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The Relationship Between Statistics Self-Efficacy, Statistics Anxiety, and Performance in an Introductory Graduate Statistics Course

William Ray Schneider
University of South Florida, schwi11@hotmail.com

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The Relationship Between Statistics Self-Efficacy, Statistics Anxiety, and
Performance in an Introductory Graduate Statistics Course

by

William R. Schneider

A dissertation submitted in partial fulfillment
of the requirements for the degree of
Doctor of Philosophy
Department of Adult, Career, and Higher Education
College of Education
University of South Florida

Major Professor: Wayne B. James, Ed.D.
Jeffrey Kromrey, Ph.D.
James Eison, Ph.D.
William Young, Ed.D.

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Dedication

To my mother Christine for teaching me to read. To my wife Marge for her many hours working with me through the edits and changes and her love, encouragement, and support during this epic journey

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Abstract

The purpose of this study was to determine the relationship between statistics self-efficacy, statistics anxiety, and performance in introductory graduate statistics courses.

The study design compared two statistics self-efficacy measures developed by Finney and Schraw (2003), a statistics anxiety measure developed by Cruise and Wilkins (1980), and a course performance measure. To view self-efficacy from two perspectives, the Current Statistics Self-Efficacy (CSSE) assessed student confidence in their ability to complete specific statistics tasks in the present, whereas Self-Efficacy to Learn Statistics (SELS) assessed student confidence in their ability to learn statistics in the future. The performance measure was the combined average of the midterm and final exam scores only, excluding grades from other course activities.

The instruments were distributed to four sections of an introductory graduate statistics course ($N = 88$) in a College of Education at a large metropolitan university during the first week of the semester during Fall 2009 and Spring 2010.

Both of the statistics self-efficacy measures revealed a low to moderate inverse relationship with statistics anxiety and a low to moderate direct relationship with each other. In this study there was no correlation between

statistics anxiety (CSCS), statistics self-efficacy (CSSE and SELS), and course performance. There was high internal reliability for each instrument's items making the instruments suitable for use with graduate students. However, none of the instruments' results were significant in relation to course performance with graduate students in this sample.

Unlike prior research involving undergraduate-level statistic students that has reported a relationship between the CSSE and SELS, the present study, involving graduate students, did not find any significant correlation with performance. Additional research is suggested to investigate the reasons for the differences between the studies.

Chapter 1

Introduction

There are many reasons why doctoral students fail to complete their degree programs. According to Haynes (2004), Smallwood (2004), and Bair and Haworth (1999), nationwide the attrition rate in doctoral programs of study is as high as 40 to 50%. Although attrition and persistence rates vary by field of study and program, the main reasons given for the high attrition rates were lack of satisfaction with program of study, unsupportive department culture, lack of satisfactory dissertation progress, academic achievement indicators, and employment and financial factors (Bair & Haworth, 1999). The reasons associated with student satisfaction with program of study as an indicator of degree completion described by Bair and Haworth are satisfaction with degree programs, required courses, and instructional quality.

Bair and Haworth assert that students who believed the coursework was valuable and relevant, and who saw their own work as satisfactory, were more likely to complete their degrees. Since a series of research and statistics courses are required for candidacy and eventually degree completion, student perceptions of confidence in their performance in statistics and statistics anxiety in those courses may contribute to doctoral attrition. Another contributing factor to whether or not students complete their doctoral programs may be their level of personal self-efficacy beliefs in statistics and research-related courses. Self-

efficacy, or student perception of personal competence, may reduce the effects of statistics anxiety, a major cause of attrition in statistics and research programs.

According to Onwuegbuzie (2003),

Between two thirds and four fifths of graduate students appear to experience uncomfortable levels of statistics anxiety. Indeed, for many students, statistics is one of the most anxiety-inducing courses in their programs of study. . . levels of statistics anxiety experienced by students can be so great that undertaking research methodology and statistics classes has come to be regarded by many as extremely negative (Onwuegbuzie, 1997a), and perhaps, more important, a major threat to the attainment of their degrees. (p. 1023)

Onwuegbuzie (2003) suggests that students regularly delay taking courses related to statistics or research until they can no longer avoid it. . . often waiting until the final term which is not ideal. Although the exact number of statistics and research courses vary by discipline and institution, these required statistics and research courses may create a stumbling block that not all students overcome. Based on a review of the universities classified as doctoral-degree granting, large metropolitan university with very high research activity in the southeastern U.S. listed in the Carnegie Classification of Institutions of Higher Education (2011), the number of statistics and research courses varies by college and program. The typical number of credit hours required in statistics and research is between 9 and 24. For example, Purdue University requires a minimum of 9 credit hours in foundations and research competencies. The University of Florida requires 22 credit hours of research coursework in their Higher Education Administration Ph.D. program. Auburn University requires 12 hours of research coursework, while the Educational Leadership Specialization at Colorado State University requires 15-18 credit hours of research core courses.

Self-efficacy has been defined by Bandura as the self beliefs students hold about their ability to complete specific tasks or actions successfully (1997).

Self-efficacy theory acknowledges the diversity of human capabilities. Thus, it treats the efficacy belief system not as an omnibus trait but as a differentiated set of self-beliefs linked to distinct realms of functioning. Moreover, efficacy beliefs are differentiated across major systems of expression within activity domains. . . Efficacy beliefs are concerned not only with the exercise of control over action but also with the self-regulation of thought processes, motivation, and affective and psychological states. (Bandura, 1997, p. 36)

Self-efficacy beliefs play a major role in a student's confidence in the ability to complete advanced research (Unrau & Beck, 2004). By identifying the levels of statistics self-efficacy of graduate students and the relationship to completion of doctoral-level statistics coursework, faculty should be able to enhance the research skills of those graduate students who are identified as lacking specific levels of self-efficacy by providing more help and encouragement in learning statistics.

Statistics anxiety is defined as the negative thoughts and feelings experienced by an individual when encountering statistics in any form (Bandalos, Finney, & Geske, 2003; Onwuegbuzie, 2003; Wei & Tang, 2005). Finney and Schraw (2003) in their study found a negative correlation between statistics self-efficacy as measured by the Current Statistics Self-Efficacy (CSSE) scale and statistics anxiety. This suggests that where personal self-efficacy is high, statistics anxiety is low or non-existent. In other words, when students are confident in their ability to complete certain statistics tasks or problems they will not experience high levels of statistics anxiety prior to taking a statistics exam.

Statement of the Problem

Little research has been conducted on the relationship between statistics self-efficacy, statistics anxiety, and performance for graduate-level students. Currently many graduate students may struggle with statistics courses because they do not have the personal self-efficacy to perform at the required level; and, therefore, students may delay their progress in statistics coursework--or leave the doctoral program altogether.

Onwuegbuzie (2003) states “student’s expectations of their performance are an important manifestation of their levels of self-efficacy” (p. 1023).

Onwuegbuzie succinctly restates Bandura’s approach in a passage:

Simply put, self-efficacy theory predicts that an individual’s belief system influence behavior choices, effort invested, persistence, and task success. According to this conceptualization, people tend to engage in activities that they believe they can undertake, control their efforts, persevere until this level of performance is accomplished, and then evaluate their performance according to previous expectations. (pp. 1022-1023)

Purpose of the Study

The purpose of this study was to investigate the relationship between statistics self-efficacy, statistics anxiety, and performance in introductory graduate statistics courses. This study was concerned with the confidence of students who take the required statistics courses and who may have statistics self-efficacy and statistics anxiety issues that impact their performance in statistics classes.

Research Questions

Research questions related specifically to this study include:

1. What is the relationship between statistics self-efficacy and statistics anxiety?
2. What is the relationship between the Current Statistics Self-Efficacy (CSSE) and Self-Efficacy to Learn Statistics (SELS) and performance in a graduate introductory statistics course?
3. What is the relationship between statistics anxiety and performance in a graduate introductory statistics course?
4. What is the relationship between statistics self-efficacy, statistics anxiety, and performance?

Theoretical Framework

The theoretical framework for the study encompasses social cognitive theory which, according to Bandura (1989), sees humans as self-regulating organisms influenced and shaped by behavioral, personal, and environmental factors “rather than reactive organisms shaped and shepherded by environmental forces or driven by concealed inner impulses” (Pajares, 2002, p. 2).

The relationship between behavioral, personal, and environmental factors is termed triadic reciprocal causation. It is believed that any of the factors that comprise the triad can be altered through varied teaching methods, support systems, and counseling services (Pajares, 2002). The theoretical framework of self-efficacy (SE) and its application to statistics skill development in doctoral student coursework provides the direction for this study.

According to Bandura (1997), the outcome expectations include the physical, social, and self-evaluative effects derived from a given course of action. Bandura (1997) stated: “In given domains of functioning, efficacy beliefs vary in level, strength, and generality” (p. 22). The combination of the varying levels of SE of individuals produce specific outcomes. These SE beliefs have a greater influence on outcome expectations than ability alone (Bandura, 1997). Figure 1 depicts the influence that SE beliefs have on a person’s outcome expectations.

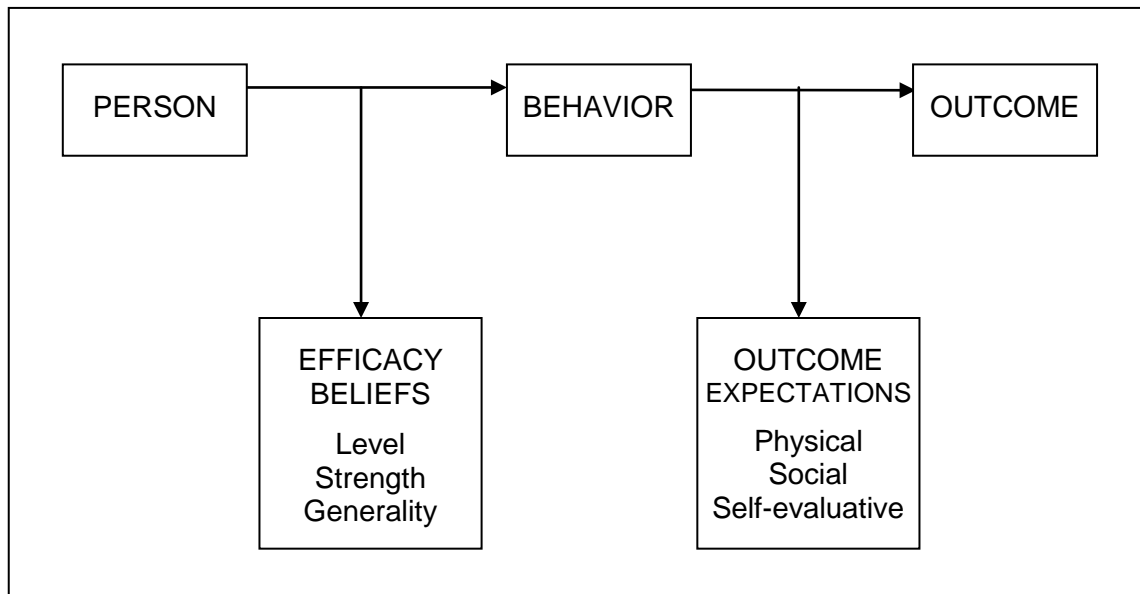


Figure 1. Relationship between efficacy beliefs and outcome expectations. Self-efficacy theory suggests that personal beliefs effects behavior, level of personal effort, resolve, and task attainment in specific learning outcomes (Bandura, 1997).

Bandura continues his explanation that:

Perceived self-efficacy is a judgment of one’s ability to organize and execute given types of performances, whereas an outcome expectation is

a judgment of the likely consequences such performances will produce. Outcome expectations can take three major forms (Bandura, 1986a).

Within each form, the positive expectations serve as incentives, the negative one's as disincentives. One distinct class of outcomes is the positive and negative physical effects that accompany the behavior. These include pleasant sensory experiences and physical pleasures in the positive forms and aversive sensory experiences, pain and physical discomfort in the negative forms. Human behavior is partly regulated by the social reactions it evokes. Positive and negative social effects form the second major class of outcomes. On the positive side, they include such social reactions of others as expressions of interest, approval, social recognition, monetary compensation, and conferral of status and power; on the negative side, they include disinterest, disapproval, social rejection, censure, deprivation of privileges, and imposed penalties. (1997, pp. 21-22)

Later Bandura writes, "This third major class of outcomes includes the positive and negative self-evaluative reaction to one's own behavior (1997, pp. 21-22). Physical effects, social effects and self-evaluative reactions are the three forms of outcome expectations.

In a study conducted by Onwuegbuzie using a model of statistics achievement and anxiety called the *Anxiety Expectation Mediation (AEM)* model, he indicates:

The importance of expectation in the Anxiety Expectation Mediation (AEM) model suggests that the social cognitive theory (Bandura, 1977, 1986) in general, and the self-efficacy theory in particular (Bandura, 1977, 1982, 1986, 1997), are pertinent to the processes underlying the learning of statistics because expectation is a manifestation of self-efficacy. Self-efficacy theory predicts that one's belief system influences behavior choices, effort invested, persistence, and task success in the learning of a foreign language (Bandura, 1977, 1982, 1986, 1997). Furthermore, the finding that expectation predicts statistics achievement suggests that a self-fulfilling prophecy prevails, in which students who have low expectations of their statistics ability exhibit behaviors that may lead to underachievement. (Onwuegbuzie, 2003, p. 1033)

Significance of the Study

According to Bair and Haworth (1999), “traditional academic indicators are not reliable predictors of persistence to the doctoral degree” (p. 18). These indicators include undergraduate institution attended, holding a master’s degree, length of time between degrees, bachelor’s or master’s degree major, amount of time taken to complete the master’s, and GPA for the last two years of undergraduate study (Bair & Haworth, 1999). The traditional indicators mentioned previously measure a construct different than that of personal self-efficacy beliefs in graduate-level statistics classes, and do not tap into students’ self beliefs about their capacity to complete certain tasks and goals required to successfully pass graduate statistics coursework.

Limitations

This research design was limited to participants who were graduate students at a doctoral-degree granting, large metropolitan university with very high research activity in the southeastern U.S. These graduate students cannot be interpreted as being representative of graduate students at all universities.

Three of the measurement tools used in this study may not have been appropriate for College of Education graduate students as anticipated. Possible differences in age, education and/or experiences may have impacted the results of the three instruments.

Assumptions

It was assumed that all students answered the instrument items accurately and truthfully to the best of their ability.

Definition of Terms

The following terms used throughout this study are defined as follows:

Computational Self-Concept subscale (CSCS) of the Statistics Test Anxiety rating Scale (STARS)—subcomponent of instrument designed to measure the anxiety level of students in relation to their concern about taking statistics tests.

Current Statistics Self-Efficacy (CSSE)—Instrument designed by Finney and Schraw (2003) to measure student's personal beliefs about their current ability to complete specific statistics tasks.

Graduate student—A student enrolled in a graduate program of study at an accredited university.

Introductory statistics—The introductory statistics course in the College of Education (COE). This course is typically taken first in the series of statistics courses and is either taken as a required course or as an elective.

On-line course—Course delivered via internet using Blackboard with instructor's guidance.

Performance measure—The performance measures for this study were based on the combined midterm and final exam scores in the introductory statistics course. The actual value of the performance measure is derived from the combined scores divided by two.

Self-efficacy—The personal beliefs held by individuals that they possess the capacity to complete certain tasks in certain domains of functioning, under certain conditions (Bandura, 1997).

Self-Efficacy to Learn Statistics (SELS)—Instrument designed by Finney and Schraw (2003) to measure a student's personal beliefs in their ability to learn to complete specific statistics tasks in the future.

Statistics anxiety—The physical, psychological, and emotional triggers experienced by a student when confronted with assignments, tests, or other deliverables (Bandalos, Finney, & Geske, 2003).

Traditional classroom course—Course delivered in the usual on-campus classroom setting.

Organization of the Study

Chapter 1 is an introduction to the study and establishes a framework for the research, including the problem, purpose, research questions, theoretical framework, limitations, assumptions, and definition of terms. Chapter 2 is a review of the literature related to social cognitive theory, academic and statistics self-efficacy, current research in self-efficacy, goal orientation, researcher preparation, statistics anxiety, and summary. Chapter 3 reports the research design, population and sample, instrumentation, data collection, and data analysis. Chapter 4 is the presentation of the research findings which includes an explanation of participant response rates, a description of the characteristics of the participants, data screening methods, findings and results of the research questions, and a summary. Chapter 5 includes the summary, conclusions, implications, and recommendations for further research.

Chapter 2

Review of the Related Literature

The purpose of this study was to investigate the relationship between statistics self-efficacy, statistics anxiety, and performance in an introductory graduate statistics course. The parts of this chapter include a review of social cognitive theory, academic and statistics self-efficacy, current research in self-efficacy, goal orientation, researcher preparation, statistics anxiety, and summary.

Social Cognitive Theory

Self-efficacy and human agency are components of social cognitive theory. Social cognitive theory also includes two causal components: “the development of competencies and the regulation of action” (Bandura, 1997, p. 34). Bishop and Bieschke (1998) studied the development of research interests using social cognitive theory. They suggest that, based on a model of social cognitive theory, students will engage in research based on their perceptions of the rewards or punishments for engaging in such research activities. Shivy, Worthington, Wallis, and Hogan (2003) state that when students conduct research they may feel rewarded or punished depending on their experiences.

According to Pajares (2002), the classes of determinants (behavioral, personal, and environmental factors) are the foundations of social cognitive theory. Pajares believes that the behavioral factors influence the personal

factors and the environmental factors. Each influences and shapes the others.

Pajares writes:

Human functioning is viewed as the product of a dynamic interplay of personal, behavioral, and environmental influences. For example, how people interpret the results of their own behavior informs and alters their environments and the personal factors they possess which, in turn, inform and alter subsequent behavior. This is the foundation of Bandura's (1986) conception of reciprocal determinism, the view that (a) personal factors in the form of cognition, affect, and biological events, (b) behavior, and (c) environmental influences create interactions that result in a triadic reciprocity. (2002, p. 1)

Graduate students work to develop the knowledge and skills to become producers of original research. In the pursuit of this goal, students exert some control over how they learn. Their beliefs in their ability to learn are related to their past educational experiences, their support systems, and their ability to persevere in challenging situations such as graduate study. These belief systems are a part of what Bandura (1997) calls human agency. Human agency is defined as a person's ability to carry out a course of action intentionally.

According to Bandura (1997),

effects are not the characteristics of agentive acts; they are the consequences of them (and) . . . the power to originate actions for given purposes is the key feature of personal agency. . . Beliefs of personal efficacy constitute the key factor of human agency. (1997, p. 3)

Self-Efficacy. Self-efficacy is defined as a person's level of confidence in his ability to perform specific tasks under specific conditions or situations.

Personal beliefs of performance precede outcomes (Bandura, 1997). Bandura states that "the outcomes people anticipate depend largely on their judgments of how well they will be able to perform in given situations" (p. 23). Prior

experiences, personal beliefs, and vicarious experiences are all influential in a person's development of personal self-efficacy.

The causal relationship between beliefs of personal self-efficacy and outcome expectations was previously discussed (Bandura, 1997). "By influencing the choice of activities and the motivational level, beliefs of personal efficacy make an important contribution to the acquisition of the knowledge structures on which skills are founded" (Bandura, 1997, p. 35). Bandura postulates that perceived self-efficacy is concerned with an individual's judgment of his ability to achieve a desired level of performance. Bandura (1997) states that performance expectations (outcomes) are affected by the important part self-efficacy plays in social cognitive theory.

