MATH ANXIETY:
THE IMPACT ON TRADITIONALLY UNDERSERVED AND MARGINALIZED ADULT 
FEMALE UNDERGRADUATE STUDENTS IN ELEMENTARY STATISTICS

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Abstract

The failure rate in elementary statistics for college students is cited to be as high as fifty percent with math anxiety identified as a chief contributing factor. Females are more prone to math anxiety than their male counterparts, and current research is exploring how a failure in elementary statistics for adult female undergraduate college students results in a higher dropout rate thus negatively affecting representation in the lucrative science, technology, engineer, and mathematical (STEM) careers for the underserved and marginalized female undergraduate population. The researcher advanced prior quantitative studies of research into math anxiety using a qualitative research case study to ask the following questions of administrators, faculty, and adult female students from an inner city four-year college: (a) What factors contribute to math anxiety in a population of female adult higher education students who are disadvantaged simultaneously by gender, race and/or ethnicity, economic status, and educational background as they pursue non-mathematical majors requiring enrollment in an elementary statistics course? (b) How do higher education administrators, faculty, and students believe math anxiety influences performance for a traditionally underserved and marginalized female adult student population in an elementary statistics course? (c) What strategies are identified by higher education administrators, faculty and students to help relieve math anxiety for a traditionally underserved and marginalized female adult student population in an elementary statistics course? Fifteen participants provided insights into the causes and effects of math anxiety offering suggestions regarding how to prevent and disable the harmful effects of math anxiety within the underserved and marginalized female undergraduate population. Major findings outlined are (a) the effect of early childhood stereotypical practices that diminish female competence in mathematical courses in comparison with males; (b) the academic organization’s failure to respond adequately to the
effects of math anxiety thus encouraging student self-defeating behaviors of procrastination and reluctance to ask for help; (c) recognition of best practices that included faculty education, use of technology, and early identification of at risk students. The recommendations for practice include the adoption of early preparation and retention strategies by college educators and officials to identify and assist at risk students early in their higher education careers and the continuation of qualitative research across a broader spectrum of participants, with the optimal goal of moving closer to fairness and equality in educational achievement across gender to enhance the global economic balance of our society.

Key words: Math Anxiety, Case Study, Stage Environment Fit Theory (SEF), Gender
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“To whom much is given; much is expected”

- John F. Kennedy, 1961

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Chapter I: Introduction

Statement of the Problem

In a global economy where organizations recruit the best and brightest knowledge workers, adults (ages 25 and older) are returning to school in record numbers. Prospective adult higher education students recognize that, in order to achieve an optimal earning capacity, they must invest significant time and mental capital into pursuing advanced educational degrees. In response, higher education institutions are actively competing for student dollars by instituting creative learning modalities that offer a suspension of entrance exams, flexibility with short term degree paths, and scrutiny for academic readiness that focuses on soft skills (reliability, study skills) and value systems, rather than “discrete knowledge” needed for mathematics and science (DeAngelis, 2015. p. 58). Additionally, admission counselors as the gatekeepers for maintaining academic enrollment standards are often focused on marketing efforts rather than on assessing student readiness for the rigors of higher education; they are not always able to counsel them regarding the selection of appropriate career paths (McDonough & Robinson, 2012, p. 99).

