 2 3 4 5

51. I'm too slow in my thinking to get through statistics.

1 2 3 4 5

APPENDIX E

PART II: DEMOGRAPHIC SURVEY

52. Gender: Male __ Female __

53. What race/ethnic group?

□American Indian or Alaskan Native

□Asian / Pacific Islander

□Black or African American

□Hispanic

□White / Caucasian

□Others

54. To What Age Group do you belong:

□ Under 21

□ 22-25

□ 26-30

□ 31-35

□ 36-40

□ 41-49

□ 50-59

□ Over 60

55. What is the highest college degree you have received?

□ Bachelor's

□ Master's

□ Doctorate

56. Please check which program you are currently enrolled:

□Doctor of Nursing Practice (D.N.P)

□Ph.D. in Health Sciences related disciplines (e.g. Ph.D. in Health Sciences, Ph.D. in Rehabilitation Sciences, Ph.D. in Environmental and Occupational Health, etc.)

□Ph.D. in Nursing

57. Have you taken the statistics course(s) (which cover at least the descriptive statistics and the inferential statistics e.g. the hypothesis testing) in your currently enrolled program?

□ Not yet

□ Currently taking

□ Already taken

58. Please indicate if you have taken a Bachelor's or Master's level statistics course(s) (which cover at least the descriptive statistics and the inferential statistics e.g. the hypothesis testing) prior to entering the doctoral program:

□ Yes

□ No

APPENDIX F

Below is the email trail indicating that the original lead author Dr. Robert Cruise approved the principle investigator the use of his STARS instrument per the principle investigator's requests. The original correspondence is available from the principle investigator.

From: Bob Cruise <bobcruise@mac.com>

Sent: Sunday, April 22, 2018 8:50 PM

To: Quincy Chau

Cc: Terrence F Cahill;

Subject: Re: Please help Dr. Cruise

This sounds fine and I appreciate your attention to details of what I suggested. Therefore please accept this note as my approval of the use as defined, of the STARS instrument in your dissertation. I trust that when it is finished I can get a digital copy of it. I will be excited to read it and refer to it when appropriate for others doing research with the instrument.

When are they suggesting your defense will be?

Robert J. Cruise, Ph.D.

On Apr 20, 2018, at 2:37 PM, Quincy Chau wrote:

Dear Dr. Cruise

Thanks so very much for your support in the use of your survey. I acknowledge that it must have been very busy for you to answer inquiries like mine from people around the world. I recognize that you have a great survey which comes with an awesome responsibility. I would love to create something great like yours one day.

Yes, I have your 1985 6-page publication. I studied your survey and used your 51 items as directed exactly and hence the integrity of your survey has not been and will not be violated in my dissertation research and subsequent publications. I did not modify/remove/add any item. The average time to finish your survey was 6 min according to the App's tracking and it was fantastic.

I think you are suggesting to me to insert Pages 93 and 94 of your 1985 publication as an Appendix plus your contact info. Pages 93-94 has all 51 items although they are not in a chronological order. Yes, I will do so.

I have also typed out and listed all of your 51 items in a chronological order in my online survey (under Seton Hall University) for students who answered them in Fall last year. I will show them in an Appendix as well.

In any event, if there is anything that is missing, please let me know. I am very motivated and grateful to have connected with you in my doctoral journey.

Many thanks

Quincy Chau

APPENDIX G

Pages 93-94 of the original article by Cruise, Cash, and Bolton (1985) were re-published in this Appendix with the permission of the American Statistical Association and listed on the next 2 pages.

decided to test various combinations of potential variables and factors to see if a more interpretable factor structure could be determined. Item analysis substantiated the relative usefulness of certain items, and was utilized in determining which items to delete or retain. Ideally, the resulting factor structure would have each variable load significantly (greater than .3) on no more than one factor, and every variable load on a factor with other items measuring similar aspects of statistical anxiety. The most interpretable structure was yielded by the rotation of six factors using 51 variables. Factor loadings for the items are shown on Table 7.

Reliability

The extent to which the scores show consistency (reliability) was estimated using two measures. Coefficient alpha, a measure of reliability, was determined for each factor and point multi-serial correlations were determined for each item within that factor. The results can be found in Table 8. Test-retest reliability was determined on a group of 161 who took STARS twice, with a period of five weeks intervening between initial and final testing. Test-retest reliability for each item and factor is also given on Table 8.