There are three levels of self-efficacy (SE) generality assessment. At the most basic level, SE is measured "for a particular performance under a specific set of conditions" (Bandura, 1997, p. 49). At the second highest level, SE is measured "for a class of performances within the same activity domain under a class of conditions sharing common properties" (Bandura, 1997, p. 49). And at the highest level (or global level), measures of perceived SE are taken "without specifying the activities or the conditions under which they must be performed" (Bandura, 1997, p. 49). Bandura (1997) states that "the optimal level of generality at which self-efficacy is assessed varies depending on what one seeks to predict and the degree of foreknowledge of the situational demands" (p. 49). The current study will be assessed at the specific or basic level of SE: statistics tasks under a specific set of conditions.

Motivational Force and Expectancy Theory. Scholl (2002b) defines

motivation as the force that:

Energies Behavior--What initiates a behavior, behavioral patterns, or changes in behavior? What determines the level of effort and how hard a person works? This aspect of motivation deals with the question of "What motivates people? (para. 2)

Directs Behavior--What determines which behaviors an individual chooses? This aspect of motivation deals with the question of choice and conflict among competing behavioral alternatives. (para. 3)

Sustains Behavior--What determines an individual's level of persistence with respect to behavioral patterns? This aspect of motivation deals with how behavior is sustained and stopped. (para. 4)

Motivational force and expectancy theory are influenced by personal self-efficacy (Scholl, 2002b). According to Bandura (1997), self-efficacy beliefs "affect the nature and intensity of emotional experiences: through the exercise of personal control over thought, action, and affect" (p. 137).

Bandura (1997) states:

The thought-oriented mode in the regulation of affective states takes two forms. Efficacy beliefs create attentional biases and influence whether life events are construed, cognitively represented, and retrieved in ways that are benign or emotionally perturbing. The second form of influence centers on perceived cognitive abilities to control perturbing trains of thoughts when they intrude on the flow of consciousness. In the action-oriented mode of influence, efficacy beliefs regulate emotional states by supporting effective courses of action to transform the environment in ways that alter its emotive potential. The affect-oriented mode of influence involves perceived efficacy to ameliorate aversive emotional states once they are aroused. (p. 137)

According to Scholl (2002a), certain situations cause individuals to experience emotional states or reactions. Scholl continues "Emotional reactions are in reality, physiological states (e.g., changes in blood pressure, heart rate,

chemical secretions) that we feel under certain situations” (2002a, para. 2).

These reactions under certain situations influence individual beliefs about the ability to complete certain tasks and/or achieve specific goals. And these task choices are further influenced by the expectancy-value individuals place on effort to achieve these chosen tasks and goals (Scholl, 2002a).

Expectancy theory describes how individuals make choices based on various behavioral options. Expectancy theory postulates that personal beliefs about one’s ability to achieve specific desirable outcomes can increase the motivation to perform particular tasks or activities (Bandura, 1997). Motivational force is the mechanism to achieve desired outcomes and expectancy-value theory is a component of motivational force.

Scholl (2002b) states that there are three components of motivational force. Expectancy theory is one component. The other two components are instrumentality and valance. Instrumentality is the belief by the performer that high performance will lead to a desired outcome. Valance is an individual’s belief in the value of a desired outcome. If individuals believe the reward to be great, they will invest more effort in the performance and goal achievement.

Expectancy theory is the belief that an individual’s effort will lead to good performance. Self-efficacy, goal difficulty, and perceived control all influence the individual’s expectancy beliefs and goal performance (Scholl, 2002b).

Bandura asserts:

In expectancy-value theory, motivation is regulated by the expectation that a given course of behavior will produce certain outcomes and the value placed on those outcomes. But people act on their beliefs about what they can do as well as on their beliefs about the likely outcomes of

performance. The motivating influence of outcome expectancies is thus partly governed by efficacy beliefs. There are countless attractive options people do not pursue because they judge they lack the capabilities for them. The predictiveness of expectancy–value theory is substantially enhanced by including the influence of perceived self-efficacy. (Ajzen & Madden, 1986; deVries, Dijkstra, & Kuhlman, 1988; Dzewaltowski, Noble, & Shaw, 1990; Schwarzer, 1992). (Bandura, 1995, p. 7)

Academic and Statistics Self-Efficacy

Self-efficacy can be measured at the global level, the domain level, or the task-specific level (Bandura, 1997; Finney & Schraw, 2003; Lent, Brown, & Gore, 1997). Measures of academic self-efficacy would be considered a global measure. Some researchers have suggested that self-efficacy, in general, and different levels of self-efficacy measures, can be hypothesized to exist in a hierarchical relationship where a person's self-efficacy beliefs move from the general to the more specific task levels within similar domains (Bandura, 1997; Lent, Brown, & Gore, 1997). As individuals begin to believe that they are capable of completing a specific task at the desired level of performance, it is then possible for them to transfer those personal self-efficacy beliefs to more global self-efficacy contexts (Bandura, 1997).

Statistics self-efficacy measures were reported by Finney and Schraw (2003). Statistics self-efficacy is defined as individuals' confidence in their ability to complete specific statistics-related tasks. Prior to the Finney and Schraw study, the closest self-efficacy research related to statistics were measures of math self-efficacy. Bandura (1997), Pajares (2002), and Schunk and Pajares (2002) state that in order to better predict performance, measures of self-efficacy should be task specific and directly related to the domain of interest. Finney and

Schraw (2003) state that measures of math SE (or confidence in one's ability to complete math problems) were found to be better predictor's "in problem solving performance than confidence to succeed in math related courses or to perform math related tasks" (2003, p. 162). They also state that:

Along the same lines, confidence to receive an "A" or "B" in a math-related course was the best predictor of math-related major. While the particularized measure of self-efficacy was the best predictor of the corresponding task, it was also found that each measure of math self-efficacy was related to both criterion measures. This implies that domain-general self-efficacy is somewhat generalizable to specific tasks within that domain; however, the closer the correspondence between the task and self-efficacy assessment, the better the prediction of performance on the task. (Finney & Schraw, 2003, p. 163)

Although statistics self-efficacy shares some of the same domain characteristics as math self-efficacy, the two are different enough to be considered two separate constructs since they are very different at the task level. Finney and Schraw (2003) state "Task-specific self-efficacy judgments should be better predictors of performance than domain-specific judgments, which in turn, should be better predictors than domain-related judgments (e.g., learning mathematics)" (p. 162).

Current Research in Self-Efficacy

Personal self-efficacy has been studied in many different domains. Some of the domains have included mathematics self-efficacy, research skills self-efficacy, statistics self-efficacy, and general academic self-efficacy to name a few.

See Appendix A for a synopsis of the instruments related to self-efficacy mentioned throughout this chapter. The data in this chart include the constructs

and the validity and reliability reported by the instrument developers, as well as other explanatory information.

Self-efficacy research, related to academic or researcher skills, has been studied by various scholars (Bong, 1998; Finney & Schraw, 2003; Forester, Kahn & Hesson-McInnis, 2004; Holden, Barker, Meenaghan, & Rosenberg, 1999; Schunk & Pajares, 2002; Silver, Smith, & Greene, 2001). In the past 10 years, numerous researchers have attempted to identify and define the construct of research self-efficacy. According to Forester et al. (2004), “research self-efficacy may be defined as one’s confidence in successfully performing tasks associated with conducting research (e.g., performing a literature review or analyzing data)” (p. 4).

Forester et al. (2004) conducted confirmatory factor analysis of three measures of research self-efficacy: the Research Self-Efficacy Scale (originally created by Greeley, Johnson, Seem, Braver, Dias, & Evans in 1989) (Holden, Barker, Meenaghan, & Rosenberg, 1999) and later adapted by Bieschke, Bishop, and Garcia (1996); the Self-Efficacy in Research Measure by Phillips and Russell (1994); and the Research Attitudes Measure developed by O’Brien, Malone, Schmidt, and Lucas (1998).

In addition, two other scales were also developed. The Research Training Environment Scale created by Gelso, Mallinckrodt, and Judge (1996) and the Research Self-Efficacy scale created by Holden et al. (1999).

Of the many scales created to measure research self-efficacy, the Research Self-Efficacy Scale, the Research Training Environment Scale, and the

Research Attitudes Measure were designed to measure the research self-efficacy beliefs of graduate science students. Whereas the Self-Efficacy in Research Measure and the Research Self-Efficacy Scale were designed to measure the research self-efficacy beliefs of counseling psychology graduate students. No research studies specifically assessing the statistics self-efficacy beliefs of doctoral students enrolled in Colleges of Education could be found.

Statistics self-efficacy measures are few. Only two instruments, Current Statistics Self-Efficacy (CSSE) and Self-Efficacy to Learn Statistics (SELS), have been developed (Finney & Schraw, 2003). The CSSE (current SE measure) and the SELS (future SE measure) instruments measure the relationships between statistics self-efficacy and statistics performance and the increase of statistics self-efficacy at the end of an introductory statistics course for groups of undergraduate students. In Finney and Schraw, the CSSE (current SE measure) and SELS (future SE measure) instruments were compared to:

- general test anxiety (Test Anxiety Inventory),
- statistics test anxiety (Survey of Attitudes Toward Statistics),
- Mathematics Self-Efficacy Scale-Revised, and
- statistics performance measures.

The construct of self-efficacy is more accurate at predicting outcomes when it is specific in its measurement. It is therefore necessary to differentiate between the more global construct of academic self-efficacy and the more specific constructs such as research self-efficacy and statistics self-efficacy (Bandura, 1997).

Academic self-efficacy was defined by Wood and Locke (1987) as the ability to complete specific tasks in certain sub domains of functioning. Wood and Locke (1987) “classified academic self-efficacy into seven task domains, memorization, exam concentration, understanding, class concentration, discriminating concept, expanding concepts, and note-taking” (p. 2). Owen and Froman (1988) developed the College Academic Self-Efficacy Scale (CASES). According to Choi (2005), the CASES is a “self-report measure of academic self-efficacy designed to measure the degree of confidence of performing typical academic behaviors of college students” (p. 200). In the Choi study, academic self-efficacy was not found to be as powerful a predictor of term grades as the more specific measure of self-efficacy such as the SELS and CSSE scales (Finney & Schraw, 2003).

The instruments previously discussed tap into several domains with similar factors. Appendix A contains the description of the specific instruments and their domains. These domains include research skills, ability to learn statistics, personal self-efficacy beliefs to learn statistics, math self-efficacy, math competence, and the more global domain of academic self-efficacy. Bandura (1997) states that personal self-efficacy beliefs can transfer across domains provided that these domains are similar. In the case of the instruments discussed, each shares similarity of tasks and the skills needed to complete research, statistics, and math-related work, which is a component of research work.

Goal Orientation

Similar to personal self-efficacy beliefs which have some influence on motivation and orientation in task outcomes, student motivation and goal orientation combine to influence the outcomes of a learning task. According to Bandalos, Finney, and Giske (2003), the goals of learning can be bivariate. These orientations encompass both learning and performance goals. Those with an orientation toward learning goals seek knowledge and are therefore less likely to be affected by an imperfect outcome such as a grade lower than an "A." They see their lack of optimal achievement outcomes as the result of their choice of study strategies, for example, and will work harder to improve in this area. Those with a performance goal orientation seek to demonstrate their abilities through higher levels of performance such as earning straight A's.

According to Bell and Kozlowski (2002), students with high levels of learning orientation tend to be able to handle the harmful effects of failure, and therefore, are able to increase or maintain their levels of self-efficacy. Those with a performance goal orientation had reduced or negative levels of self-efficacy because they believe that effort is not synonymous with ability for task mastery and will not expend the effort needed to succeed in difficult or challenging situations. Bell and Kozlowski (2002) believe:

High ability individuals have the capabilities to do well on the difficult aspects of tasks and therefore are expected to experience high levels of self-efficacy. Low ability individuals, on the other hand, can be expected to do very poorly on complex tasks, thereby leading to lower levels of self-efficacy. (p. 7)

Motivation of students is dependent on their goal orientation. Students with performance goal orientation may stop or continue their involvement in a particular course based on how they perceive their performance, or how they are viewed by others. They may disengage from a course they find challenging beyond the performance rewards (recognition, high grades, etc.). Those with learning orientation goals will persevere even when faced with the possibility of lower than expected performance (Bandalos et al., 2003; Bell & Kozlowski, 2002). According to Bandura (1997), a student with high self-efficacy beliefs in one domain will persevere in completing a task or reaching a goal, whereas a student with lower self-efficacy in a particular domain may quit. A student with a learning orientation goal will act similarly.

Researcher Preparation

Researcher skills are a component part of graduate study. Most measurement and psychology departments offer courses that teach graduate students to interpret the statistics results in research articles and how to design experiments that produce sound research models. Almost all graduate programs require that the graduate student complete a basic set of research and statistics courses in preparation for their dissertation work.

Eisenhart and DeHaan (2005), in their article *Doctoral Preparation of Scientifically Based Education Researchers*, state that they oppose a narrow definition of scientifically based research as being strictly experimental. Instead they suggest:

a broader conception of scientifically based researchers as professionals who engage in inquiry to identify or develop defensible explanations or interpretations by following six guiding principles:

1. to pose significant questions that can be investigated empirically;
2. to link research to relevant theory;
3. to use methods that permit direct investigation of the question;
4. to provide an explicit and coherent chain of reasoning;
5. to replicate and generalize across studies; and
6. to make research public to encourage professional scrutiny and critique. (p. 3)

Eisenhart and DeHaan (2005) restate the suggestion of the National Science Foundation and the Institute for Educational Sciences that colleges and universities “train graduate students for scientifically based education research” (p. 3). Eisenhart and DeHaan (2005) emphasize the continued importance of developing research skills in graduate education programs. These skills include quantitative inquiry, sampling schemes, data collection methods, and data analysis. Eisenhart and DeHaan state:

They [graduate students in education programs] must learn how to pose researchable questions, whether requiring quantitative or qualitative methods and data; they must develop strategies for sampling, data collection, and analysis. They must learn ways of reasoning and arguing from evidence, means of assessing quality, styles of writing for technical reports and publishable articles, and ways of scrutinizing and constructively critiquing other’s work. (p. 7)

One major problem when preparing graduate students in education to become researchers is that many of these students have little or no previous research experience. They did not get training as undergraduates, and they may not have had any exposure to training in a master’s program—a program that was preparing them to teach not conduct research (Eisenhart & DeHaan, 2005).

According to Gelso et al. (1996), the ability to create original scholarly work is possible only when educational researchers are given the knowledge and skills necessary to carry out such work. Even the best and brightest of students (these future researchers) struggle with the many concepts and theories that are a part of any researcher's education; and because statistics requires an abundance of various learning strategies called on simultaneously, many students have difficulty utilizing cognitive powers (such as quantitative reasoning) that may not have been their primary mode for learning and processing information (Gelso et al., 1996).

In a study of research training environments, Gelso et al. (1996) measured the factors that affect the production of scholarly research. Their research reviewed Ph.D.-granting clinical, counseling, and school psychology training programs. They found that the research productivity of doctoral students in applied psychology was very low. Although there were other reasons cited for low research productivity such as financial support and lack of socialization in the culture of research, one of the other reasons cited by Gelso et al. (1996) was that students do not feel competent in their research abilities. Gelso and Lent (2000) in the *Handbook of Counseling Psychology* state that "Personal factors including student ambivalence, anxiety, and under confidence, seem to diminish students' enthusiasm for research" (pp. 120-121). Gelso and Lent (2000) state that the best research training environments are those that reduce or eliminate anxiety and uncertainty, and promote scientific discovery.

Without the requisite research skills, environmental support (both financial support and adequate socialization) graduate students in education will continue to struggle to become competent researchers, possibly reducing the number of qualified researchers in the field of education. One approach that may help counteract this trend is to assess the statistics self-efficacy beliefs of graduate students and to apply these findings to the design of required statistics classes in graduate programs of study.

Statistics Anxiety

Cruise, Cash, and Bolton (1985) state that statistics anxiety can be defined as the feelings of anxiety experienced by students when “taking a statistics course or doing statistical analysis” (p. 92). Onwuegbuzie (2003) defines statistics anxiety as “an apprehension that occurs when a student encounters statistics in any form at any level” (p. 1023). Onwuegbuzie (2003) explains that the findings “that expectation predicts statistics achievement suggests that a self-fulfilling prophecy prevails, in which students who have low expectations of their statistics ability exhibit behavior that may lead to underachievement” (p. 1033).

Bandura (1995) believes that when individual coping efficacy is raised to different levels through guided mastery treatment, individuals exhibit little anxiety and autonomic arousal to threats they believe they can control. He also writes that “after the perceived coping efficacy is raised to the maximal level by guided mastery experiences, they manage the same threats without experiencing any distress, autonomic arousal, or activation of stress-related hormones” (p. 9).

According to Bandura (1995), the stronger a person's sense of efficacy, the more likely they are to take on situations that produce stress and to produce outcomes that are favorable to them.

Onwuegbuzie's (2003) *anxiety expectation mediation* (AEM) model demonstrates that social cognitive theory and self-efficacy are "pertinent to the processes underlying the learning of statistics because expectation is a manifestation of self-efficacy" (p. 1033). The AEM was first used in studies of library anxiety. The AEM model is based on theories of anxiety and social cognition, which is based on Wine's Cognitive-Attentional Interference theory. This theory postulates that anxiety produces cognitive interference by causing a shift from task-relevant thoughts to task-irrelevant thoughts (Onwuegbuzie & Jiao, 2004).

Summary

Personal self-efficacy beliefs are based on Social Cognitive Theory. The foundations of Social Cognitive Theory are behavioral, personal, and environmental factors (Pajares, 2002). Self-efficacy influences an individual's persistence and effort when engaged in the completion of specific tasks. Personal self-efficacy beliefs are influenced by the environment in which the individual find themselves, their previous experience with similar tasks, and vicarious experiences.

The number of published studies of the construct of personal self-efficacy beliefs has increased greatly in the last decade. The domains being measured include researcher skills and task completion in graduate science and counseling

psychology, and in dissertation completion. While these domains are different than those found in educational research, the tasks and skills required at specific levels of self-efficacy beliefs related to statistics self-efficacy are similar. In other words, when the skills are similar across domains they can inform personal self-efficacy theory in graduate programs in colleges of education. These domains in other disciplines provide the starting point for statistics self-efficacy research within the field of graduate education and educational researcher preparation.

Chapter 3

Methods

The purpose of this study was to investigate the relationship between statistics self-efficacy, statistics anxiety, and performance in an introductory graduate statistics course. The sections of this chapter include the research design, population and sample, instrumentation, data collection, and data analysis.

Research Design

A research design was developed to compare personal levels of statistics self-efficacy (self-efficacy to learn statistics and current statistics self-efficacy), statistics anxiety, and course performance (defined as the average of the combined midterm and final exam scores) in a graduate introductory statistics course. The study design was a correlation analysis comparing the two self-efficacy measures with each other and with the statistics anxiety measure and with the course performance measure.

A set of demographic questions were included to allow the participants to indicate their age group, gender, and race/ethnicity. It also provided space for the participants to identify prior statistics course experiences as well as degrees previously earned and the individual's current degree program. This key descriptive data was requested in order to provide an accurate representation of the sample.