Adult females currently represent 71% of college enrollees seeking educational equity and improved career opportunities (Adebayo, 2008, para. 7; Gorski, 2013; Lopez & Gonzalez-Barrera, 2014, para. 2). In the socioeconomic strata of the 21st Century, despite inroads in equal rights legislation initiated by activists and supported by lawmakers, women as a whole remain traditionally underserved and marginalized by gender inequities, with a significant group denied equality because of a combination of race, ethnicity, and access to quality education (Tate, Fallon, Casquarelli, & Marks, 2014). Recent yearly statistics revealed that the United States has dropped eight places to a current ranking of 28th on the global world gender equality list, and places 74th out of 145 countries for providing equal pay for equal work (Weise, 2015, para. 1).
A traditionally underserved population is defined as one that experiences disparity in ability to access the necessary resources to live and work fairly amongst all populations (Underserved, n.d., para. 1). Marginalization, defined as “keeping someone in a powerless or unimportant position within a society or group” (Marginalization, n.d., para. 1), is more likely to occur in traditionally underserved populations with inequities resulting from gender, race, class, ethnicity and generational educational status (Tate, et. al., 2014). Beyond these distinctions of marginalization, all women experience a degree of the disparity of being underserved simply because they are women in a society historically defined by power relations based on the binary dynamics of patriarchy. For the purposes of this study, it is important to note that these structural inequities are pervasive within the realm of academia, particularly within higher education (Gill & Jones, 2013).

Adult females as a traditionally underserved group face unique challenges and barriers to successful degree attainment. These obstacles are especially notable in courses where basic mathematics is a critical component of course assessments. Many adult students who return to higher education after a long absence have historically poorly understood or forgotten mathematical concepts (Whyte & Anthony, 2012). For females, this problem is compounded by several societal factors that include dysfunctional beliefs, stereotyping practices, and poverty that compromise ability and achievement (Geist, 2010; Whyte & Anthony, 2012). Simultaneously, confidence in ability and self-efficacy may often be negatively shaped by the views and perceptions of critical authority figures such as parents and teachers (Todor, 2014, p. 320). Many of these influences are rooted in archaic assumptions based in genetics; males are perceived to be superior in math achievement (John-Henderson, Rheinschmidt, & Mendoza-Denton, 2015). Also, higher education instructors prepare and execute teaching strategies with
little oversight, and many mathematics teachers employ instructor-centric techniques or traditionalist approaches rooted in the positivist paradigm that favor structured lectures and skills assessment through computation testing instruments.

The mathematics discipline prioritizes the positivist method under the assumptions that competence is validated primarily through mastery of mathematics formulas and computations resulting in a single, unique answer (Zieffler, et al., 2008; Zieffler, et al. 2012). Current reform ideas for teaching practices in math encourage a student-centered approach (constructivist) that identifies and supports different learning styles and that uses a collaborative method involving numeracy, i.e. adding a context to a problem result (Liljedahl, 2015). However, many mathematics instructors are steeped in traditionalist behaviorist philosophic paradigms, and although past research has found that competency is not an outcome of traditionalist methods (Olani, Hoekstra, Harskamp, & van der Werf, 2011, p. 52), resistance to change is pervasive (Olani, et al., 2011; Zieffler, et. al. 2012).

Most higher education degree programs include elementary statistics as a core curriculum subject that all students must pass to achieve graduation status. Elementary statistics instruction is rooted within the mathematics discipline and is primarily taught by instructors with advanced degrees in mathematics (Firmin & Proemmel, 2011). Many students experience irrational fear and anxiety when faced with taking the course, leading to negative behaviors such as procrastination, avoidance, test anxiety, and flawed interpretations (Williams, 2013). College and university statistics departments report a failure rate as high as 50% in mathematical subjects for non-mathematical major students (Kalajdzievska, 2014, p. 376). Math anxiety is cited as a primary contributing factor contributing to this lack of success (Nunez-Pena, Suarez-Pellicioni, & Bono 2013).
Math anxiety is a “bona fide anxiety reaction” (Ashcraft, 2002, p. 184) characterized by exaggerated feelings of apprehension, stress, and worry when confronted with a course that is based on prior mathematics knowledge (Ashcraft, 2002, p. 181). A student struggling with math anxiety, if left alone with no positive interventions, can ultimately experience a debilitating fear of failure (Ashcraft, 2002). Researcher Mark H. Ashcraft, a pioneer in exploring math anxiety, recognized how this phobia can diminish memory functioning especially when an individual is engaged in high task performing skills such as mathematics (Ashcraft & Kirk, 2001, p. 226). Albert Bandura, a prominent researcher and behaviorist (Moore, 1999), further posited that disruption to cognitive functions can seriously erode a student’s perception of self-efficacy, thus ultimately impairing quality performance (Bandura, Barbaranelli, Caprara, & Pastorelli, 1996, p. 1206). Despite the narrowing of achievement gaps between women and men, especially in mathematics (Ross, Scott, & Bruce, 2012), females’ performance in this subject tends to be significantly impacted by emotions of anxiety and fear, induced and fostered by societal and environmental influences (McLean & Anderson, 2009; Muris, Meesters, & Knoops, 2005).