Factor Descriptions and Items

Factor 1: Worth of Statistics

This factor has to do with the student's perception of the relevance of statistics. A person scoring high on this factor sees no purpose in taking a statistics course and no possible future personal or professional application. Another aspect is that the students find statistics pointless because it does not fit their personnality. It can also indicate a negative attitude toward statistics.

Item Number

24...Since I am by nature a subjective person, the objectivity of statistics is inappropriate for me.
26...I wonder why I have to do all these things in statistics when in actual life I'll never use them.
27...Statistics is worthless to me since it's empirical and my area of specialization is philosophical.
28...Statistics takes more time than it's worth.
29...I feel statistics is a waste.
33...I lived this long without knowing statistics, why should I learn it now?
35...I don't want to learn to like statistics.
36...Statistics is for people who have a natural leaning towards math.
37...Statistics is a grind, a pain I could do without.
40...I wish the statistics requirement would be removed from my academic program.
41...I don't understand why someone in my field needs statistics.
42...I don't see why I have to clutter up my head with statistics. It has no significance to my life work.
45...I can't tell you why, but I just don't like statistics.
47...Statistical figures are not fit for human consumption.
49...Affective skills are so important in my profession that I don't want to clutter my thinking with something as cognitive as statistics.
50...I'm never going to use statistics so why should I have to take it?

Factor 2: Interpretation Anxiety

This factor is concerned with the anxiety experienced when a student is faced with making a decision from or interpreting statistical data. A person scoring high on this factor finds it very difficult to decide which analysis to use and whether to reject or retain the null hypothesis. When analyzing statistical data, the student will experience anxiety trying to understand it and make interpretations for everyday life.

Item Number

2...Interpreting the meaning of a table in a journal article.
5...Making an objective decision based on empirical data.
6...Reading a journal article that includes some statistical analyses.
7...Trying to decide which analysis is appropriate for your research project.
9...Reading an advertisement for an automobile which includes figures on gas mileage, compliance with population regulations, etc.
11...Interpreting the meaning of a probability value once I have found it.
12...Arranging to have a body of data put into the computer.
14...Figuring out whether to reject or retain the null hypothesis.
17...Trying to understand the odds in a lottery.
18...Seeing a student poring over the computer printouts related to his/her research.
20...Trying to understand the statistical analyses described in the abstract of a journal article.

Factor 3: Test and Class Anxiety

This factor deals with the anxiety involved when taking a statistics class or test. A person scoring high on this factor experiences great anxiety when enrolling in, doing course work or taking an exam in a statistics course.

Item Number

1...Studying for an examination in a statistics course.
4...Doing the homework for a statistics course.
8...Doing the final examination in a statistics course.
10...Walking into the classroom to take a statistics test.
13...Finding that another student in class got a different answer than you did to a statistical problem.
15...Waking up in the morning on the day of a statistics test.
21...Enrolling in a statistics course.
22...Going over a final examination in statistics after it has been graded.

Factor 4: Computation Self-Concept

This factor involves anxiety experienced when doing mathematical problems, as well as the student's self-perception of his/her ability to understand and calculate statistics. It doesn't reflect so much the student's ability to do mathematics, but rather measures the student's attitude toward mathematics. A person scoring high on this factor might not mind statistics per se, but experiences anxiety because it involves mathematical calculations, and he/she feels inadequate to comprehend statistics.

Item Number

25...I haven't had math for a long time. I know I'll have problems getting through statistics.
31...I can't even understand seventh- and eight-grade math; how can I possibly do statistics.
34...Since I've never enjoyed math, I don't see how I can enjoy statistics.
38...I don't have enough brains to get through statistics.
39...I could enjoy statistics if it weren't so mathematical.
48...Statistics isn't really bad. It's just too mathematical.
51...I'm too slow in my thinking to get through statistics.

Factor 5: Fear of Asking for Help

This factor measures the anxiety experienced when asking for help. A person scoring high on this factor will experience anxiety when asking a fellow student or professor for help in understanding the material covered in class of any type of statistical data, such as an article or a printout.