Population and Sample

The population of interest was graduate students enrolled in graduate introductory statistics courses in the College of Education at a doctoral-degree granting, large metropolitan university with very high research activity in the southeastern U.S. (Carnegie, 2011). According to this University's website, the median age of students in the College of Education graduate programs was 34 years old; 78% of graduate students were female and 22% were male. At the graduate level, 6.7% of the students were African American, 5.2% were Hispanic, with a total graduate minority population of 13.8%. The average GRE (Graduate Record Exam) scores (Verbal and Quantitative) were 993.

Sample Selection. According to the Cohen's (1988) power tables on sample size estimation, a sample size sufficient to determine a difference between the sample and the population of interest is best satisfied when estimates of effect size and power are set and tested so that the sample size is not too small to determine an effect or so large that the researcher wastes time and resources unnecessarily. Cohen (1988) suggested that effect size can be set at the small, medium, and large levels. The size chosen by the researcher depends on how much Type 1 or Type 2 error risk is acceptable. Type 1 and 2 errors are balanced against the desired goals of the researcher and the research design (Cohen, 1988, 1992).

Based on Cohen's (1988) power tables, the chance of correctly rejecting the null hypothesis in a two-tailed test is improved when the significance of a product moment r with a .05 (alpha) significance criterion and a medium effect

size of .30 and a power of 82 can be established with a minimum sample size of 88. Although 108 instrument packages were distributed, the actual number of participants remaining was 88, which coincidentally was the minimum number of respondents required. The difference of 20 consisted of 8 students who dropped the course before the final exam, 2 students who did not sign the informed consent, and 10 students who submitted incomplete surveys. These last 12 students were classified as “non-usable” participants.

The sample included graduate students (both masters degree-seeking and doctoral degree-seeking) enrolled in graduate introductory statistics courses during two semesters. In this study, data collection began in the fall semester of 2009 and continued through the spring semester of 2010. The sample participants were obtained from College of Education graduate students enrolled in EDF 6407 Statistical Analysis for Educational Research I. Four sections were offered during this time period. Three sections during fall 2009 included two traditional classroom courses and one on-line course. During spring 2010, one traditional classroom course was offered.

Instrumentation

The instrumentation for this research study consisted of a demographic questionnaire, two self-efficacy measures, one anxiety measure, and course performance measures. To collect the information needed for this study, four of the instruments were combined into one package (instrument packet) for administration to students.

The four instruments that were combined for ease of administration in gathering data are:

- a demographic questionnaire;
- the Computational Self-Concept Subscale of the STARS;
- the Current Statistics Self-Efficacy (CSSE) scale; and,
- the Self-Efficacy to Learn Statistics (SELS) scale.

Each of these instruments is discussed below.

Demographic Questionnaire. The demographic questionnaire was developed by the researcher to gather information about individual students involved in this study. Items were chosen to obtain a demographic characteristics profile of the participants as a means of describing the sample. The questions included information related to age group, gender, race/ethnicity, degree program, and prior statistics experience. See Appendix B for a copy of the demographic questionnaire.

Statistical Anxiety Rating Scale (STARS). The Statistics Anxiety Rating Scale (STARS) was developed by Cruise and Wilkins (1980). The STARS was 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. The final form of the instrument consisted of 51 items and six factors, which were Worth of Statistics, Interpretation Anxiety, Test and Class Anxiety, Computation Self-Concept, Fear of Asking for Help, and Fear of Statistics Teachers. See Appendix C for a copy of the complete STARS instrument.

The first factor, *Worth of Statistics*, is described by the authors as the individual student's perceptions of the worth of statistics. The second factor, *Interpretation Anxiety*, is described as the anxiety experienced by a student when they are required to interpret data or make a decision based on the data. The third factor, *Test and Class Anxiety*, is described as the anxiety experienced when taking a statistics course or test. The fourth factor, **Computational Self-Concept**, is described as anxiety experienced when solving mathematics problems and the student's perceptions of their ability to understand and calculate statistics. The fifth factor, *Fear of Asking for Help*, is described as the anxiety experienced when asking for help from a professor or student. The sixth factor, *Fear of Statistics Teachers*, is described as the student's perception of their statistics teacher. A high score on any one of the factors is interpreted as a high anxiety level within that construct (Cruise, Cash, & Bolton, 1985).

The instrument consists of two parts. The first part includes 23 items (or situations) related to statistics anxiety. Item responses are scored on a Likert-type scale from 1 to 5. A score of 1 indicates no anxiety and a score of 5 indicates high anxiety. The second part includes 28 items "dealing with or related to statistics" (p. 92). Items are scored on a Likert-type scale from 1 to 5. A score of 1 indicates strong disagreement with the statement and a score of 5 indicates strong agreement with the statement.

Computation Self-Concept Subscale of the STARS. The fourth factor, *Computational Self-Concept*, has been used by various researchers to assess statistics anxiety (Cruise & Wilkins, 1980; Onwuegbuzie, 2003). According to

Onwuegbuzie (2003) “a high score on this [computational self-concept] subscale represents high anxiety associated with poor computation self-concept” (p. 1027). Singular use of the computation self-concept subscale was justified because many introductory statistics courses require that students calculate statistics by hand in order to develop a better understanding of the underlying theory before they move on to using a statistical software package to solve statistical problems. See Appendix D for a copy of the specific items contained in the Computation Self-Concept Subscale of the STARS (statistics anxiety measure).

Onwuegbuzie (2003) justifies the use of this subscale as appropriate to assess anxiety by explaining that

scores on this subscale were found by Onwuegbuzie, Slate, et al. (2000), alongside students’ levels of achievement expectation, to be the best predictor of overall success in research methodology courses—explaining 12.2% of the variance in achievement. (p. 1027)

Onwuegbuzie (2003) reported the alpha reliability for the sample data of 130 graduate students on the computation self-concept subscale at .86.

The CSCS (statistics anxiety measure) consists of seven items. Scores on the scale range from a low of 7 to a maximum of 35 on this scale. According to the authors, the subscale measures the level of anxiety

experienced [by students] 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. (Cruise, Cash, & Bolton, 1985, p. 93)

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. 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. 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.

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. Specifically related to the CSCS, Onwuegbuzie (2003) found an alpha reliability of .86 for the CSCS of the STARS in his study.

Administration. Cruise and Wilkins (1980) explained that there are no special qualifications needed to administer the instrument. The instrument can be given individually or in groups. The authors suggest that even though the directions are self explanatory, the instructions for taking the instrument should be read aloud and any student's questions answered at that time. The authors also 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. The CSCS (statistics anxiety measure) should take no more than 5 minutes to complete.

Current Statistics Self-Efficacy (CSSE) and Self-Efficacy to Learn Statistics (SELS). The CSSE (current SE measure) and the SELS (future SE measure) were developed in 2003 to assess the growth in statistics self-efficacy beliefs of undergraduates enrolled in a semester-long introductory statistics course. A copy of the CSSE (current SE measure) is provided in Appendix E, while a copy of the SELS (future SE measure) is provided in Appendix F. These instruments are statistics specific (domain and task specific) and were chosen to assess the changes in statistics self-efficacy for graduate students in an introductory graduate statistics course. These were the only two statistics specific self-efficacy scales available in the literature.

According to Finney and Schraw (2003), items for the SELS (future SE measure) and CSSE (current SE measure) scales were developed by reviewing various introductory statistics textbooks and course syllabi. The items were then

reviewed by 13 introductory statistics instructors. The instructors were asked to review an initial set of 10 items to see if the items should be modified or deleted and also to determine seven common goals students are required to achieve at the end of an introductory statistics course.

After agreement on the common goals by all the instructors, additional items were written to represent the common goals identified by the instructors. The original 10 items along with 4 new items comprised the final versions of CSSE (current SE measure) and SELS (future SE measure). The primary difference between the two scales is in the instructions for completing the scales. The SELS (future SE measure) asks students to rate their current self-efficacy belief in their ability to learn statistics, whereas the CSSE (current SE measure) asks students to rate their confidence in their current ability to complete specific statistics tasks.

The SELS (future SE measure) and CSSE (current SE measure) use a 6-point scale from 1 (no confidence at all) to 6 (complete confidence). All items were designed to represent particular statistical concepts introductory statistics students would experience. The choice to use both these instruments was directly influenced by the smaller number of items per instrument to help prevent participant fatigue (Finney & Schraw, 2003).

Validity. Factor analysis was conducted separately for the first and second administrations of the CSSE (current SE measure) and SELS (future SE measure). A single factor solution was determined for both the CSSE (current SE measure) and SELS (future SE measure). The CSSE (current SE measure)

one-factor solution accounted for 44.53% of the variance ($N = 138$). Other identified CSSE (current SE measure) factors accounted for less than 10% of the variance and had eigenvalues less than 1.00. The SELS (future SE measure) one-factor solution accounted for 73.71% of the variance ($N = 140$).

The CSSE (current SE measure) and SELS (future SE measure) were reported by Finney and Schraw (2003) as demonstrating preliminary evidence of validity. According to the authors, “both measures had predictable relationships with performance” (p. 179). Finney and Schraw discussed self-efficacy and achievement.

Specifically, current statistics self-efficacy at the end of the course had relationships in the $r = .40$ - $.50$ range with achievement as predicted based on previous findings (Bandura, 1997; Pajares, 1996b, 1997; Zimmerman & Bandura, 1994). While the SELS did have positive relationships with achievement, the relationships were lower than predicted. Schunk (1989, 1991) found that self-efficacy to learn tended to have relationships in the range of $r = .33$ -.42 with achievement. The correlations found in the current study are weaker than the lower bound. Further study of the relationship between achievement and the SELS is needed in order to establish its predictive utility.

Findings that current statistics self-efficacy at the end of the semester had moderate (.441 and .496) relationships with the performance task score and course percentage is extremely important given that two recent studies examining self-efficacy for statistics failed to report a significant positive relationship between self-efficacy and achievement. (Bandalos et al., 1995; Benson, 1989). (Finney & Schraw, 2003, pp. 179 -180)

Reliability. Cronbach’s (1951) coefficient alpha for the CSSE (current SE measure) for the first administration was .907 ($N = 138$), and .935 ($N = 130$) for the second administration, and item-total correlations for all 14 items were above .53. The coefficient alpha for the SELS (future SE measure) was equal to .975 ($N = 140$) and item-total correlations were above .77 for all 14 items.

Administration. The only difference between the two self-efficacy instruments is in the directions for completing each instrument. The instructions for administering the CSSE (current SE measure) assessed the participants' confidence in their current ability to successfully complete the identified tasks. The item scale has six possible responses: 1 equals no confidence at all, 2 equals a little confidence, 3 equals a fair amount of confidence, 4 equals much confidence, 5 equals very much confidence, and 6 equals complete confidence. On the other hand, the instructions for administering the SELS (future SE measure) assessed the participants' confidence in learning the skills necessary while they were in the class to successfully complete the tasks that followed. The item response scale was identical to that used in the CSSE (current SE measure) as described above.

Instrument Development Process. According to Finney and Schraw (2003), the CSSE (current SE measure) and SELS (future SE measure) items were initially developed by reading several introductory statistics textbooks. Thirteen instructors who taught introductory statistics were contacted and asked to review a first set of 10 items written by the researcher (Finney). Each instructor reviewed the items and was asked to add or remove items that they felt were missing or were not appropriate. Each instructor was also asked to identify seven fundamental course goals. Goals were combined to incorporate similarity among instructors. New items were written to represent all goals. The first 10 items and the newly written items were combined. The final number of items was 14 for the statistics self-efficacy instruments.

Course Performance Measures. The dependent variable, class performance measure, was calculated by combining the midterm and final exam scores and dividing by two to obtain an average. A performance measurement score was calculated for each student in each class section.

Validity. Validity of the midterm and final exams was verified by the instructors of each section. All of the faculty teaching the statistics courses stated that a student could attend one instructor's class and take the exam in a different instructor's class and pass either instructor's exam. The instructors stated that the test items and the course content were very similar even though the instructors wrote their own exams and no two exams were identical. Also the scoring of the exams and the percentage of each exam as part of the final grade were identical. Therefore, combining the exam scores from the three instructors was appropriate.

Exam scores for both the midterm and final test could range from 0-100 points. In the context of the course grading, each exam counted for 30% of the final course grade. In addition, there were two collectible individual projects, one research group project, and various weekly activities included in determining the final course grade that were not part of the performance measure used in this study.

Reliability. The reliability measures for each course section were as follows. For Sections 1 and 2, the midterm and final scores correlated to .65, and when the midterm and final were treated as two items going into a score, the internal consistency based on these two items was .77 (course instructor,

personal communication, January 11, 2010). Section 3 (online) was .68 for the midterm and .79 for the final exam (course instructor, personal communication, December 16, 2009). Section 4 demonstrated a reliability of .76 for the midterm and .80 for the final exam (course instructor, personal communication, May 22, 2010).

Administration. Whether participants were in the traditional classroom sections or the on-line section, the exam procedures for both the midterm and the final test were similar. The midterm and final exam procedures for each exam included two parts. One part utilized a take-home computational set of test items and the second was an in-seat multiple choice exam. The take-home test required each student to complete computational problems using a statistics software package such as SAS or SPSS. This part of the exam counted as 50 points, or half of the overall score.

The in-seat portion of the exam required students to complete multiple choice items. This part of the exam also counted for half of the overall score and was administered during class time for the traditional classes and in a statistics computer lab for the on-line class.

Each individual student's score for the take-home and in-seat exams were combined which resulted in a total exam score for midterm and final exam. The scores used to compute the performance measures for this study were drawn from the addition of the midterm and final exam scores. These two scores were then divided by two to get the average which was the performance measure for each student.

Course Section Comparison. There were four introductory graduate-level statistics class sections in this study. Sections 1, 2, and 4 were traditional classroom courses and Section 3 was an on-line course.

One instructor taught two sections (Sections 1 and 2) in the traditional classroom format in the fall semester of 2009. A third section (Section 3) was taught online in the fall semester of 2009 and was facilitated by a different instructor. The fourth section (Section 4) was taught in traditional classroom format and was taught in the spring of 2010 by a third instructor. The data for Sections 1, 2, and 3 were collected in the fall semester of 2009. The data for Section 4 were collected in the spring semester of 2010.

Data Collection

The data for this study were collected in several phases depending on whether the class was a traditional classroom course or an on-line course. The first phase consisted of distribution of data collection and research items to students in each class. The second phase consisted of obtaining the midterm and final exams from each of the instructors. In the traditional classroom courses (Sections 1, 2, and 4), the combined instruments were given to each introductory statistics course during the first week of the semester. Participants were given the informed consent form requesting their participation in the study which included requesting their permission to obtain their midterm and final exam scores from their instructors. They were informed that their scores would be kept confidential and that no personal information including name would be published in the research study, thus ensuring anonymity.

Each student received an instrument packet inserted into an envelope which included the informed consent, the CSCS (statistics anxiety measure), the CSSE (current SE measure), the SELS (future SE measure), the demographic questionnaire, and a three-by-five index card with a unique ID number. The unique ID number was used so that the instrument packet could be matched to each participant using the number as the common link to ensure anonymity in data reporting. These packets were distributed at the beginning of the class during the first week of the semester. Prior to distribution of the packets to students, the instructor introduced the researcher to the students. Subsequently the researcher read the instructions for completing the instruments and stated the importance of the research study. The words “current ability” and “learning” were emphasized so that participants were able to distinguish between the CSSE (current SE measure) and SELS (future SE measure) respectively. Students were informed that they did not have to participate and that they would not be penalized for non participation. Completion rates by section were: S1 = 100%, S2 = 100%, S3 = 42%, and S4 = 100%. The students were given the instruments just prior to the class break and completed them during the class break.

All packets were returned in closed envelopes and were collected by the researcher for analysis. The researcher did not know who participated and who did not until after the data were collected, the instruments were checked for completion, and the informed consent was verified as signed.

Section 3 was also taught in the fall of 2009; however, Section 3 was unique in that it was the on-line statistics course. The instruments and the informed consent form were uploaded to the course Blackboard site for distribution to the students. The researcher did not have control over when the instruments were completed and did not have the opportunity to distribute the instruments in person. The administration was handled by the course instructor. The instruments and informed consent forms of those students who participated were returned to the researcher by the course instructor. Because no unique ID was assigned to this group of on-line students, the researcher assigned these ID numbers after the instruments were returned.

Time Line for Data Collection. The time line involved in collecting data for this study extended over two semesters. Data collection began in the fall of 2009 and concluded in the spring of 2010. For all traditional classroom sections, the researcher distributed the instrument packets at the beginning of the class during the first week of the semester. The on-line class received the instruments, consent form, demographic questionnaire, and a letter of explanation of the study purpose from the information posted online on the Blackboard site.

Data Analysis

After all the data from the students and the instructors were obtained, the researcher analyzed the results. The researcher then matched and verified all pieces of information and data for each person's unique ID.

To allow for accurate and reliable judgments of significance given a set sample size, a power analysis was conducted to detect the possibility of Type I

and Type II error. High (2000) suggests that a power analysis is “the ability of a test to detect an effect, given that the effect actually exists” (p. 1). According to High (2000), in an exploratory study, a significance level of .10 is considered adequate probability of detecting a Type 1 error. The power to detect an effect or Type 2 error is commonly set at .80. In some studies, these numbers have been set lower and still were considered significant.

For this study to reduce the probability of Type 1 and Type 2 error, power was set at the .05 level of significance. Effect size measures were set at .30, a medium effect size. Means and standard deviations were also calculated. Based on Cohen's (1988) power tables, the chance of correctly rejecting the null hypothesis in a two-tailed test is improved when the significance of a product moment r with a .05 (alpha) significance criterion and a medium effect size of .30 and a power (1-beta) of .82 can be determined with a minimum sample size of 88. The resultant final sample size of 88 which matches the minimal sample size suggested by Cohen's (1988) power tables is strictly coincidental.

Score Reliability. Hatcher (1994) and Nunnally (1978) defined the reliability coefficient as the proportion of variance in the observed variable accounted for by true scores on the underlying construct. Nunnally (1978) suggested that instruments used in basic research have a reliability of .70 or greater. A Coefficient Alpha of .70 or greater is considered adequate reliability consistency in social science research and was used as the benchmark in this study. Reliability estimates were calculated for the three instruments (CSCS, CSSE, and SELS).

Analysis by Research Question. The research questions were analyzed in the following ways.

1. What is the relationship between statistics self-efficacy and statistics anxiety?

Correlation analysis was conducted to compare the relationships among instrument results and any trends in the data. A correlation analysis was conducted between the SELS (future SE measure) and statistics anxiety. A correlation analysis was conducted between the CSSE (current SE measure) and Computational Self-Concept subscale (CSCS) of the STARS. Means and standard deviations were calculated to determine the representative score on the SELS (future SE measure) and CSSE (current SE measure) and the CSCS of the STARS (statistics anxiety measure) in the group of scores.

2. What is the relationship between the two statistics self-efficacy instruments and performance in a graduate introductory statistics course?

Multiple regression correlation analysis was conducted to compare the relationships among instrument results and any trends in the data. Correlation analysis was conducted between the SELS (future SE measure) and performance (average combined midterm and final exam scores), and between the CSSE (current SE measure) and performance (average combined midterm and final exam scores). Means and standard deviations were calculated to determine the representative scores on the SELS (future SE measure) and performance (average of combined midterm and final exam scores) and the

CSSE (current SE measure) and performance (average of combined midterm and final exam scores). Analysis of variance (ANOVA) was conducted to test for differences in mean scores and percentage of variation accounted for by each section on the CSSE (current SE measure) and SELS (future SE measure).