The purpose of this study is to understand the influence of math anxiety among adult female non-mathematical majors from traditionally underserved populations and the impact of it on their performance in elementary statistics.

This instrumental case study, based on the qualitative methodology of Stakes and Merriam (Yazan, 2015), expands on past quantitative research that has suggested that future studies be conducted to more deeply understand the effects of math anxiety and its impact on achievement; needed is the examination of variables such as underserved populations, gender disparities, segregation by race, and culture (Currie, 2014). A proliferation of quantitative research into mathematics-based curricula has identified factors affecting student performance in
elementary statistics. Prior research into math anxiety has validated that this behavioral condition exists and that it ultimately affects cognitive performance, particularly for women. Since performance is negatively impacted, researchers using quantitative methodologies also question the long-term implications of math anxiety on educational success (Ashcraft, 2002). Several research studies conducted within the past 10 years by Mark H. Ashcraft and Anthony J. Onwuegbuzie (as cited in Currie, 2014) have significantly influenced the understanding of how adults experience fear and anxiety when taking mathematics courses. Using several quantitative assessment scales, scholars have reported with statistical significance that a negative correlation exists between math anxiety and student cognition: In short, as math anxiety heightens, performance diminishes (Plake & Parker, 1982; Zakaria & Nordin, 2007). However, despite the validation of this hypothesis, there is a scarcity of current research dedicated to uncovering empirical evidence – particularly through qualitative approaches -- that explains the underlying cause of math anxiety and its long term effects on degree attainment, especially for underserved and marginalized adult female undergraduate students (Ashcraft, 2002).

Significance of Research Problem

The issue of the traditionally underserved and marginalized females’ performance in elementary statistics has significant and far-reaching impact on individuals, society, and the national economic environment. Poor academic performance in general can generate lack of persistence (Ortiz & Sriraman, 2015), leading to academic withdrawal and increased poverty; this deepens economic instability for individuals and whole families alike. It also creates a workforce possessing only minimal transferrable skills that do not match demands of employers seeking to hire individuals that can provide a competitive advantage in a challenging global economic environment.
An ongoing concern for educators is the high failure rate of students taking elementary statistics, particularly women. For students, failure outcomes in this required course generate frustration and can ultimately contribute to an increasing dropout rate that leads to a significant erasure of future career opportunities (Kalajdzievska, 2014). Tangentially related, the combined tuition and taxpayer loss (as subsidy rates) is estimated at approximately $240 million per year for a school where average tuition rates are $200 to $300 per credit hour (Marshall & Reidel, 2005, p. 55).

The United States leads the world’s developing countries in maintaining the widest gender gap in poverty rates across all races and ethnicities (Cawthorne, 2008). Poverty is considered a risk factor resulting in low mathematics achievement for females (p. 24), linked not to a lack of aptitude, but to early family generational ideas of natural born talent and based on the assumption that “by the time people become adults the damage is already done” (Geist, 2010, p. 28). Women who fail a core curriculum subject are less likely to obtain their degrees (Leveson, McNeil, & Joiner, 2013). This perpetuates cycles of poor employment opportunities and poverty for these individuals.