Item Number

3...Going to ask my statistics teacher for individual help with material I am having difficulty understanding.
16...Asking one of your professors for help in understanding a printout.
19...Asking someone in the computer center for help in understanding a printout.
23...Asking a fellow student for help in understanding a printout.

Factor 6: Fear of Statistics Teachers

This factor is concerned with the student's perception of the statistics teacher. A person scoring high on this factor perceives the statistics teacher as lacking the ability to relate to the student as a human being. He questions the humanness of the teacher and regards him as someone who the student must fear.

Item Number

30...Statistics teachers are so abstract they seem inhuman.
32...Most statistics teachers are not human.
43...Statistics teachers talk a different language.
44...Statisticians are more number oriented than they are people oriented.
46...Statistics teachers talk so fast you cannot logically follow them.

References

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Table 1
Percentile Rank Norms for Total Sample for Each Factor (N = 1150)

Raw Score	Factors[a] 1	2	3	4	5	6
80	99					
79	99					
78	99					
77	99					
76	99					
75	99					
74	99					
73	99					
72	99					
71	99					
70	99					
69	99					
68	99					
67	98					
66	98					
65	98					
64	98					
63	97					
62	97					
61	97					
60	97					
59	97					
58	96					
57	95					
56	94					
55	93					
54	92					
53	92	99				
52	91	99				
51	90	99				
50	89	99				
49	87	99				
48	86	99				
47	85	99				
46	83	99				
45	81	99				
44	80	99				
43	78	98				
42	76	98				
41	74	98				
40	72	97	99			
39	70	96	99			
38	67	95	98			
37	65	93	97			
36	63	92	94			
35	61	90	92	99		
34	58	88	89	99		
33	56	86	87	99		
32	53	83	84	99		
31	50	80	81	98		
30	46	76	78	98		
29	43	73	74	97		
28	41	69	70	96		
27	38	65	66	95		
26	35	60	62	94		
25	32	56	58	92		99
24	29	52	52	90		99
23	26	48	48	88		99
22	24	42	44	85		99
21	21	37	40	82		98
20	18	33	36	78		97
19	15	27	32	75	99	95
18	12	22	28	71	99	94
17	8	19	24	66	99	91
16	3	15	20	62	98	88
15		12	16	57	97	83
14		9	13	51	94	76
13		6	10	46	91	68
12		4	7	40	86	59
11		1	5	33	82	50
10			3	27	76	41
9			2	21	68	32
8			1	14	58	24
7				6	48	16
6					38	9
5					26	3
4					10	

[a]Factor 1 = Worth of Statistics
Factor 2 = Interpretation Anxiety
Factor 3 = Test and Class Anxiety
Factor 4 = Computation Self-Concept
Factor 5 = Fear of Asking for Help
Factor 6 = Fear of Statistics Teacher

APPENDIX H

Below is the email trail indicating that permission was granted by the American Statistical Association to republish Pages 93-94 of the article by Cruise, Cash, and Bolton (1985). The original correspondence is available from the principle investigator.

From: Porzio, Steve <steve@amstat.org>

Sent: Monday, April 23, 2018 3:41 PM

To: Quincy Chau

Cc: Wilkins, Jojuana; Quincy Chau

Subject: RE: A question regarding the use of a publication

Quincy,

No problem. Approved.

Steve

From: Quincy Chau

Sent: Monday, April 23, 2018 3:11 PM

To: Porzio, Steve <steve@amstat.org>

Cc: Wilkins, Jojuana <jojuana@amstat.org>; Quincy Chau

Subject: Re: A question regarding the use of a publication

Hello Steve and Jojuana

Sorry for my typo. I meant "Pages 93 and 94" instead of "Pages 93 and 34 "

In any event, many thanks

Quincy Chau

From: Porzio, Steve <steve@amstat.org>

Sent: Monday, April 23, 2018 2:30 PM

To: Quincy Chau

Cc: Wilkins, Jojuana

Subject: RE: A question regarding the use of a publication

Hello Quincy,

I hereby approve your request for permission to take out Page 93 and Page 34 of this publication and add them to your PhD dissertation as an appendix.

Steve

Stephen Porzio

Associate Executive Director and Director of Operations