3. What is the relationship between statistics anxiety and performance in a graduate introductory statistics course?

Multiple regression correlation analysis was conducted to compare the relationships among instrument results and any trends in the data. A correlation analysis was conducted between the Computational Self-Concept (CSCS) subscale of the STARS and performance (average combined midterm and final exam scores). Means and standard deviations were calculated to determine the representative scores on the CSCS (statistics anxiety measure) and performance (average combined midterm and final exam scores). Analysis of variance was conducted to test for differences in mean scores and percentage of variation accounted for by each section on the CSCS (statistics anxiety measure).

4. What is the relationship between statistics self-efficacy, statistics anxiety, and performance?

Multiple regression correlation analysis was conducted to compare relationships among instrument results and any trends in the data. A correlation analysis was conducted between the CSSE (current SE measure) and Computational Self-Concept subscale (CSCS) of the STARS. Correlation analysis was conducted between the SELS (future SE measure) and performance (average of combined midterm and final exam scores) and CSSE

(current SE measure) and performance (average of combined midterm and final exam scores). A correlation analysis was conducted between the Computational Self-Concept subscale (CSCS) of the STARS and performance (average of combined midterm and final exam scores). Means and standard deviations were calculated to determine the representative score on the SELS (future SE measure) and CSSE (current SE measure) and the Computational Self-Concept subscale (CSCS) of the STARS in the group of scores.

Chapter 4

Results

The purpose of this study was to investigate the relationship between statistics self-efficacy, statistics anxiety, and performance in an introductory graduate statistics course. The parts of this chapter include response rates for participants, demographic characteristics, screening methods, ANOVA results, findings and results of research questions, observations, and summary.

Response Rates for Participants

The total number of students in this study was 108. After removing students who dropped the class or who provided incomplete responses to the instruments, there were 88 participants left for inclusion in the analysis. These participants came from four class sections as enumerated below.

Section 1 was taught in the fall of 2009 and had 29 students enrolled with a completion rate in this study of 100%. Of the original 29 who completed the instruments, one student dropped the course, one unusable set of data was removed by the researcher prior to analysis, and another four sets of incomplete data were eliminated during the analysis, leaving 23 participants as part of the study.

Section 2 was taught in the fall of 2009 and had 41 students enrolled with a completion rate in this study of 100%. Of the original 41, three students

dropped the course and two sets of incomplete data were eliminated during the analysis, leaving 36 participants in the study.

Section 3, taught during fall 2009, was the only on-line course. Although it had 26 students enrolled, only 11 (42%) volunteered to participate in the study. From this number, three unusable sets of data were removed by the researcher prior to analysis and another two sets of incomplete data were subsequently eliminated during the analysis, leaving 6 participants included in the study.

Section 4 was taught in the spring of 2010 and had 27 students enrolled with a completion rate in this study of 100%. Of the original 27, two students dropped the course, one unusable set of data was removed by the researcher prior to analysis, and one set of incomplete data was eliminated during the analysis, leaving 23 participants as part of the study.

The total number of participants from these four sections was 88. This number was the minimum sample size identified by Cohen for a medium effect size as shown in Cohen's power tables (Cohen, 1988). The information from these participants was analyzed by the SAS program (SAS Institute, 2005).

Demographic Characteristics of Participants

Analysis was conducted on 88 master's-level and doctoral-level students enrolled in four introductory graduate statistics classes in a College of Education at a doctoral-granting, large metropolitan university with very high research activity in the southeastern U.S. during the fall 2009 semester and spring 2010. Three sections of the course were taught in a traditional classroom and one section was offered as an online version. Sixty-nine out of a total of 88 students

completed all or part of the demographic questionnaire found in Appendix B. The ages of the participants ranged from 22 to 59 years of age and were classified as shown in Figure 2. The two largest percentages were the 26-30 year olds (20%) and the 31-35 years of age (18%). The smallest categories were the 22-25 year olds (8%) and the 41-49 year olds (9%). About 22% of the participants did not specify their age group. Fifty-one percent of the participants in this study were between the ages of 26 to 40 years.

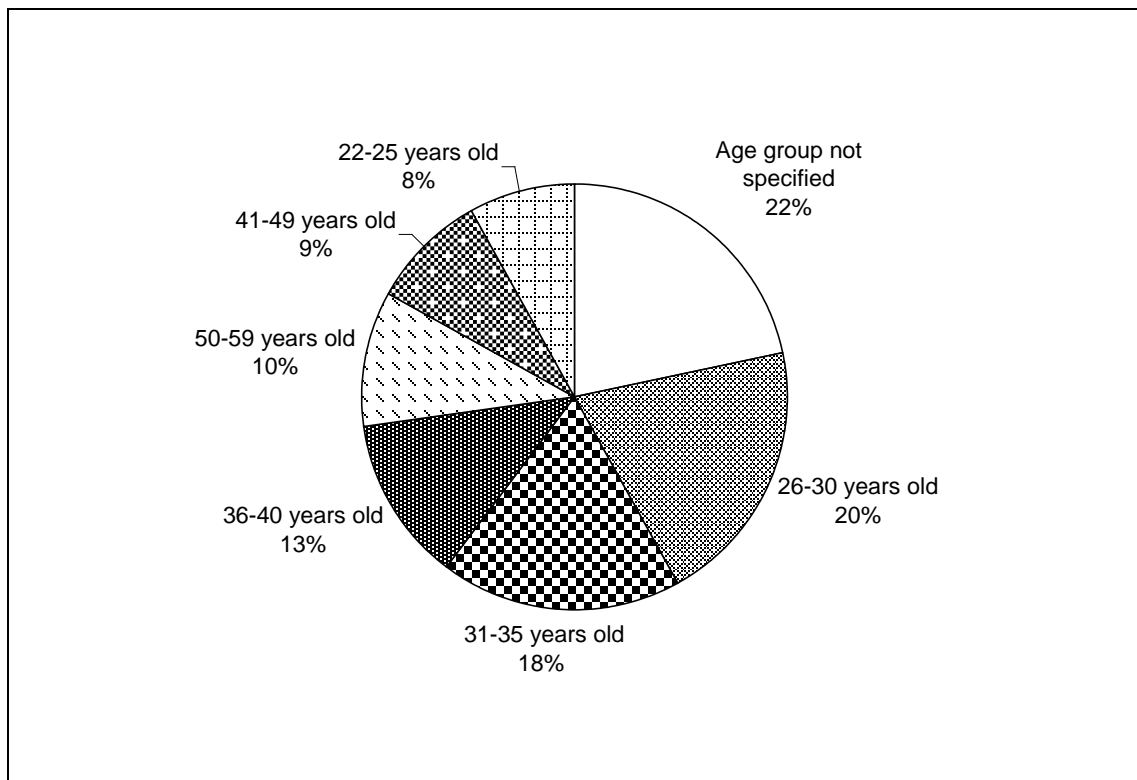


Figure 2. Pie chart of percentages of age groups as reported by participants.

Figure 3 depicts the current degree enrollment of the participants at the time of the study. Eight students (9%) were enrolled as master's degree seeking students, 59 were enrolled as doctoral degree seeking students (67%), two others were identified as "other", and 19 did not specify an answer.

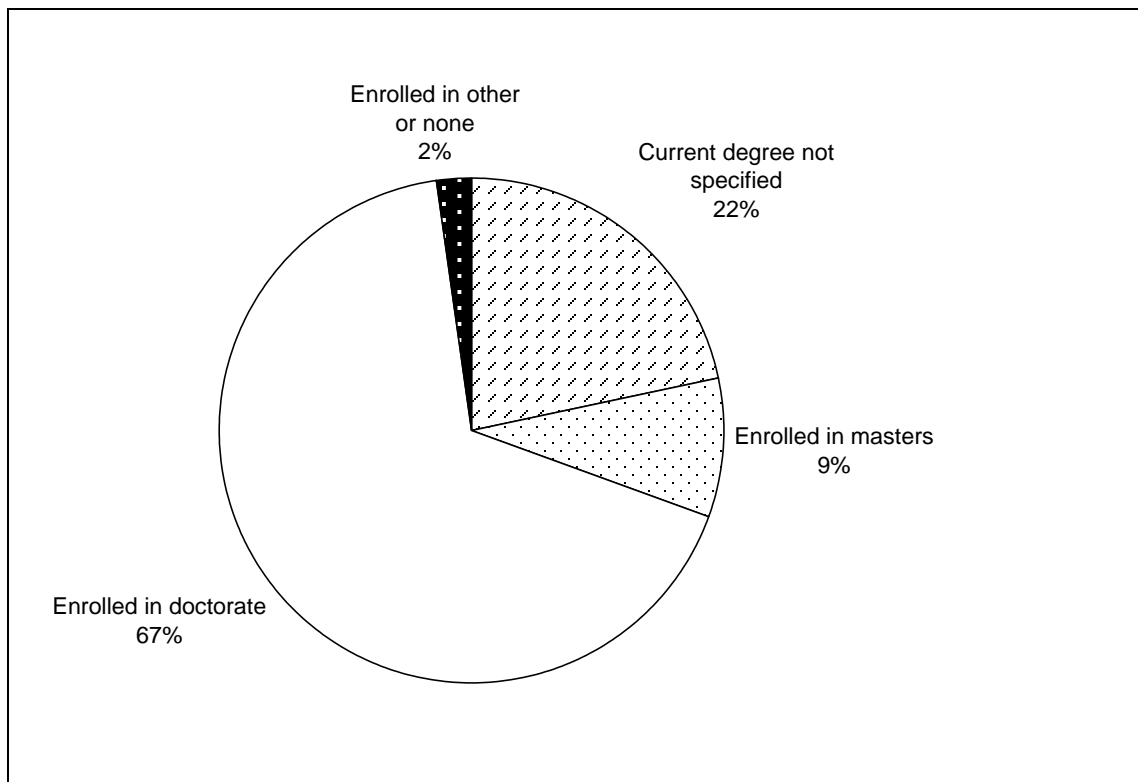


Figure 3. Pie chart of percentages of degree programs in which participants were currently enrolled.

The earned academic degrees of participants are shown in Figure 4. Prior to enrolling in the graduate introductory statistics classes, 10 participants had received a bachelor's degree, 58 had received a master's degree, and 1 reported

receiving a doctoral or professional degree. There were an additional 19 who did not specify their degree program.

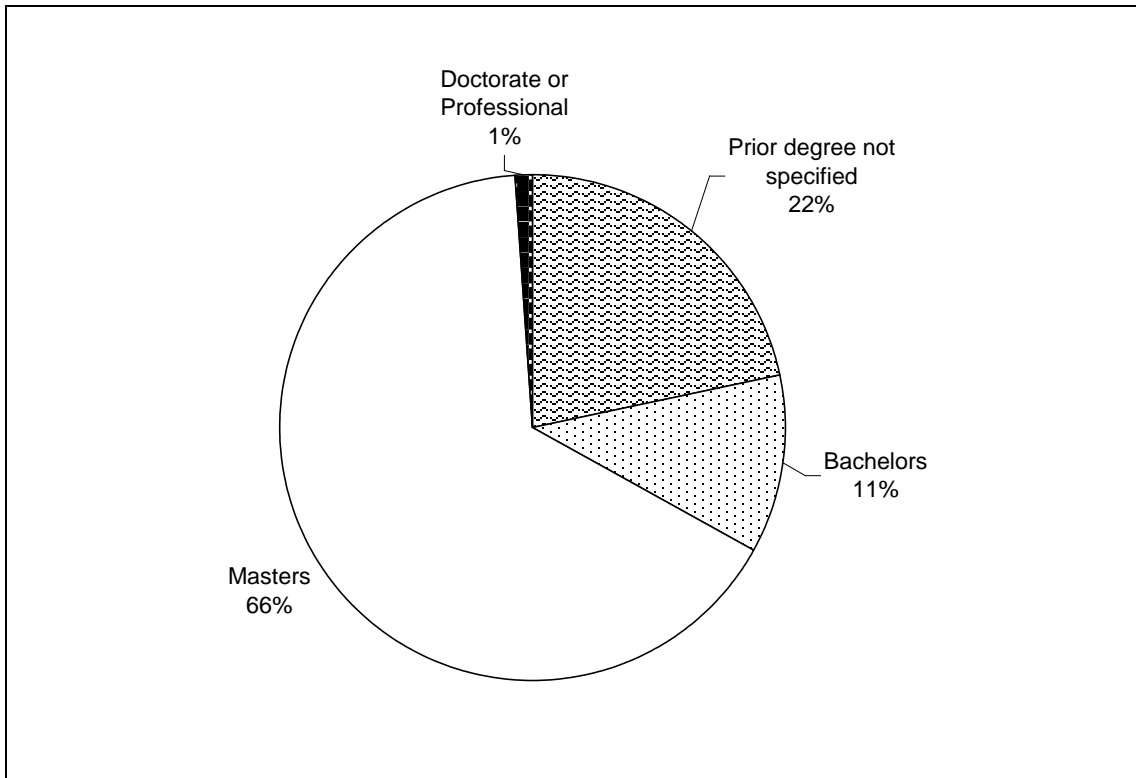


Figure 4. Pie chart of percentage of earned degrees as reported by participants.

Forty-five participants reported that they had previously taken a statistics course in college. An additional four students were not sure if they had taken a previous course in statistics. Based on the written responses to when they had taken a statistics course, 22 students reported having taken a statistics class within the last five years. Nineteen students reported taking a statistics course more than 10 years ago.

There were 37 (42%) females and 31 (35%) males who participated in the study. Another 20 students did not specify their gender. These numbers are presented in Figure 5.

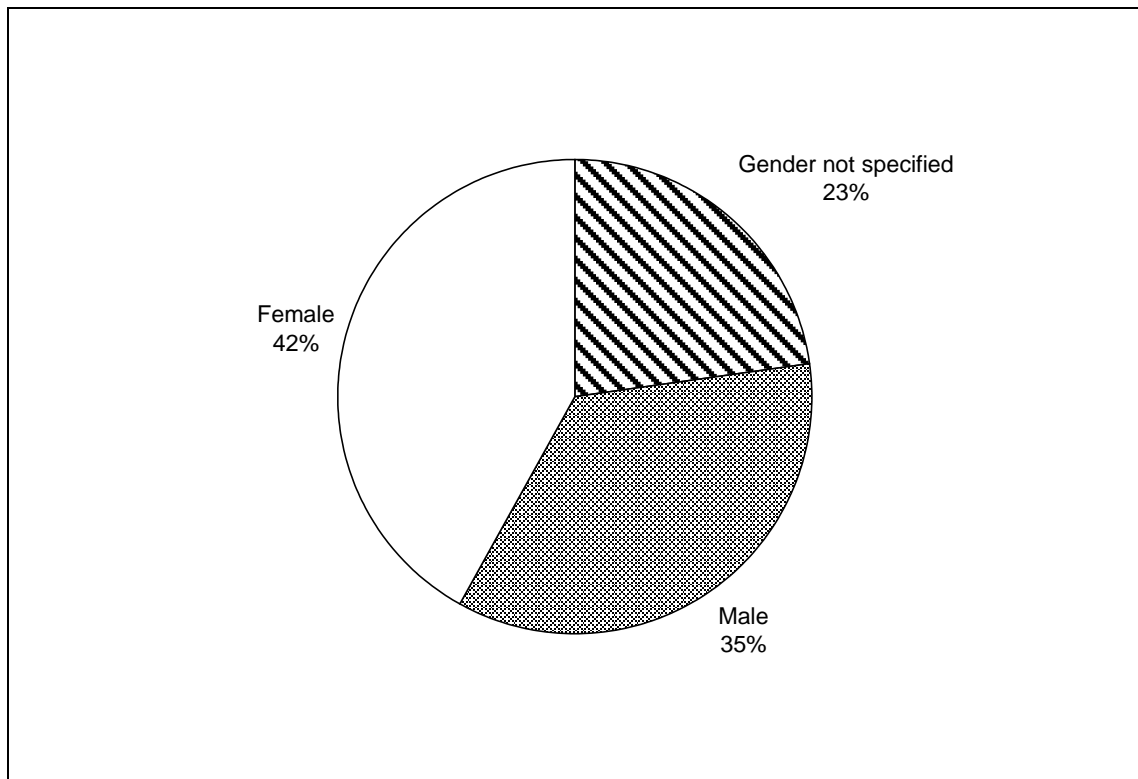


Figure 5. Pie chart of percentages of males and females as reported by participants.

Race/ethnicity categories were self-selected. The results of this item are shown in the pie chart in Figure 6. Participants were instructed to write in their own race/ethnicity as the demographic questionnaire did not provide pre-identified categories for them to select. Thirty-seven participants identified themselves as White/Caucasian, 9 as Black/African-American, 4 identified as

Asian/Southeast Asian American, 2 as Hispanic, 1 as Black/West Indian, 1 as Black/Caribbean, 1 as Multiracial, and 33 did not specify their race.

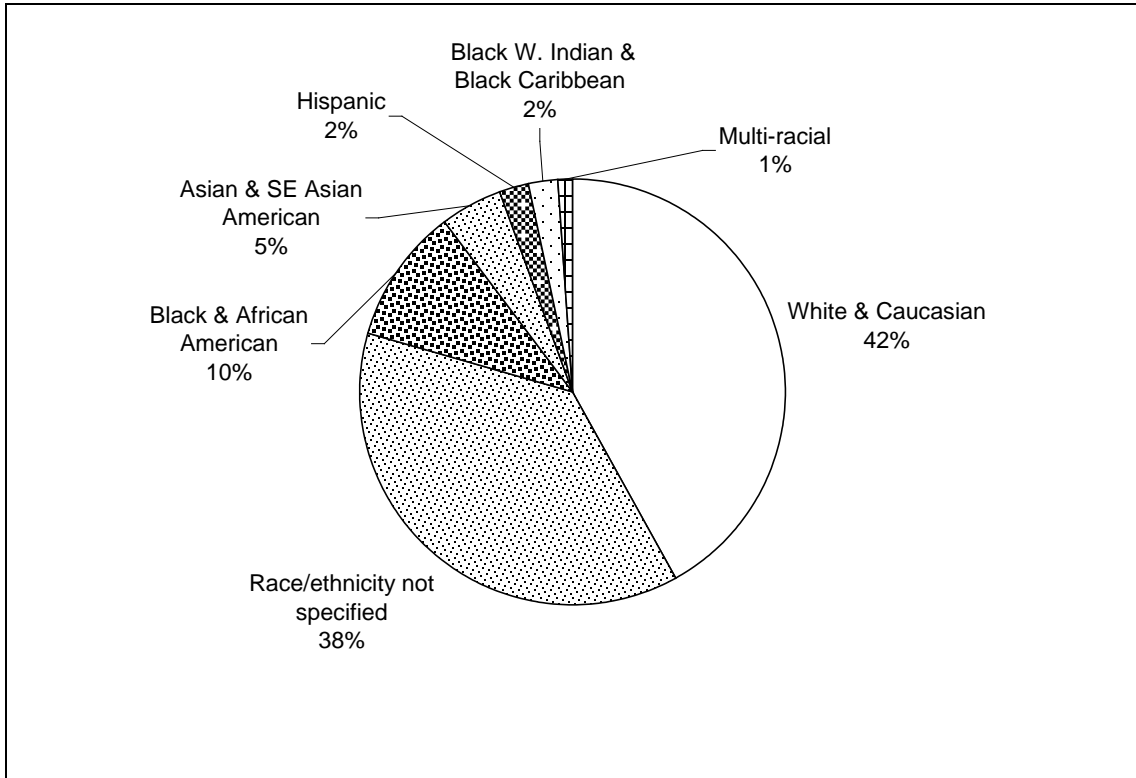


Figure 6. Pie chart of percentages of race/ethnicity as self-reported by participants.