In the United States, female breadwinners hold primary responsibility for 40% of families with dependent children under the age of 18, an increase of 29% since 1960 (W. Wang, Parker & Taylor, 2013, para. 1). From this group of females, 63% are heads of household as single parents, with mixed diversity and social status (W. Wang et al., 2013). Many of these women have repeatedly experienced poor academic achievement which has driven a higher probability of them living in poverty, which is related to their participation in the workforce as unskilled labor (Geist, 2010; p. 26). As college and university admissions actively recruit adult students by providing incentives of flexibility and accessibility, traditionally underserved and marginalized
female adults are increasingly seizing the opportunity to return to school to secure degrees and improve their economic futures (Lopez & Gonzalez-Barrera, 2014).

The Commission on the Future of Higher Education published a bleak outlook in 2006, claiming that “America does not have the workforce it needs for the economy that it has” (Ebersole, 2010, p. 23). More recently, a U.S. Congress Joint Economic Committee report, *Stem education: Preparing for the jobs of the future*, prepared by Senator Robert Casey (D-PA), committee chairman, noted that the United States is “failing to produce an ample supply of workers to meet the growing needs of STEM employers” (p. 3). The core competencies found in employees with STEM advanced degrees would, if enhanced, benefit the United States in its bid to remain competitive in the global marketplace, but higher education scholars and policymakers reported a steady decline in both undergraduate and graduate STEM degrees between the years of 1985 and 2009 (Casey, 2012, p. 4). Students who major in STEM course work are better prepared in critical thinking and problem-solving through exposure to, and mastery of, math and science concepts (X. Wang, 2013). The lack of females and other underserved and marginalized groups electing STEM majors and entering STEM careers is one major reason cited for the shortage of skilled workers in these professions (Davison, Jew, & Davenport, 2014; Ing, 2014).

Although 21st century global research has reported a significant narrowing of the gender divide in mathematics achievement, women overall struggle with societal and educational influences that erode self-esteem and self-efficacy beliefs (Williams, 2013). As a result, for women struggling to improve their economic plight, doubts about performance exacerbated by math anxiety can sabotage efforts to achieve and can contribute to academic failure (Ashcraft, 2002). Additionally, government reports and current research studies have found that women and minorities are significantly underrepresented in the highly lucrative job opportunities in the
STEM fields (Ortiz & Sriraman, 2015). Female students experiencing math anxiety and its negative effects on self-efficacy beliefs commonly avoid college majors where they perceive a greater risk for failure (Rinn, Miner, & Taylor, 2013; Sass, 2015).

**Positionality Statement**

My personal position, bias and passionate advocacy for educational equality and success for females as an underrepresented and marginalized population was formulated in three phases: Phase one came from personal experience; phase two evolved during my time as an adjunct professor at an elite college; and phase three is related to my position as a full time professor offering services to students in dire need of remediation based on past educational performance, income, culture, and their status as a marginalized group.

I obtained my higher education degree as an adult female student accessing a degree completion program through an accelerated format. In my elementary statistics class, I was one of only two people who completed homework and one of eight people out of 30 who passed the course. I noted high anxiety from most female students, including myself, triggered by a mathematics professor who had little regard or patience for our lack of understanding of the simple mathematical concepts that underlined the coursework. Learning outcomes were assessed by using timed testing and were based on one’s ability to compute a numeric answer. Numeracy, the ability to apply knowledge to real world experience (Liljedahl, 2015), was discounted.

Working for 15 years as an adjunct faculty member in a nonmathematical business major program at an elite university, I was tasked with teaching elementary statistics in a five-week format. I consistently provided recommendations for improvements in the traditionalist methodology used. Overall, most students expressed anxiety-laden attitudes during the first class; almost exclusively, however, the females persisted in negativity, even though they
exhibited competency and mastery of concepts. The course was revised to complete computations using Microsoft Excel, to emphasize numeracy (statistical literacy) by providing contextualization to calculations, and to promote active learning strategies by replacing the lecture format with assignments that required peer and instructor collaborations (Weimer, 2016).

Finally, as a full time professor at a college that offered remediation and hope to poor, disadvantaged, minority, and traditionally underrepresented populations living in and around a large metropolitan area, I fine-tuned my ideas about the teaching and learning of elementary statistics. When faced with taking elementary statistics, I found that female students from less-affluent environments exhibited the same fear and anxieties as their elite counterparts, but the added variables of low income, poor elementary and secondary educational experiences, and difficult family histories, provided another layer of obstacles, especially for the female students.

My lifelong experience has honed a passion to investigate and remediate the barriers for females in search of educational success and better career choices. To reduce my personal incidence for bias, during the scope of this research study, I declined all involvement as an instructor in elementary statistics courses to suspend pre-conceived notions of how the women would describe the factors that represented barriers to their learning.

**Research Questions**

This study addressed the following research questions in attempt to discover the underlying cause of math anxiety for the underrepresented female adult college student in elementary statistics. It used a qualitative research design that and factored into the analysis the lived experiences and interpretations from administrators, faculty, and the students in a higher education setting where elementary statistics was a core and required course in all undergraduate curricula, science and non-science majors alike.
Research question 1: What factors contribute to math anxiety in a population of female adult higher education students who are disadvantaged simultaneously by gender, race and or/ethnicity, economic status, and educational background as they pursue non-mathematical majors requiring enrollment in an elementary statistics course?

Research question 2: How do higher education administrators, faculty, and students believe math anxiety influences performance for a traditionally underserved and marginalized female adult student population in an elementary statistics course?

Research question 3: What strategies are identified by higher education administrators, faculty and students to help relieve math anxiety for a traditionally underserved and marginalized female adult student population in an elementary statistics course?

Theoretical Framework

Overview. Stage environment fit theory (SEF) was the framework selected to underpin this study because the model links achievement to students’ perceptions of autonomy, relatedness, and competence; within the framework, these factors are mediated by how strongly these constructs are interwoven into the academic organization (school fit) (Zimmer-Gembeck, Chipuer, Hanisch, Creed, & McGregor, 2006). This case study utilized SEF to investigate how an academic organizational structure, social climate, and instructional processes framed student behavior. The data collected was be interpreted using a qualitative research method (Eccles, 2004).

Eccles et al, (1993), prominent researchers of behaviors that affect cognition and primary developers of SEF theory, proposed that the beliefs and practices that define the educational environment affect a student’s expectations, experiences, and motivations (Eccles et al., 1993). Eccles and Roeser (1999) further developed SEF by describing the organizational context as a
multilayer hierarchal system with levels of increasing complexity structured in rank order and ingrained into a cultural environment. Within this system are “regulated processes which are organizational, social and instructional in nature” (p. 126) that connect student behaviors to levels of achievement (Eccles, 2004). The author asserted that it is also important for academia to have the agility and flexibility to change, based on the needs of students, to ensure continued motivation, interest, and engagement (Eccles, 2004).

**Framework components.** SEF theorists have posited that individuals are motivated and engaged in learning when their physiological needs (constructs) for autonomy (control), competence (self-efficacy), and relatedness (belonging) are satisfied within an academic organization (school fit) (see Fig. 1) (Jenkins-Guarnieri, Vaughan, & Wright, 2015; M. T. Wang, 2012; Zimmer-Gembeck, et al.;2006, ). The constructs of autonomy, competence, and relatedness are interrelated, and all three must be satisfied for optimal achievement (Jenkins-Guarnieri et al., 2015, p. 267). A supportive academic environment that fosters school fit as the overarching influence is critical in motivating all students; researchers have found that school fit also leads to significant success in galvanizing low achievers (Jenkins-Guarnieri et al., 2015, p. 267).