Data Screening Methods

Student data from the four sections of the introductory statistics classes were entered into a Microsoft Excel spreadsheet after being reviewed for the informed consent form with authorizing signature, verification of completion of each instrument (CSCS, CSSE, and SELS), and verification of completion of the

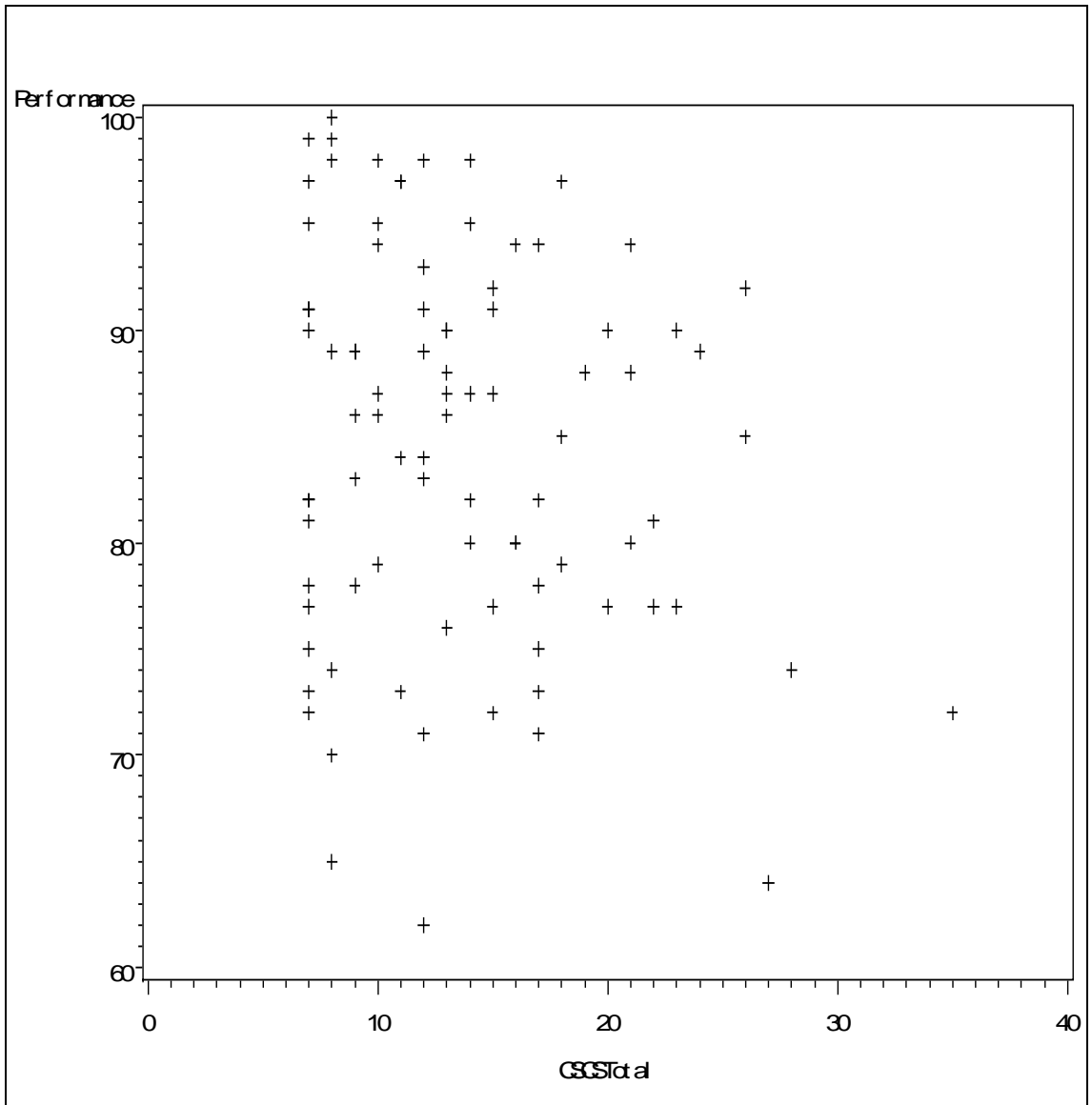
demographic questionnaire. Any participants who failed to sign the informed consent or who dropped the course were excluded from the analysis.

A scatter plot analysis of the data was conducted to test for outliers that could affect the outcome of results of the multiple regression correlation analysis. Outliers were detected in all three scatter plots: the CSCS (statistics anxiety measure) with performance, CSSE (current SE measure) with performance, and SELS (future SE measure) with performance. Six outliers were dropped from the scatter plot analysis to produce a more relevant view of the data. The scatter plots for each of the instruments are included to illustrate the relationship between each instrument and the performance measure.

The CSCS with performance. The scatter plot for the CSCS (statistics anxiety measure) data is presented in Figure 7. There are some data points stacked up on the left side of the graph and there is a loose “D” pattern of data. There did not appear to be any correlation between the measures.

The CSSE with performance. The scatter plot for the CSSE (current SE measure) data is presented in Figure 8. There is no discernible pattern. There is some clustering of data at the lower end of the CSSE scale; however, overall there did not appear to be any correlation between the measures.

The SELS with performance. The scatter plot for the SELS (future SE measure) data is presented in Figure 9. There is a group of data points vertically aligned near the middle and the right of the graph. Overall there did not appear to be any correlation between the SELS (future SE measure) and performance (average combined midterm and final exam scores).



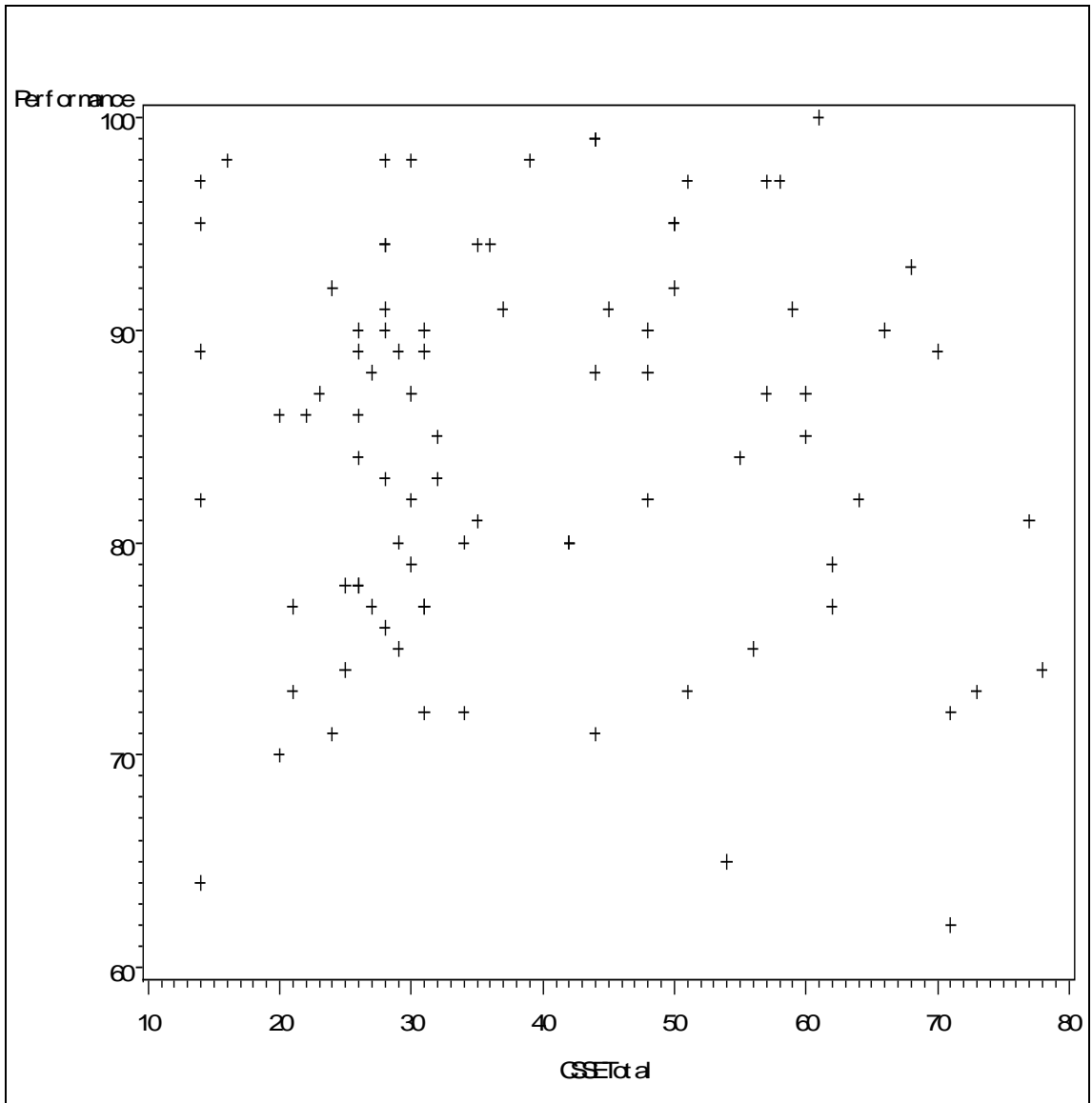


Figure 8. Scatter plot of relationship between Performance (average combined midterm and final exam scores) and Current Statistics Self-Efficacy (current SE measure) total score.

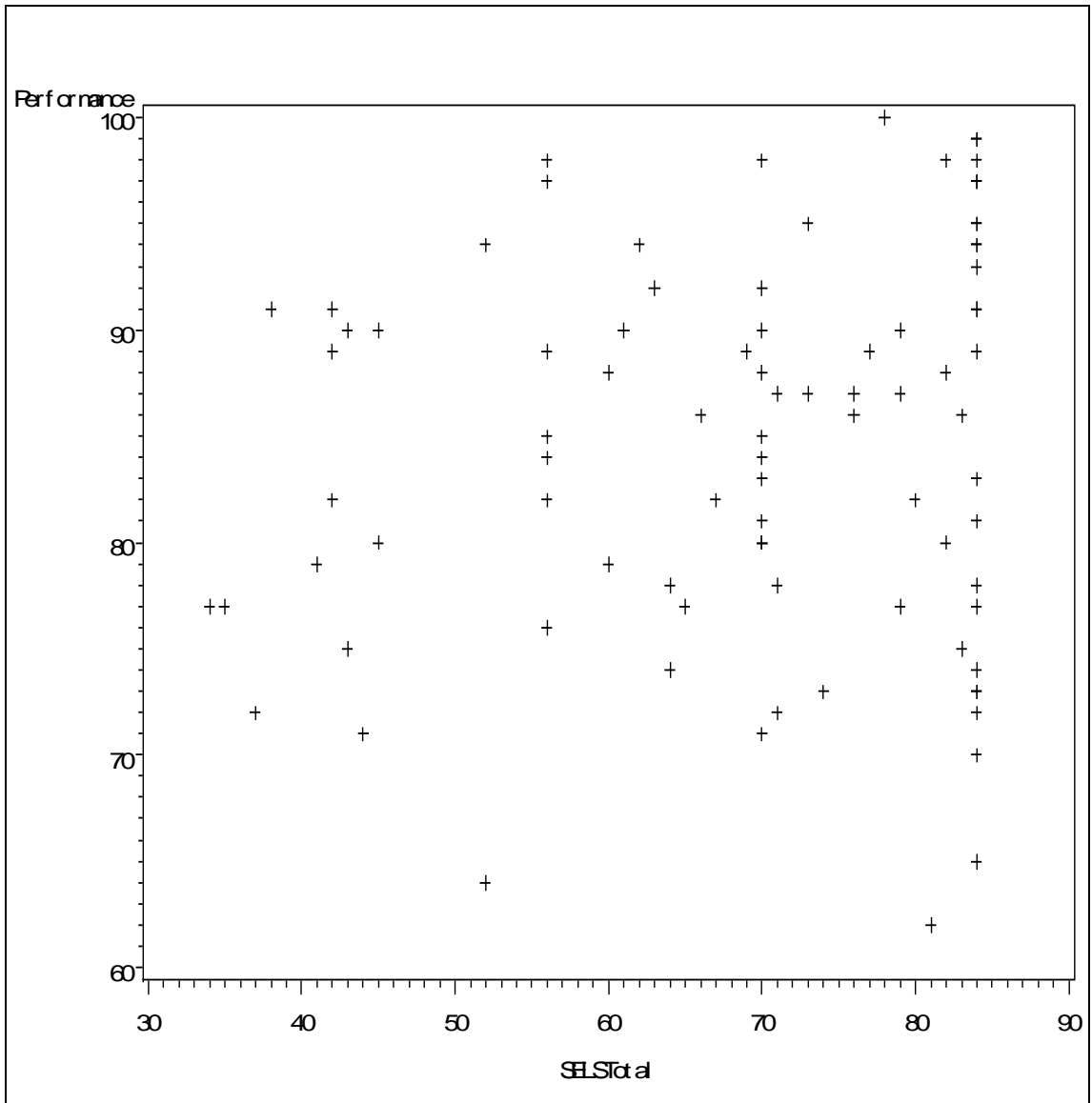


Figure 9. Scatter plot of relationship between Performance (average combined midterm and final exam scores) and Self-Efficacy to Learn Statistics (future SE measure) total score.

ANOVA results. Results were analyzed using one-factor ANOVA testing the differences in means between the four course sections and by each instrument (CSCS, CSSE, and SELS). Differences in mean scores and percentage of variation accounted for by each section on the CSCS (statistics anxiety measure), CSSE (current SE measure), and SELS (future SE measure) are displayed in Tables 1, 2, and 3.

Table 1

ANOVA and Coefficient of Determination Values for Course Section and Computational Self-Concept Subscale

Source	<i>df</i>	SS	<i>MS</i>	<i>F</i>	<i>p</i>	<i>R</i> ²
Section	3	259.88	86.63	2.59	.058	.0846
Within Groups	84	2811.21	33.47			
Total	87	3071.09				

Note. *N* = 88.

**p* < .05

Table 2

ANOVA and Coefficient of Determination Values for Course Section and Current Statistics Self-Efficacy

Source	<i>df</i>	SS	<i>MS</i>	<i>F</i>	<i>p</i>	<i>R</i> ²
Section	3	493.74	164.58	.57	.635	.0200
Within Groups	84	24179.24	287.85			
Total	87	24672.99				

Note. *N* = 88.

**p* < .05

Table 3

ANOVA and Coefficient of Determination Values for Course Section and Self-Efficacy to Learn Statistics

Source	<i>df</i>	SS	MS	<i>F</i>	<i>p</i>	<i>R</i> ²
Section	3	1743.87	581.29	2.7	.051	.0881
Within Groups	84	18059.40	214.99			
Total	87	19803.27				

Note. *N* = 88.

**p* < .05

There was no significant effect between instruments (CSCS, CSSE, and SELS) and course sections and there was no difference in course sections and the *p* values for each were greater than .05. The amount of variation on each instrument's (CSCS, CSSE, and SELS) mean score was approximately 8% for the CSCS (statistics anxiety measure) and SELS (future SE measure) and 2% for the CSSE (current SE measure). There were no main or simple effects demonstrated in the data.

Means and least square means. The means, standard deviations, and range of scores for the performance measure for each course section were as follows: Section 1 had a mean of 85.83 (*SD* = 10.91) with a range from 62 to 100 points, Section 2 had a mean of 82.76 (*SD* = 9.10) with a range from 64 to 99 points, Section 3 had a mean of 87.67 (*SD* = 7.45) with a range from 77 to 98 points, and Section 4 had a mean of 84.91 (*SD* = 9.11) with a range from 72 to 97 points. These means are based on the number of students who were used in

the analysis in each course section. The highest means were reported in Section 3 ($n = 6$). The lowest means were reported in Section 2 ($n = 36$).

The least square (LS) means procedure in SAS was used to analyze the means for each instrument for each section. This procedure is appropriate because each course section had a different number of participants thus creating an unbalanced design. The least square means for each instrument with each course section is depicted in Figure 10. The graph shows the least square mean scores for each instrument. Section 1 had the highest mean scores for the SELS (future SE measure) and CSSE (current SE measure) and the lowest mean scores for the CSCS (statistics anxiety measure) compared to the other three course sections. Sections 2, 3, and 4 are almost identical in their mean scores. The means for all sections were comparable and the differences were not significant.

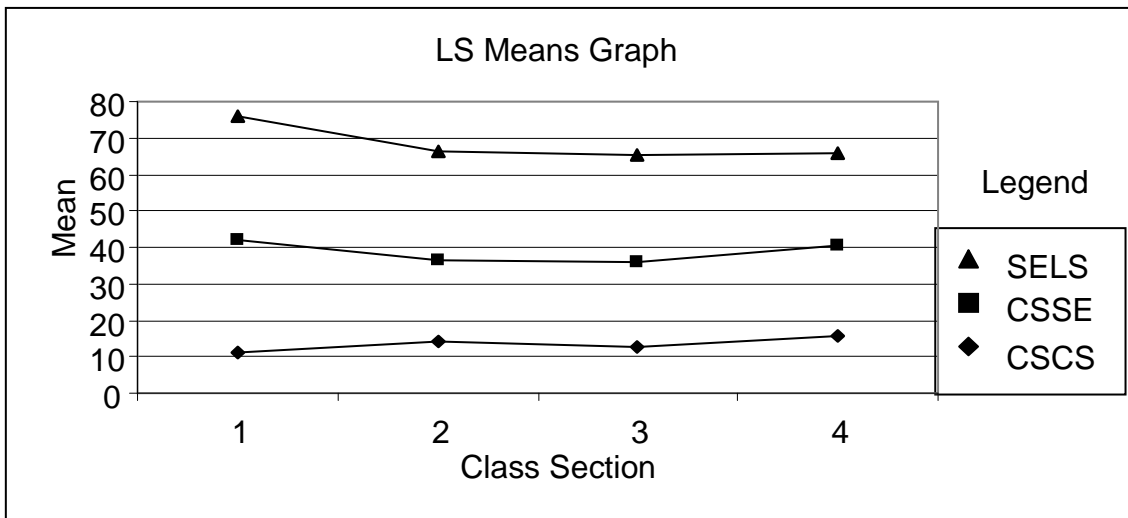


Figure 10. A comparison of least square means for each of the instruments by course section.

Cronbach's Alpha for each instrument. Alpha reliability measures for each instrument are as shown in Table 4. Alphas for each instrument were as follows: the CSCS (statistics anxiety measure) had an alpha coefficient of .90, the CSSE (current SE measure) had an alpha coefficient of .95, and the SELS (future SE measure) had an alpha coefficient of .98. These were consistent with the results of the Finney and Schraw (2003) study.