*Autonomy* relates to how free an individual perceives he/she is to independently determine their own needs and the level of agency they possess to make changes (Jenkins-Guarnieri et al., 2015). This control is granted by the academic organization, which provides all the necessary resources for proficiency development (Jenkins-Guarnieri et al., 2015). Freedom of choice, in this context, encourages students to seek challenges that will improve their skills, ultimately increasing competence and self-determination. Students who perceive they possess
greater expertise in executing assignments embrace opportunities to hone their abilities, and they simultaneously find satisfaction in demonstrating competence (Jenkins-Guarnieri et al., 2015).

*Competence* is defined as the “possession of a required skill” (Competence, n.d., para. 1), and perception of competency level is directly affected by changes in autonomy (Jenkins-Guarnieri et al, 2015). Students with discretion to access resources for improvement sanctioned by the economic environment are more likely to experience high self-efficacy beliefs and are motivated to cultivate and sharpen their knowledge (Jenkins-Guarnieri et al., 2015). As students feel empowered and perceive a high quality of competence, they become more closely aligned with the culture and seek affinity/relatedness within the environment (Jenkins-Guarnieri et al., 2015).

*Relatedness* is defined within SEF theory as an “individual’s relationship with others” (Jenkins-Guarnieri et al., 2015, p. 267) This construct includes connectedness fostered by demonstrations of caring; it is a reciprocal arrangement between the student and the various components of the academic environment. The environment of relatedness focuses on student-teacher and student-peer relationships, which are simultaneously supported and influenced by the academic environment. Agency here, however, rests on the individual, who must seek belonging, since trust is established as the constructs of autonomy and competence are fulfilled.

*School fit* is understood as the model’s main outcome representing achievement for college students. A student’s perception of how seriously the academic organization promotes autonomy, competence, and relatedness helps to solidify instructor and peer relationships, and it is these relationships that create the path from school fit to achievement (Zimmer-Gembeck, et al., 2006).

**Linking the theory to the study.** The SEF theory model indicates that student performance improves when favorable relationships develop between peers and instructors, facilitated by the academic environment (Jenkins-Guarnieri, et al., 2015; M. T. Wang, 2012). SEF theory suggests a causal link between student perceptions of an academic organization’s culture, individual motivation, and subsequent career choice (M. T. Wang, 2012). Therefore, student learning difficulties and negative academic behaviors can result from a “mismatch” that develops between individual needs (autonomy, competence, and relatedness) and school fit, the latter which is defined by organizational influences (Symonds & Hargreaves, 2014, p. 54). These influences include the academic structure that provides the guidelines for creating academic
policies and procedures, the societal impact of family and community within the organizational culture, and sanctioned instructional methodologies (Eccles, 2004).

Academic policies and procedures determine which courses are contained within a discipline and establish standards for instructor content mastery. Elementary statistics is traditionally assigned to the mathematics discipline, where most faculty hold masters or doctoral degrees in mathematics (Artzt, Sultan, Curcio, & Gurl, 2011). An essential question that continues to be inadequately answered and that has caused controversy within academia is whether or not the disciplinary placement of and instructional methodologies assigned to this course are appropriate. In short, is elementary statistics really a mathematics course or should it be taught in other disciplines (Ben-Zvi & Garfield, 2008)? This controversy is a result of research studies that have explored the extent to which students successfully apply reasoning skills to real-world problems after completing an elementary statistics course. These studies have reported significant misconceptions in applying statistics as mathematical concepts to support logical conclusions, and researchers recommend using “authentic activities” (Ben-Zvi & Garfield, 2008, p. 356) to improve understanding. These activities include student engagement in collecting data, explanation of the relevance for each statistical test, and recognition of the implications or consequences derived from statistical analysis (Ben-Zvi & Garfield, 2008). Most importantly, statisticians support moving the elementary statistics course from the mathematics discipline to sub-fields because learning outcomes should focus on comprehension or “insights” rather than numerical answers (Ben-Zvi & Garfield, 2008, p. 356).