Table 4

Coefficient Alpha Estimates, Means, Standard Deviations, and Correlations, of Study Measures

Variable	Coef. Alpha Est.	Mean/ Total Possible	SD	CSCS* <i>r</i>	CSSE* <i>r</i>	SELS* <i>r</i>	Perf* <i>r</i>
CSCS	0.90	13.68/ 35	5.94	---			
CSSE	0.95	39.01/ 84	16.84	-.35 ^a	---		
SELS	0.98	68.90/ 84	15.08	-.52 ^a	.26 ^a	---	
Performance	---	84.63/ 100	9.09	-.18	-.04	.13	---

Note. *CSCS = Computational Self-Concept Subscale (statistics anxiety measure), CSSE = Current Statistics Self-Efficacy (current SE measure), SELS = Self-Efficacy to Learn Statistics (future SE measure), Perf = Performance (average of combined midterm and final exams).

^a These correlations are statistically significant.

$p < .05$, $N = 88$.

Findings and Results by Research Question

Question 1. What is the relationship between statistics self-efficacy and statistics anxiety?

Multiple regression correlation analysis was conducted to compare the relationships among instrument results and any trends in the data. Means and standard deviations were calculated to determine the representative score on the CSCS of the STARS (statistics anxiety measure), the CSSE (current SE measure), and the SELS (future SE measure) in the group of scores. The means, standard deviations, and correlations for the CSCS (statistics anxiety measure), CSSE (current SE measure), and SELS (future SE measure) were presented in Table 4.

A correlation analysis was conducted between the SELS (future SE measure) scale and statistics anxiety as measured by the CSCS of the STARS (statistics anxiety measure). See Table 4 for the correlations for the study measures.

The correlation between the SELS and CSCS was $-.52$ ($p < .0001$). This is consistent with the findings of Finney and Schraw (2003) who found a negative correlation of $-.471$ between the SELS (future SE measure) and Spielberger's 1980 Statistics Test Anxiety (STA) instrument during the first administration of the instruments.

The correlation between the CSCS (statistics anxiety measure) and SELS (future SE measure) in this study may be the result of the fact that the CSCS (statistics anxiety measure) assessed participants' level of anxiety as it related to

specific statistics test items on that day; whereas the SELS (future SE measure) assessed their personal beliefs in their ability to learn specific statistics tasks over a semester. This difference in the perception of time available to learn statistics may give students a feeling of confidence over and above what they would experience if they were given less time to learn statistics or were tested on their statistical problem solving on that day.

A correlation analysis was conducted between the CSSE (current SE measure) and CSCS of the STARS (statistics anxiety measure). The correlation between the CSSE and CSCS was $-.35$ ($p = .0007$). The resulting correlation between the CSCS (statistics anxiety measure) and CSSE (current SE measure) in this study may be partly a result of the fact that the CSCS (statistics anxiety measure) assessed participants' level of anxiety as it related to specific statistics test items, whereas the CSSE (current SE measure) assessed their personal beliefs in their current ability to complete specific statistics tasks.

The higher negative correlation between the CSCS (statistics anxiety measure) and SELS (future SE measure) compared to the CSCS (statistics anxiety measure) and CSSE (current SE measure) may be the result of the fact that the SELS (future SE measure) assessed participant's beliefs in their ability to learn, which, because of this future skill requirement, makes individuals more confident, which is dissimilar enough to the statistics anxiety construct represented by the CSCS (statistics anxiety measure). The CSSE (current SE measure) is closer in construct to the CSCS (statistics anxiety measure) since the CSSE (current SE measure) assessed about participants' current ability to

complete specific statistics tasks and this construct is similar to the CSCS (statistics anxiety measure) which also assessed participants' feelings about completing specific statistics tasks. A student with low current statistics self-efficacy could have higher statistics anxiety. This study demonstrated that the CSSE (current SE measure) and CSCS (statistics anxiety measure) data have a weaker relationship than the relationship between the CSCS (statistics anxiety measure) and SELS (future SE measure) data. All correlations were significant at the .05 level.

Question 2. What is the relationship between the two statistics self-efficacy instruments and performance in a graduate introductory statistics course?

Performance measures for this study are defined as the average of the combined midterm and final exam scores in the introductory statistics course that account for part of the final course grade. The average of the combined scores on the midterm and final exam scores in an introductory statistics class were correlated with the CSSE (current SE measure) and SELS (future SE measure). The relationship between the two predictor variables (CSSE and SELS) and performance is presented in Table 4. Performance (average combined midterm and final exam scores) was negatively correlated to a slight degree with the CSSE (current SE measure), but not significant at the .05 level of significance. The SELS (future SE measure) and Performance (average combined midterm and final exam scores) were positively correlated to a slight degree, but also not significant at the .05 level.

Question 3. What is the relationship between statistics anxiety and performance in a graduate introductory statistics course?

Multiple regression correlation analysis was conducted between the CSCS of the STARS (statistics anxiety measure) and performance (average combined midterm and final exam scores). The results of the multiple regression correlation analysis show a small negative correlation between the CSCS (statistics anxiety measure) and performance (average combined midterm and final exam scores) (-.18) ($p = .0931$). The relationship is not significant as p value $> .05$.

Question 4. What is the relationship between statistics self-efficacy, statistics anxiety, and performance?

Multiple regression correlation analysis was conducted to compare relationships among instrument results and any trends in the data. A multiple regression correlation analysis was conducted between the CSSE (current SE measure) scale, CSCS of the STARS (statistics anxiety measure), the SELS (future SE measure) scale, and the performance measure (average combined scores for the midterm and final exams). The data in the multiple regression correlation analysis indicated that when the three predictor variables (CSCS, CSSE, and SELS) were added, the R^2 value was .0475 explaining 4.7% of the variance in performance (average combined scores for the midterm and final exams) as shown in Table 5, which includes the beta weights and uniqueness indices by instrument.

Table 5

Beta Weights and Uniqueness Indices Obtained in Multiple Regression Analysis Predicting Performance

Predictor	<i>B</i>	<i>SE B</i>	β	<i>t</i>	Uniqueness Index
*CSCS	-0.3037	0.2046	-.1983	-1.48	.0255
*CSSE	-0.0708	0.0630	-.1310	-1.12	.0146
*SELS	0.0462	0.0777	.0766	0.59	.0041

Note. $R^2 = .0475$ ($F[6,81] = .93$). The multiple regression $R^2 = .047$. *CSCS = Computational Self-Concept Subscale, CSSE = Current Statistics Self-Efficacy, SELS = Self-Efficacy to Learn Statistics.

* $p > .05$ for predictor variables.

The correlation between performance (average combined midterm and final exam scores), CSCS (statistics anxiety measure), CSSE (current SE measure), and SELS (future SE measure) measures are listed in Table 4. In reviewing the data, there were moderate and significant relationships. These are the relationships between the CSCS and the SELS $-.52$ ($p < .0001$), the CSCS and the CSSE $-.35$ ($p = .0007$), and the CSSE and SELS $.26$ ($p = .0143$).

As discussed earlier, the results between the CSCS and SELS ($r = -.52$) ($p < .0001$) show a moderate negative correlation. As an individual's score on the CSCS (statistics anxiety measure) decreases, his score on the SELS (future SE measure) increases and vice versa. So an individual with low CSCS (statistics anxiety measure) scores would inversely have high self-efficacy to learn statistics SELS (future SE measure) scores.

The relationship between the CSCS and the CSSE $-.35$ ($p = .0007$) is negative and significant. There was a slight correlation between the CSCS

(statistics anxiety measure) and CSSE (current SE measure) and this may be because the CSSE (current SE measure) is closer in construct to the CSCS (statistics anxiety measure). The CSSE (current SE measure) assessed participants' current ability to complete specific statistics tasks and this construct was similar to the CSCS (statistics anxiety measure) which also assessed participants' feelings about completing specific statistics tasks. A student with low current statistics self-efficacy would also have higher statistics anxiety and thus the CSSE (current SE measure) and CSCS (statistics anxiety measure) would have a lower negative correlation compared to the CSCS (statistics anxiety measure) with the SELS (future SE measure).

The association between the SELS and CSSE was weak, but significant .26 ($p = .0143$). As was discussed in Chapter 2, the CSSE (current SE measure) and SELS (future SE measure) consist of the same 14 items and the only difference between them is in the instructions given to the participants prior to completing the instruments. Specifically, the CSSE (current SE measure) assessed participants' confidence in their current ability to complete statistics related tasks and the SELS (future SE measure) assessed their confidence in their ability to learn statistics related tasks. The main difference was in their rating their current ability and their ability to learn.

Finally, a multiple regression correlation was conducted between the CSCS (statistics anxiety measure), SELS (future SE measure), CSSE (current SE measure), and performance as measured by the average of the combined midterm and final exam scores. The data from the CSCS (-.18) ($p = .0931$), the

CSSE (-.04) ($p = .7299$), and the SELS (.13) ($p = .2131$) showed only slight correlations with performance and none of the correlations were significant.

The beta weights and uniqueness indices for the six predictors are presented in Table 5. Using multiple regression, performance scores (average combined midterm and final exam scores) were regressed on the linear combination of CSCS (statistics anxiety measure), SELS (future SE measure), and CSSE (current SE measure). The equation containing these three variables accounted for approximately 4% of the observed variance in performance, $F(6, 81) = .93, p > .05$.

Beta weights (standardized multiple regression coefficients) and uniqueness indices were reviewed to assess the relative importance of the three variables in the prediction of performance. The uniqueness index for a given predictor is the percentage of variance in the criterion accounted for by that predictor, beyond the variance accounted for by the other predictor variables. Beta weights and uniqueness indices are presented in Table 5.

None of the predictors displayed significant beta weights as presented in Table 5. The CSCS has the largest beta weight at $-.1983$ ($p > .05$). The uniqueness index for the CSCS was $.0255$. The CSCS accounted for 2% of the variance in performance beyond the variance accounted for by the other two predictors, $F(6, 81) = .93, p > .05$.

Summary

This chapter described the results of one measure of computational self-concept as measured by the CSCS (statistics anxiety measure), and two

measures of self-efficacy; specifically current statistics self-efficacy (CSSE) and self-efficacy to learn statistics (SELS) with performance (average combined midterm and final exam scores) in an introductory graduate statistics course. Students enrolled in four sections in the fall of 2009 and the spring of 2010 were assessed to determine whether computational self-concept and statistics self-efficacy influence performance as measured by the average of the midterm and final exam scores.

Internal consistency among items for each instrument was high (CSCS = .90, CSSE = .95, and SELS = .99). This was consistent with the findings of Finney and Schraw (2003).

The results of the statistical data analysis were presented to answer four research questions. Means and standard deviations were presented and the results of each instrument and the correlation and intercorrelation of each instrument with performance were also reported. In addition, multiple regression and correlation were conducted on the data to determine the amount of variance accounted for by the scores of each participant for each instrument and course section with performance.

The results of the multiple regression correlation indicate that when all course sections were added to the regression equation along with the three instruments; the amount of variance explained was approximately 6%.

The SELS (future SE measure) and performance (average combined midterm and final exam scores) were positively correlated to a slight degree, but not significant at the .05 level. Bandura (1997) suggested that when self-efficacy

measures are assessed in close proximity to performance measures, the results of the self-efficacy measures is more valid and reliable. Therefore the lack of significance may be the result of the fact that the SELS (future SE measure) was measured during the first week of the semester but the performance measures (midterm and final exams) were not assessed until the middle and end of the semester.

Another possibility is that the sample was different from the sample in the Finney and Schraw (2003) study. The sample in the Finney and Schraw study was undergraduates. The sample in this study was primarily doctoral students and they may have seen themselves as more confident as most have already earned a degree beyond the bachelors.

A multiple regression correlation was conducted between the CSCS (statistics anxiety measure), CSSE (current SE measure), SELS (future SE measure), and performance as measured by midterm and final-exam scores. The CSCS (-.18) ($p = .0931$), the CSSE (.04) ($p = .7299$), and the SELS (.13) ($p = .2131$) showed only slight correlations with performance and were not significant. As previously stated these results may be because the self-efficacy measures and performance were assessed at different times and beyond what is recommended by Bandura (1997).

The results of the multiple regression correlation analysis show a small negative correlation between the CSCS and performance (average combined scores for the midterm and final exams) (-.18) ($p = .0931$). The relationship is not significant as the p value is greater than (.05).

The correlation between the SELS (future SE measure) and the CSCS was (-.52) ($p < .0001$). This is consistent with Finney and Schraw (2003) who found a negative correlation of (-.471) between the SELS (future SE measure) and Spielberger's 1980 Statistics Test Anxiety (STA) instrument during the first administration of the instruments.

The resulting correlation between the CSCS (statistics anxiety measure) and SELS (future SE measure) in this study may be the result of the fact that the CSCS (statistics anxiety measure) is asking participants to identify their level of anxiety as it relates to specific statistics test items at the present moment; whereas the SELS (future SE measure) is asking about their personal beliefs in their ability to learn specific statistics tasks at a later date. The difference of personal perception of time available to learn statistics could give students a feeling of over confidence.

The correlation between the Current Statistics Self-Efficacy (CSSE) and Computational Self-Concept (CSCS) subscale of the STARS was (-.35) ($p = .0007$). As previously stated the resulting correlation between the CSCS (statistics anxiety measure) and CSSE (current SE measure) in this study could be because the CSCS (statistics anxiety measure) assessed participants' level of anxiety as it related to completing specific statistics test items whereas the CSSE (current SE measure) assessed participants' personal beliefs in their current ability to complete specific statistics tasks.

The stronger inverse correlation between the CSCS (statistics anxiety measure) and SELS (future SE measure) compared to the CSCS (statistics

anxiety measure) and CSSE (current SE measure) may be the result of the fact that the SELS (future SE measure) is asking about participant's beliefs in their ability to learn statistics which because the SELS (future SE measure) asks participants to assess their own level of confidence in acquiring future skills makes them more confident which is dissimilar to the Statistics Anxiety construct represented by the CSCS (statistics anxiety measure) which asks them to assess their statistics problem solving skills in the present. The CSSE (current SE measure) is closer in construct to the CSCS (statistics anxiety measure) as the CSSE (current SE measure) asks about participant's current ability to complete specific statistics tasks which is similar to the CSCS (statistics anxiety measure). The CSCS (statistics anxiety measure) also asks participants to rate their feelings about completing specific statistics tasks. A student with low current statistics self-efficacy would also have higher statistics anxiety. The relationship between the CSSE (current SE measure), SELS (future SE measure) and CSCS (statistics anxiety measure) were significant at the .05 level.

Observations

Several observations occurred during the conduct of the study which were not a direct part of the research, but which were noteworthy. The Section 3 statistics course was unique compared to the other course sections in that it was offered online and that administration of the instrument packet did not exactly follow the process of the three traditional classroom courses. However, there was not difference in the four course sections. The instruments were not provided to the course participants until after the first week of classes and the

researcher did not have the opportunity to state the nature of the study. The instruments were uploaded to the course Blackboard web site and the students downloaded the instruments and informed consent forms. Study participants returned the informed consent forms and the completed instruments to the course instructor who then gave them to the researcher.

The Section 4 traditional classroom statistics course was taught by a different instructor than the Section 1 and Section 2 instructor-led statistics courses. Prior to administration of the instrument packet the course instructor introduced the researcher to the students but did not state the importance of the research study as had the instructor of Sections 1 and 2. This omission may have impacted the level of participation of the students.

Two of the professors who typically teach the introductory graduate statistics class expected different outcomes in relation to the effect that statistics anxiety and statistics self-efficacy would have on student exam performance. One of the professors who taught course sections used in this study stated that he was not surprised that there was no relationship between the statistics anxiety measure, statistics self-efficacy, and performance. He commented:

Anecdotally I have seen students that appear anxious do well in my course and other students that appear anxious do not so well in my course. Similarly, I have seen students that don't appear anxious at all do both well and not so well in my course. (statistics course professor, personal communication, March 24, 2011)

The other statistics professor stated that he was surprised that the results of the study showed no relation between statistics anxiety, statistics self-efficacy, and performance.

Chapter 5

Summary, Conclusions, Implications, and Recommendations

The purpose of this study was to investigate the relationship between statistics self-efficacy, statistics anxiety, and performance in an introductory graduate statistics course. The sections of this chapter are a summary of the study, conclusions, implications, and recommendation for further research.

Summary

Little research had been conducted on the relationship between statistics self-efficacy, statistics anxiety, and performance in introductory graduate statistics courses. The perception was that many graduate students struggle with statistics courses, because they do not have the necessary level of personal self-efficacy to achieve at the required level.

The purpose of this study was to determine if there was a relationship between self-efficacy, statistics anxiety, and performance in introductory graduate statistics courses. Specifically, if a student's statistics anxiety was high would their statistics self-efficacy be low demonstrating a negative relationship? Also would lower levels of self-efficacy and higher levels of statistics anxiety have an influence on performance in statistics classes?

The research questions identified for this study included:

1. What is the relationship between statistics self-efficacy and statistics anxiety?

2. What is the relationship between the two statistics self-efficacy instruments and performance in a graduate introductory statistics course?
3. What is the relationship between statistics anxiety and performance in a graduate introductory statistics course?
4. What is the relationship between statistics self-efficacy, statistics anxiety, and performance?

The research design compared the relationship between personal levels of statistics self-efficacy (future self-efficacy to learn statistics and current statistics self-efficacy), statistics anxiety, and performance. Performance was defined as the average of the combined midterm and final exam scores in a graduate introductory statistics course.

During the fall of 2009 and the spring of 2010 the instruments were distributed to 108 graduate students from four different sections of an introductory graduate statistics course in a College of Education at a doctoral-degree granting, large metropolitan university with very high research activity in the southeastern U.S. After removing the students who did not complete all the instruments or informed consent or who dropped the course prior to taking the final exam, the study was left with 88 graduate students.

The study design compared two statistics self-efficacy measures (current statistics self-efficacy and self-efficacy to learn statistics), with each other and with statistics anxiety and course performance (average combined midterm and final exam scores). The two statistics self-efficacy measures used the same 14

items; however, the difference between the two instruments was in the instructions to the students. To view the items from different perspectives, the Self-Efficacy to Learn Statistics (SELS) instrument assessed the student to rate their confidence in their ability to learn statistics, whereas the Current Statistics Self-Efficacy (CSSE) assessed the students' confidence in their ability to complete those tasks at the current point in time. In other words, the SELS (future SE measure) assessed their confidence in learning tasks in the future, without requiring them to demonstrate their current ability; while the CSSE (current SE measure) assessed their ability to complete those tasks in the present.

A demographic questionnaire was included to assess the sample from this doctoral-degree granting, large metropolitan university with very high research activity in the southeastern U.S. by age group, gender, and race/ethnicity and to identify prior statistics course experiences as well as the degree being sought. The three instruments plus the demographic questionnaire were combined into one package for administration to participants. The dependent variable, class performance, was measured by averaging the combined midterm and final exam scores for each student in each class section. There were four class sections with the following characteristics. Sections 1 and 2 were traditional classroom courses that were taught in the fall semester of 2009 by one instructor. Section 3 was conducted as an on-line class that was taught in the fall semester of 2009 by a second instructor. Section 4 was a traditional classroom course that was taught in the spring semester of 2010 by a third instructor.

All instruments were distributed in the first week of classes except in the on-line class section. The four instruments used to gather data were:

- A demographic questionnaire;
- the Computational Self-Concept Subscale of the STARS, an anxiety measure;
- the Current Statistics Self-Efficacy (CSSE) scale, a current SE measure; and,
- the Self-Efficacy to Learn Statistics (SELS) scale, a future SE measure.

Both of the statistics self-efficacy measures (CSSE and SELS) demonstrated a low to moderate relationship with statistics anxiety (CSCS). The relationship between the CSSE (current SE measure) and SELS (future SE measure) was small, positive, and significant. The relationship between statistics anxiety and performance (average combined midterm and final exam scores) was small and negative, but not significant. The relationship between the statistics self-efficacy measures and performance (average combined midterm and final exam scores) was weak, but positive for the SELS (future SE measure) and weak but negative for the CSSE (current SE measure). Neither statistics self-efficacy measure was significant in relation to performance.

Conclusions

There was an inverse relationship between statistics self-efficacy and statistics anxiety. As students' level of statistics anxiety increased, their level of statistics self-efficacy decreased. So students experiencing moderate to high levels of statistics anxiety would display low to moderate levels of personal statistics self-efficacy.

Neither statistics self-efficacy nor statistics anxiety had an influence on course performance. Measures of statistics self-efficacy (CSSE) and statistics anxiety (CSCS) displayed a negative relationship with performance. The relationship was weak and not significant. The CSSE (current SE measure) had a slightly larger negative relationship to performance (average combined midterm and final exam scores) than did the CSCS (statistics anxiety measure). The SELS (future SE measure) displayed a weak but positive relationship with performance (average combined midterm and final exam scores). However, none of the instruments were significant in relation to performance.

The CSCS (statistics anxiety measure) showed a moderate but negative relationship with the SELS (future SE measure) and the relationship was significant. The correlation between the CSCS (statistics anxiety measure) and the SELS (future SE measure) in this study may be partly a result of the fact that the CSCS (statistics anxiety measure) is assessing participants' level of anxiety as it related to specific statistics test items on that day; whereas the SELS (future SE measure) is assessing their personal beliefs in their ability to learn specific statistics tasks over a semester. This difference in the perception of time available to learn statistics may give students a feeling of confidence over and above what they would experience if they were given less time to learn statistics, or were tested on their statistical problem solving on that day.

The CSCS (statistics anxiety measure) showed a weak, but negative relationship with the CSSE (current SE measure) and the relationship was significant. The resulting correlation between the CSCS (statistics anxiety

measure) and CSSE (current SE measure) in this study may be partly a result of the fact that the CSCS (statistics anxiety measure) is asking participants to identify their level of anxiety as it relates to specific statistics test items whereas the CSSE (current SE measure) is asking about their personal beliefs in their current ability to complete specific statistics tasks.

The higher negative relationship between the CSCS (statistics anxiety measure) and SELS (future SE measure) compared to the CSCS (statistics anxiety measure) and CSSE (current SE measure) may be the result of the fact that the SELS (future SE measure) is asking about participant's beliefs in their ability to learn; which because of this future skill requirement, makes them more confident, which is dissimilar enough to the Statistics Anxiety construct represented by the CSCS (statistics anxiety measure). The CSSE (current SE measure) is closer in construct to the CSCS (statistics anxiety measure) as the CSSE (current SE measure) relates to a participant's current ability to complete specific statistics tasks and this construct is similar to the CSCS (statistics anxiety measure) which also asks participant's to rate their feelings about completing specific statistics tasks. A student with low current statistics self-efficacy could have higher statistics anxiety. This study demonstrates that the CSSE (current SE measure) and CSCS (statistics anxiety measure) data have a weaker relationship than the relationship between the CSCS (statistics anxiety measure) and SELS (future SE measure) data.

There was no relationship between the two self-efficacy instruments (SELS and CSSE) and course performance. However the direction of the

relationship indicated students had more confidence in their future ability than in their current ability. This may be a product of the age and experience level of the graduate students. Course performance did not appear to be affected by statistics self-efficacy in the graduate students.

There was no relationship between the statistics anxiety instrument (CSCS) and course performance (average combined midterm and final exam scores). However, the direction indicated an inverse relationship. Students demonstrated that as their statistics anxiety decreased their performance increased. This may be a product of the prior statistics experience level of the graduate students. Those students with prior statistics knowledge could have lower statistics anxiety than those students who had no prior statistics experience. Course performance did not appear to be affected by statistics anxiety in the students.

As discussed earlier, the results between the CSCS (statistics anxiety measure) and the SELS (future SE measure) showed a moderate negative relationship. As an individual's score on the CSCS (statistics anxiety measure) decreased, his score on the SELS (future SE measure) increased and vice versa. An individual with low statistics anxiety would inversely have high self-efficacy to learn.

The inverse relationship between the CSCS (statistics anxiety measure) and the CSSE (current SE measure) was weaker than the inverse relationship between the CSCS (statistics anxiety measure) and SELS (future SE measure). This weaker relationship between the CSCS (statistics anxiety measure) and

CSSE (current SE measure) may be because the CSSE (current SE measure) appears to be closer in construct to the CSCS (statistics anxiety measure) compared to the relationship between the CSCS (statistics anxiety measure) and SELS (future SE measure). The CSSE (current SE measure) assessed a participant's current ability to complete specific statistics tasks and this construct was similar to the CSCS (statistics anxiety measure) which also assessed participants' feelings about completing specific statistics tasks. The CSSE (current SE measure) with the CSCS (statistics anxiety measure) had a lower negative relationship compared to the CSCS (statistics anxiety measure) with the SELS (future SE measure) in this study.

The association between the SELS (future SE measure) and CSSE (current SE measure) was weak but significant. As discussed in Chapter 2, the CSSE (current SE measure) and SELS (future SE measure) consisted of the same 14 items; and the only difference between them was in the instructions given to the participants prior to completing the instruments. Specifically, the CSSE (current SE measure) assessed participants' confidence in their current ability to complete statistics-related tasks and the SELS (future SE measure) assessed their confidence in their ability to learn statistics-related tasks. The main difference was the emphasis that participants were rating their current ability to learn in one instance and the other was their ability to learn in the future.

Implications

The implications arising from the research relate to faculty, students, researchers, and programs.

Faculty. The three instruments the CSCS (statistics anxiety measure), the CSSE (current SE measure), and the SELS (future SE measure) may not be appropriate with graduate students because their age and/or experiences may impact their self-efficacy or anxiety levels and there were no significant differences between the instruments and performance. The setting for this study was in a College of Education at a doctoral-degree granting, large metropolitan university with very high research activity in the southeastern U.S. The sample was primarily doctoral students from four different sections of a graduate statistics course. These students were primarily enrolled in education-related doctoral programs. Finney and Schraw (2003) in their research study found lower mean scores on the first administration of the CSSE (current SE measure) for their sample than the mean scores of the sample in this study. Their sample included undergraduate students enrolled in a statistics course offered through the Educational Psychology department. The sample for their study was made up of sophomores (32.1%), juniors (32.1%) and seniors (19.3%).

This difference in the characteristics between Finney and Schraw's study and this study was mainly that this study included graduate students, many who had already taken and completed statistics courses in the past and had earned a bachelor's or master's degree prior to enrollment, which may have contributed to a higher level of statistics self-efficacy at the beginning of a statistics course. The mean score in the Finney and Schraw (2003) study was 29.33 ($SD = 11.33$). In this study, the mean score for the CSSE was 39.01 ($SD = 16.84$). This 10 point variance between the two studies may be a result of this difference.

Of note to the researcher was the fact that the SELS (future SE measure) mean score for the Finney and Schraw (2003) study was higher 71.55 ($SD = 11.77$) than in this study 68.90 ($SD = 15.08$). However, in this study, the SELS (future SE measure) did not appear to influence course performance (average combined midterm and final exam scores). It appears that graduate students who may have had a low sense of self-efficacy to learn at the beginning of the semester did not let that influence their performance on the midterm or final exams.

The statistics anxiety instruments used in each study were different, but the construct was similar. For this study, the total possible score on the CSCS (statistics anxiety measure) was 35 points, indicating high statistics anxiety. In the Finney and Schraw (2003) study the total possible number of points was 80. The mean score in this study for the CSCS (statistics anxiety measure) was 13.88 ($SD = 5.94$) and in the Finney and Schraw (2003) study the mean score was 37.56 ($SD = 13.01$).

Understanding where students rank in relation to their statistics anxiety level and statistics self-efficacy level can help to identify those students who may need extra attention at the beginning of a semester. Faculty can target students demonstrating low self-efficacy in statistics and offer them assistance in developing statistics study skills. Helping students develop these skills could reduce their statistics anxiety and increase their self-efficacy to learn statistics, which may in turn give them a psychological boost to their self-worth and reduce the struggle associated with learning statistics.

Determining a graduate student's level of statistics self-efficacy early in the semester is important in creating a stress-free and supportive learning environment, allowing graduate students to approach other classes with more confidence. Faculty can use the SELS (future SE measure) and the CSSE (current SE measure) instruments during a graduate/doctoral retreat or in the first statistics class, along with the class schedule list of assignments, etc. as a way to identify students who may require some additional support during the semester and during their programs of study.

Neither the statistics self-efficacy measures nor the statistics anxiety measure were significant in this study. The data indicated that performance (average of combined midterm and final exam scores) was not affected by either statistics self-efficacy level or statistics anxiety level. Two of the professors who typically teach the statistics courses expressed two different opinions. One professor stated that he was surprised that there were no significant relationships between the statistics anxiety measure and performance. His expectation was that statistics anxiety would affect performance. The other professor stated that he was not surprised at the results and he expected there to be no significant relationship between statistics anxiety and performance.

The instructors who taught the courses used in this study provide a supportive learning environment and they are available to meet with their students as needed. There is also a lab staffed with tutors available to students who seek extra help. This support could be another factor that influenced course outcomes in this study.

Faculty at other institutions in a different learning environment may not be as supportive. They may believe in a “sink or swim” approach to learning statistics and, therefore, may have higher levels of statistics anxiety related to their statistics classes.

Students. Students preparing to take statistics courses can assess their own levels of statistics self-efficacy and statistics anxiety to see how ready they believe themselves to be when beginning a statistics course. Those students who score high on statistics self-efficacy measures can begin a statistics plan of study with confidence. Those students who score lower on statistics self-efficacy measures can request extra help, utilize extra resource materials, and visit the lab to increase their statistics self-efficacy and decrease their statistics anxiety.

Students at other institutions can also assess their levels of statistics self-efficacy and statistics anxiety prior to or at the beginning of a statistics course. In this way, they can develop an assessment of their abilities and seek out extra resources and assistance as needed.

Researchers. This study did not find a relationship between statistics anxiety, statistics self-efficacy, and performance in a graduate statistics course. The Finney and Schraw (2003) study did find a relationship. One of the main differences between the two studies was that the CSSE (current SE measure) was given a second time before the final exam in the Finney and Schraw (2003) research. Finney and Schraw were able to show an increase in current statistics self-efficacy over the course of a semester and as a result conclude that statistics anxiety affected performance.

Finney and Schraw (2003) used a series of performance measures to define course performance. These included a student's performance on 14 statistics problems that corresponded to each item on the CSSE (current SE measure) and the SELS (future SE measure), and the total percentage of points earned in the class. In this study, the average of the combined midterm and final exam scores were used as the definition of performance. The 14 statistics problems used by Finney and Schraw (2003) were given to students at the same time that the CSSE (current SE measure) was distributed. Bandura (1997) suggested that the closer the criterion measure is to the performance outcome, the more accurate are the results. In this study, the performance measure was not obtained until the midpoint of the semester and again at the end of the semester.

Increase in statistics self-efficacy and reduction of statistics anxiety are goals in themselves. CSSE (current SE measure) would be useful when developing different teaching methods and assessing if they affect personal self-beliefs about statistics. The SELS (future SE measure) instrument would be helpful when administered prior to beginning a course to identify students who have low self-efficacy beliefs to learn the skills necessary to finish statistical tasks.

Researchers can use the statistics self-efficacy measures and statistics anxiety measures as part of a set of diagnostic tools to identify statistics anxiety in a sample of students. By doing so, they may be able to create better ways of reducing statistics anxiety to a level where it is manageable for students.

This study contributes to the body of research by confirming that items in the three instruments had high internal reliability and measured graduate students' level of statistics self-efficacy and statistics anxiety for the sample. Even though the results of the instruments did not show a significant relationship with performance, the results did show that these measures of statistics anxiety and statistics self-efficacy existed in a sample of graduate students.

Recommendations for Further Research

As previously stated no relationship was found in this study between the statistics anxiety, statistics self-efficacy, and performance measures. However, other studies have found a relationship between, statistics anxiety, statistics self-efficacy, and performance measures. Therefore, more research could be conducted in the area of statistics anxiety, statistics self-efficacy, and performance measures as discussed below.

Further research could be conducted with a larger sample size from the same population using the same instruments, but offering the CSSE (current SE measure) instrument a second time, the week prior to final exams. In this way, a comparison between CSSE (current SE measure) at "time 1" and "time 2" could be compared to performance at the end of the semester. Questions that could be raised might include the following. Specifically, does current statistics self-efficacy increase by the end of the semester? Does level of current statistics self-efficacy influence performance?

Additional research could be conducted to compare the statistics self-efficacy and statistics anxiety of graduate and undergraduate populations.

Statistics self-efficacy measures can investigate whether there is a difference in the statistics anxiety and statistics self-efficacy of undergraduates compared to graduate students. Specifically, do graduate students possess higher levels of statistics self-efficacy and lower levels of statistics anxiety than undergraduates?

Another possibility for future research might be to conduct a longitudinal research study to measure the change in statistics self-efficacy and statistics anxiety of students as they advance through their college career. It could begin as they enter college as undergraduates and continue to the point where they enter and complete an advanced graduate or doctoral degree. Specifically, does statistics self-efficacy increase and statistics anxiety decrease as a student progresses through undergraduate studies and advances through doctoral studies?

Another study could be conducted to compare differences between female and male graduate students' levels of statistics self-efficacy and statistics anxiety. Specifically, do female graduate students possess different levels of statistics self-efficacy or statistics anxiety than their male counterparts?

A follow-on research study could include a set of interviews with those participants who scored high or low on the statistics self-efficacy and statistics anxiety measures. These interviews would focus on the thoughts and feelings of participants as they relate to statistics. Ideally these interviews could be conducted once, a week prior to class attendance. In this way, the scope of the thoughts, feelings, and actions of students as they relate to statistics self-efficacy

and statistics anxiety and their relationship to class performance could be better defined.

Other research could include a sample of graduate or doctoral dropouts or non starters to help determine what factors influenced their decision to leave a doctoral program of study or not pursue the doctorate. Specifically, a set of diagnostic instruments (including statistics self-efficacy measures and statistics anxiety measures) and interviews could be used to assess common issues, program characteristics, and student profiles. Determining these factors could help doctoral programs to minimize or alleviate these factors so that doctoral students have fewer roadblocks to the attainment of the degree.

A comparison of graduate students studied in this research and students at other similarly classified institutions could be conducted. Finally a research study could be developed to determine if there is a difference between levels of statistics anxiety and statistics self-efficacy in graduate students who attend public universities compared to those who attend private universities.

References

- Bair, C., & Haworth, J. (November, 1999). Doctoral student attrition and persistence: A meta-synthesis of research. Paper presented at the annual meeting of the Association for the Study of Higher Education, San Antonio, TX.
- Bandalos, D. L., Finney, S. J., & Geske, J. A. (2003). A model of statistics performance based on achievement goal theory. *Journal of Educational Psychology, 95*(3), 604-607. doi:10.1037/0022-0663.95.3.604
- Bandura, A. (1989). Regulation of cognitive processes through perceived self-efficacy. *Developmental Psychology, 25*(5), 729. doi:10.1037//0012-1649.25.5.729
- Bandura, A. (1995). Exercise of personal and collective efficacy in changing societies. In A. Bandura (Ed). *Self-efficacy in changing societies* (pp. 1-45). Cambridge, UK: Cambridge University Press.
- Bandura, A. (1997). *Self-efficacy: The exercise of control*. New York, NY: W. H. Freeman.
- Bell, B. S., & Kozlowski, S. W. 1. (2002). Goal orientation and ability: Interactive effects on self-efficacy, performance, and knowledge. *Journal of Applied Psychology, 87*(3), 497-505. doi:10.1037//0021-9010.87.3.497
- Bieschke, K., Bishop, R., & Garcia, V. (1996). The utility of the research self-efficacy scale. *Journal of Career Assessment, 4*(1), 59-75. doi:10.1177/106907279600400104
- Bishop, R., & Bieschke, K. (1998). Applying social cognitive theory to interest in research among counseling psychology doctoral students: A path analysis. *Journal of Counseling Psychology, 45*(2), 182-188. doi:10.1037//0022-0167.45.2.182
- Bong, M. (1998). Tests of the internal/external frames of reference model with subject-specific academic self-efficacy and frame-specific academic self-concepts. *Journal of Educational Psychology, 90*(1), 102-110. doi:10.1037//0022-0663.90.1.102

- The Carnegie Foundation for the Advancement of Teaching. (2011). The Carnegie Classification of Institutions of Higher Education. Retrieved from www.carnegiefoundation.org/classifications
- Choi, N. (2005). Self-efficacy and self-concept as predictors of college students' academic performance. *Psychology in the Schools, 42*(2), 197-205. doi:10.1002/pits.20048
- Cohen, J. (1988). *Statistical power analysis for the behavioral sciences*. Hillsdale, NJ: Lawrence Erlbaum.
- Cohen, J. (1992). A power primer. *Quantitative Methods in Psychology, 112*(1), 155-159. doi:10.1037//0033-2909.112.1.155
- Cronbach, L. (1951). Coefficient alpha and the internal structure of tests. *Psychometrika, 16*(3), 297-334. doi:10.1007/BF02310555
- Cruise, R. J., Cash, R. W., & Bolton, D. L. (1985). *The development and validation of an instrument to measure statistical anxiety*. Paper presented at the annual meeting of the American Educational Research Association, Chicago, IL.
- Cruise, R. J., & Wilkins, E. M. (1980). *STARS: Statistical Anxiety Rating Scale*. Unpublished manuscript, Andrews University, Berrien Springs, MI.
- Eisenhart, M., & DeHaan, R. (2005). Doctoral preparation of scientifically based education researchers. *Educational Researcher, 34*(4), 3-13. doi:10.3102/0013189X034004003
- Finney, S., & Schraw, G. (2003). Self-efficacy beliefs in college statistics courses. *Contemporary Educational Psychology, 28*, 161-186. doi:10.1016/S0361-476X(02)00015-2
- Forester, M., Kahn, J., & Hesson-McInnis, M. (2004). Factor structure of three measures of research self-efficacy. *Journal of Career Assessment, 12*(1), 3-16. doi:10.1177/1069072703257719
- Gelso, C. J., & Lent, R. W. (2000). Scientific training and scholarly productivity: The person, the training environment, and their interaction. In S. D. Brown & R. W. Lent (Eds.), *Handbook of counseling psychology* (3rd ed., pp. 109-139). New York, NY: Wiley.
- Gelso, C. J., Mallinckrodt, B., & Judge, A. B. (1996). Research training environments, attitudes toward research, and research self-efficacy: The revised research training environment scale. *The Counseling Psychologist, 24*(2), 304-322. doi:10.1177/0011000096242010

- Greeley, A., Johnson, E., Seem, S., Braver, M., Dias, L., & Evans, K. (1989). *Research self-efficacy scale*. Unpublished scale presented at the Conference of the Association for Women in Psychology, Bethesda, MD.
- Hackett, G., & Betz, N. E. (1989). An exploration of the mathematics self-efficacy/mathematics performance correspondence. *Journal for Research in Mathematics Education*, 20, 261-273. doi:10.2307/749515
- Hatcher, L. (1994). *A step-by-step approach to using SAS for factor analysis and structural equation modeling*. Cary, NC: SAS Institute.
- Haynes, V. D. (2004). High rate of doctoral dropouts draws concern, research of its own. *Dixie Sun Online Edition*, 34(20), 1-3.
- High, R. (2000). Important factors in designing statistical power analysis studies: The size of your study sample is critical to producing meaningful results. *Computing News*, Summer 2000. Retrieved from <http://cc.uoregon.edu/cnews/summer2000/index.html>
- Holden, G., Barker, K., Meenaghan, T., & Rosenberg, G. (1999). Research self-efficacy: A new possibility for educational outcomes assessment. *Journal of Social Work Education*, 35(3), 463-476.
- Lent, R. W., Brown, S. D., & Gore, P. A. (1997). Discriminant and predictive validity of academic self-concept, academic self-efficacy, and mathematics-specific self-efficacy. *Journal of Counseling Psychology*, 44(3), 307-315. doi:10.1037/0022-0167.44.3.307
- Lent, R. W., Lopez, F. G., & Bieschke, K. J. (1991). Mathematics self-efficacy: Sources and relation to science-based career choice. *Journal of Counseling Psychology*, 38(4), 424-430.
- Nunnally, J. C. (1978). *Psychometric theory* (2nd ed.). New York, NY: McGraw-Hill.
- O'Brien, K., Malone, M., Schmidt, C., & Lucas, M. (1998). *Research self-efficacy: Improvements in instrumentation*. Poster session presented at the annual conference of the American Psychological Association, San Francisco, CA.
- Onwuegbuzie, A. J. (2003). Modeling statistics achievement among graduate students. *Educational and Psychological Measurement*, 63(6), 1020-1038. doi:10.1177/0013164402250989
- Onwuegbuzie, A. J., & Jiao, Q. G. (2004). Information search performance and research achievement: An empirical test of the Anxiety-Expectation

Mediation model of library anxiety. *Journal of the American Society for Information Science and Technology*, 55, 41–54. doi:10.1002/asi.10342

Owen, S., & Froman, R. (1988). *Development of a college academic self-efficacy scale*. (Report No. 012 263). East Lansing, MI: National Center for Research on Teacher Learning. (ERIC Document Reproduction Service No. ED298158)

Pajares, F. (2002). *Overview of social cognitive theory and of self-efficacy*. Retrieved from <http://www.emory.edu/EDUCATION/mfp/eff.html>

Phillips, J., & Russell, R. (1994). Research self-efficacy, the research training environment, and research productivity among graduate students in counseling psychology. *Counseling Psychologist*, 22(4), 628-641. doi:10.1177/0011000094224008

Roberts, D. M., & Bilderback, E. W. (1980). Reliability and validity of a statistics attitude survey. *Educational and Psychological Measurement*, 40, 235. doi:10.1177/001316448004000138

SAS Institute. (2005). *SAS 9.1.2*. Cary, NC: SAS Institute.

Schau, C., Stevens, J., Dauphinee, T. L., & Del Vecchio, A. (1995). The development and validation of the survey of attitudes toward statistics. *Educational and Psychological Measurement*, 55, 868. doi:10.1177/0013164495055005022

Scholl, R. W. (2002). *Affective motivation and emotional competency*. Retrieved from http://www.uri.edu/research/lrc/scholl/webnotes/Motivation_Affective.htm

Scholl, R. W. (2002). *Expectancy theory*. Retrieved from http://www.uri.edu/research/lrc/scholl/webnotes/Motivation_Expectancy.html

Schunk, D., & Pajares, F. (2002). The development of academic self-efficacy. In A. Wigfield & J. Eccles (Eds.), *Development of achievement motivation* (pp. 15-31). San Diego, CA: Academic Press. doi:10.1016/B978-012750053-9/50003-6

Sherer, M. et al. (1982). The Self-efficacy Scale: Construction and validation. *Psychological Reports*, 51(2), 663-671.

Shivy, V., Worthington, E., Wallis, A., & Hogan, C. (2003). Doctoral research training environments (RTEs): Implications for the teaching of psychology. *Teaching of Psychology*, 30(4), 297-302. doi:10.1207/S15328023TOP3004_03

- Silver, B., Smith, E., & Greene, B. (2001). A study strategies self-efficacy instrument for use with community college students. *Educational and Psychological Measurement, 61*(5), 849-865. doi:10.1177/00131640121971563
- Smallwood, S. (2004). Doctor dropout. *The Chronicle of Higher Education, 50*(19), p. A10.
- Unrau, Y., & Beck, A. (2004). Increasing research self-efficacy among students in professional academic programs. *Innovative Higher Education, 28*, 187-204.
- Varney, J. (2005). A study of the relationships among doctoral program components and dissertation self-efficacy on dissertation progress. *Dissertation Abstracts International: Section A. Humanities and Social Sciences, 66*(04), 1239.
- Wei, P., & Tang, M. (2005). Students' perceptions on factors of statistics anxiety and instructional strategies. *Journal of Instructional Psychology, 3*(32) Retrieved from http://findarticles.com/p/articles/mi_m0FCG/is_3_32/ai_n15882749/
- Wise, S. (1985). The development and validation of a scale measuring attitudes toward statistics. *Educational and Psychological Measurement, 45*(2), 401-405.
- Wood, R., & Locke, E. (1987). The relation of self-efficacy and grade goals to academic performance. *Educational and Psychological Measurement, 47*(4), 1013-1024. doi:10.1177/0013164487474017

Appendices

Appendix A Comparative Matrix for Self-Efficacy Instruments

Developer	Instrumentation	N	No. of Items	Response Scale	Domains	Instrument Description	Population Description	Validity	α
Bieschke, Bishop & Garcia, (1996)	Research Self-Efficacy Scale (RSES)	177	51 items	0 to 100 point scale	Research SE with four dimensions: research conceptualization, research implementation, early tasks, and presenting results.	An instrument to measure self-efficacy related to the research process.	Graduate students in the Sciences and Humanities	NI	0.98
Finney & Schraw (2003)	Current Statistics Self-Efficacy (CSSE)	154	14 items	1-6 Likert-type scale	Statistics SE	An instrument to assess student's confidence in their ability to solve specific statistics related tasks. (current ability)	Undergraduate students enrolled in an introductory statistics methods course	Parallel Analysis (PA) was used to extract a 1 factor solution explaining 74% of the variance in the responses	Week 1/ .90, Week 2/ .93

Appendix A Comparative Matrix for Self-Efficacy Instruments (Continued)

Developer	Instrumentation	N	No. of Items	Response Scale	Domains	Instrument Description	Population Description	Validity	α
Finney & Schraw (2003)	Self-Efficacy to Learn Statistics (SELS)	154	14 items	1-6 Likert type scale	Statistics SE	An instrument to assess student's confidence in their ability to learn to solve specific statistics related tasks.	Undergraduate students enrolled in an introductory statistics methods course	Parallel Analysis (PA) was used to extract a 1 factor solution explaining 45% of the variance in the responses.	0.97
Gelso, et al. (1996)	Revised Research Training Environment Scale (RTES-R)	173	54 items	5 point scale	Research SE	NI	173 doctoral students enrolled in six different universities	NI	0.9
Hackett & Betz(1989)	Mathematics Course Self-Efficacy (SE-Course)	205	18 items	10 point scale	Math SE	Ability to complete a series of math intensive college courses with a grade of B or better	Undergraduate students in an introductory psychology course	Parallel Analysis (PA) was used to extract a 1-factor solution explaining 51% of the variance in the responses.	0.94

Appendix A Comparative Matrix for Self-Efficacy Instruments (Continued)

Developer	Instrumentation	N	No. of Items	Response Scale	Domains	Instrument Description	Population Description	Validity	α
Hackett & Betz (1989)	Mathematics Problem Self-Efficacy (SE-Problem)	205	19 items	11 point scale	Math SE	An instrument asking students to estimate their ability to solve 18 math problems.	Undergraduate students in an introductory psychology course	NI	0.88
Holden, Barker, Meenaghan & Rosenberg (1999)	Research Self-Efficacy (RSE) Scale	135	9 research tasks	11 point scale	Social Work (SW) and Speech-Language Pathology (SLP)	A self-report survey instrument to assess student's confidence in their ability to perform specific research tasks.	Social Work (SW) and Speech-Language Pathology (SLP) graduate students	NI	0.94
Adapted from Lent, Brown and Larkin (1986)/Lent, Brown & Gore (1997)	Self-efficacy for Broad Academic Milestones Scale (SE-Broad)	205	12 items	10 point scale	Academic SE	Confidence in performing 12 generic academic behaviors	Undergraduate students in an introductory psychology course	NI	0.88

Appendix A Comparative Matrix for Self-Efficacy Instruments (Continued)

Developer	Instrumentation	N	No. of Items	Response Scale	Domains	Instrument Description	Population Description	Validity	α
Lent, Lopez & Bieschke (1991)	Mathematics Self-Efficacy	#1 295 #2 481	40	5 point scale	Math SE	Four "rationally developed" scales measuring the four sources of efficacy as described by Albert Bandura	Freshmen and sophomores enrolled in an introductory psychology class (study #1), and high school students enrolled in math courses (study #2).	Four factor model (NNFI=.989, CFI=.992, χ^2 =(51), 63.70	.56 to .90 (Study 1), .59 to .90 (Study 2)
Lent, Lopez & Bieschke (1991)	Perceived Sources of Mathematics Self-Efficacy	#1 296 #2 481	40	6 point scale	Math SE	Four "rationally developed" scales measuring the four sources of efficacy as described by Albert Bandura.	Freshmen and sophomores enrolled in an introductory psychology class (study #1), and high school students enrolled in math courses (study #2).	Four factor model (NNFI=.989, CFI=.992, χ^2 =(51), 63.71	.56 to .90 (Study 1), .59 to .90 (Study 2)
O'Brien, Malone, Schmidt & Lucas, (1998)	Research Attitudes Measure (RAM)	150	23 items	0 to 4	Research SE	A different measure of research self-efficacy.	Graduate students in Counseling Psychology	NI	0.89

Appendix A Comparative Matrix for Self-Efficacy Instruments (Continued)

Developer	Instrumentation	N	No. of Items	Response Scale	Domains	Instrument Description	Population Description	Validity	α
Owen & Froman (1988)	College Academic Self-Efficacy Scale (CASES)	230	33 items	5 point scale	Academic SE	A self-report measure of academic SE designed to measure the degree of confidence of performing typical academic behaviors of college students.	Undergraduate students enrolled in four general education classes	NI	0.92
Phillips & Russell, (1994)	Self-Efficacy in Research Measure (SERM)	NI	33 items	0 to 9	Research SE	A measure of graduate student self-efficacy in research design, practical, writing, and quantitative skills.	Graduate students	NI	0.96
Roberts and Bilderback (1980)	Statistics Attitude Survey (SAS)	NI	33 items	1-5 Likert-type scale	(1) statistics usefulness (2) personal competence (3) affective responses	An instrument designed to improve the prediction of success in statistics courses	NI	NI	0.93 in three samples

Appendix A Comparative Matrix for Self-Efficacy Instruments (Continued)

Developer	Instrumentation	N	No. of Items	Response Scale	Domains	Instrument Description	Population Description	Validity	α
Schau et al. (1995)	Survey of Attitudes Toward Statistics Scale (SATS)	NI	28 items	7 point Likert-type scale	(1) attitudes about intellectual knowledge and skills when applied to statistics, (2) positive and negative feelings concerning statistics, (3) usefulness, relevance, and worth of statistics, and, (4) statistics difficulty.	Four subscales measuring positive and negative feelings toward statistics	NI	NI	.81 to .85 for Affect subscale, .77 to .83 for the Cognitive subscale, and .64 to .77 for the Difficulty subscale.
Sherer et al., (1982)	General Self-Efficacy Subscale of the Self-Efficacy Scale	230	23 items	5 point scale	General SE	A general SE measure with two subscales (general and social)	Undergraduate students enrolled in four general education classes	NI	0.86

Appendix A Comparative Matrix for Self-Efficacy Instruments (Continued)

Developer	Instrumentation	N	No. of Items	Response Scale	Domains	Instrument Description	Population Description	Validity	α
Varney (2005)	Dissertation Appraisal Inventory	51	16	0 to 100	Dissertation writing tasks and statistics methods tasks	A 16 item instrument assessing student's ability to write the dissertation, select appropriate statistical tests, to seek help from leaders in the field, and dissertation committee.	Doctoral students in the dissertation stage	NI*	.90-.97
Wise (1985)	Attitudes Toward Statistics Scale (ATS)	NI	9 item course subscale and a 20 item field subscale	1-5 Likert-type scale	(1) attitudes toward current statistics course, and (2) usefulness of statistics in chosen field of study	Two subscales based on the SAS which measure student's attitudes toward statistics	NI	NI	0.9
Wood and Locke (1987)	Specific Self-Efficacy	230	7 items	none re-reported	Course Specific SE	SE specific to a course in seven major academic areas	Undergraduate students enrolled in four general education classes	NI	0.92

Note. NI = No Information

Appendix B Demographic Questionnaire

ID#

Please write in the unique ID number assigned to you.

Gender: Male ___ Female ___ What race/ethnic group? _____

To What Age Group do you belong:

- Under 21
- 22-25
- 26-30
- 31-35
- 36-40
- 41-49
- 50-59
- Over 60

What is the highest college degree you have received?

- Bachelor's
- Master's
- Doctorate/Professional

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

- Non-degree seeking
- Degree seeking
- Enrolled in Master's degree program
- Enrolled in Doctoral degree program
- Enrolled in other degree program, please specify

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

- Yes, please indicate date completed _____
- No

Appendix C Statistical Anxiety Rating Scale (STARS)

Part I

The items below refer to experiences that may cause anxiety. Circle the number indicating the amount of anxiety you would experience in each of the following situations.

	No Anxiety				Very Much 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

Appendix C Statistical Anxiety Rating Scale (STARS) (Continued)

	No Anxiety			Very Much Anxiety		
	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	
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	

Appendix C Statistical Anxiety Rating Scale (STARS) (Continued)

	No Anxiety			Very Much Anxiety	
	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 D Computational Self-Concept Subscale (CSCS)

This is an inventory of your feelings toward statistics. There are no right or wrong responses - only different ones. You can indicate whether or not a statement describes your feelings by circling the appropriate response below. Please respond to all of the items. A score of 5 indicates that you strongly agree. A score of 1 indicates that you strongly disagree.

Strongly Disagree					Strongly Agree
1	2	3	4		5
(Item 25) I haven't had math for a long time. I know I'll have problems getting through statistics	1	2	3	4	5
(Item 31) I can't even understand seventh- and eighth-grade math; how can I possibly do statistics.	1	2	3	4	5
(Item 34) Since I've never enjoyed math, I don't see how I can enjoy statistics.	1	2	3	4	5
(Item 38) I don't have enough brains to get through statistics	1	2	3	4	5
(Item 39) I could enjoy statistics if it weren't so mathematical.	1	2	3	4	5
(Item 48) Statistics isn't really bad. It's just too mathematical.	1	2	3	4	5
(Item 51) I'm too slow in my thinking to get through statistics.	1	2	3	4	5

Appendix E Current Statistics Self-Efficacy (CSSE)

Please rate your confidence in your **current ability** to successfully complete the following tasks.

The item scale has 6 possible responses: (1) = no confidence at all, (2) = a little confidence, (3) = a fair amount of confidence, (4) = much confidence, (5) = very much confidence, (6) = complete confidence. For each task, please mark the one response that represents your confidence in your **current ability** to successfully complete each task.

	1	2	3	4	5	6
No confidence						Complete confidence
1. Identify the scale of measurement for a variable.	1	2	3	4	5	6
2. Interpret the probability value (p -value) from a statistical procedure.	1	2	3	4	5	6
3. Identify if a distribution is skewed when given the values of three measures of central tendency.	1	2	3	4	5	6
4. Select the correct statistical procedure to be used to answer a research question.	1	2	3	4	5	6
5. Interpret the results of a statistical procedure in terms of the research question.	1	2	3	4	5	6
6. Identify the factors that influence power.	1	2	3	4	5	6
7. Explain what the value of the standard deviation means in terms of the variable being measured.	1	2	3	4	5	6
8. Distinguish between a Type I error and a Type II error in hypothesis testing.	1	2	3	4	5	6
9. Explain what the numeric value of the standard error is measuring.	1	2	3	4	5	6
10. Distinguish between the objectives of descriptive versus inferential statistical procedures.	1	2	3	4	5	6
11. Distinguish between the information given by the three measures of central tendency.	1	2	3	4	5	6
12. Distinguish between a population parameter and a sample statistic.	1	2	3	4	5	6
13. Identify when the mean, median and mode should be used as a measure of central tendency.	1	2	3	4	5	6
14. Explain the difference between a sampling distribution and a population distribution.	1	2	3	4	5	6

Permission to use granted by Finney and Schraw (personal communication, 2004).

Appendix F Self-efficacy to Learn Statistics (SELS)

Please rate your confidence in **learning** the skills necessary while you're in this class to successfully complete the following tasks. The item scale has 6 possible responses: (1) = no confidence at all, (2) = a little confidence, (3) = a fair amount of confidence, (4) = much confidence, (5) = very much confidence, (6) = complete confidence. For each task, please mark the one response that represents your confidence in **learning** the skills necessary in this course to successfully complete the task.

1	2	3	4	5	6
No confidence				Complete confidence	
1.					1 2 3 4 5 6
2.					1 2 3 4 5 6
3.					1 2 3 4 5 6
4.					1 2 3 4 5 6
5.					1 2 3 4 5 6
6.					1 2 3 4 5 6
7.					1 2 3 4 5 6
8.					1 2 3 4 5 6
9.					1 2 3 4 5 6
10.					1 2 3 4 5 6
11.					1 2 3 4 5 6
12.					1 2 3 4 5 6
13.					1 2 3 4 5 6
14.					1 2 3 4 5 6

Permission to use granted by Finney and Schraw (personal communication, 2004).

Appendix G Letter to Graduate Students

Dear Graduate Student,

I am conducting a research study to measure the personal self-efficacy beliefs of graduate students as they relate to completing statistics related tasks. My research study involves the completion of an instrument and a demographic questionnaire that needs to be completed during the second week of the semester.

Participation in this study will help you to have a better understanding of your personal self-efficacy beliefs as they relate to statistics tasks. Self-efficacy beliefs are those beliefs you have about your confidence in your ability to complete specific tasks. For example: "I am confident that I can select the appropriate statistical procedure when estimating validity"

I hope that you will help me further my research by completing the survey and demographic questionnaire. Your responses are critical to my research.

Thank you.

William Ray Schneider
Doctoral Candidate

About the Author

William (Ray) Schneider was honorably discharged from the United States Marine Corps in 1985 and began working in various industries over the next few years. He began attending community college in 1989 at the age of 25. After earning an associate's degree in 1992, he attended the University of South Florida (USF) in St. Petersburg, Florida earning a bachelor's degree in English and American Literature in 1994.

For the next few years, he worked in the construction trades until enrolling in a master's degree program in 1998 at USF in Tampa. After earning his master's degree in Adult Education, he began working as an instructional designer and performance consultant.

His Doctor of Philosophy degree is in Curriculum and Instruction with a specialization in Adult Education and a cognate in Measurement and Research. He currently lives in North Carolina with his wife and four dogs.