Socially, the traditionally underserved adult female often returns to higher education with fears and apprehensions formulated in early youth which are related to math competency. Societal influences, systemic to families and the academic organizational culture, take the form
of gender stereotyping and dysfunctional beliefs that include assertions claiming math ability is
genetic or that there is only one method and one answer to a problem. Among female adults,
stereotypes moderated by “gender identification, stigma consciousness, and beliefs about
intelligence” are rooted in early childhood experiences, and these filter perceptions of self-
efficacy (Flore & Wicherts, 2015, p. 28). These influences are exacerbated by poverty, and/or
inadequate elementary and secondary public school education (Firmin & Proemmel, 2008).
With an absence of access to remediation resources prior to acceptance into an institution of
higher education, students engage in a course from the mathematics discipline ill prepared;
simultaneously, the way the course is situated and designed does not readily help them to
identify and fill their gaps in mathematical knowledge. Many average students have reported
feeling alienated and lost because of the way math courses, particularly required statistics
courses, are taught; this creates a dynamic of isolation and heightened anxiety (Firmin &
Proemmel, 2008).

Instructional influences have a tremendous impact on channeling organizational and
societal forces to further demotivate the traditionally underserved female student. Scholarly
evidence has indicated that fear and anxiety levels for females undertaking mathematical courses
are created and exacerbated by traditional instructional methods that reinforce dysfunctional
beliefs about gender superiority and the supremacy of rigid, linear, and non-applied mathematics
instructional techniques (Williams, 2013). In this context, in 1992, the American Statistical
Association (ASA) funded the Guidelines for Assessment and Instruction in Statistics Education
(GAISE) to upgrade traditional teaching methodologies to include statistical literacy or
numeracy in the teaching of elementary statistics (Aliaga, et al., 1992). In 2005, the ASA Board
of Directors adopted the GAISE-suggested changes to the approaches used for teaching statistics.
These changes created new guidelines to promote reforms in statistical teaching aimed at mitigating fear and anxiety issues by employing critical skills of conceptual understanding, by using: real life data and technology and active learning, by incorporating student-centered problem solving, and by implementing revised assessments that eliminate rote testing instruments (Everson, Zieffler, & Garfield, 2008). Unfortunately, at the time this study was conducted, despite ASA mandates to reform traditionalist teaching methodologies, elementary statistics teaching and learning had remained focused on the process and results of calculation, rather than on outcomes based on analysis and application (Hassad, 2009; Tishkovskaya & Lancaster, 2012). In this case study, data collection using qualitative research examined the impact that a traditionalist approach had on students by documenting the narratives of students’ lived experiences and by analyzing the environment of learning in which they were immersed.

SEF theory recognizes how the constructs of autonomy, relatedness, and competence are affected by the processes defining an academic environment (school fit). These processes incorporate policy and procedures, culture, and classroom techniques into setting up a relevant school fit. However, not all researchers agree that this framework adequately addresses the issues related to the traditionally underserved adult female higher education population.

**Critics of SEF theory.** The original SEF theory focused on adolescent development, and its main purpose was to examine the degree of difficulty adolescents had transitioning from elementary to middle or secondary schools. It explored possible links between adolescent biological development and the degree to which the academic environment supported their needs during this period of individual and institutional change (Eccles & Midgley, 1989). SEF has also been used to frame adult needs in the higher educational environment, but much of the research has still remained focused on adolescents. As Symonds and Hargreaves outlined (2014), other
limitations to the framework include: (a) autonomy, competence, and relatedness represent a minimal number of variables that can affect student adaptability; (b) environmental influences should also be inclusive of “immediate experiences, proximal settings found in the home, and distal or national economic environments” (p. 58); (c) more in-depth studies are needed to understand if the “mismatch” (p. 58) between needs, and the extent to which environment is truly a school domain or simply a normal product of development; and, finally, (d) the need exists for further research on adolescents and adults that links the current psychological experiences with the learning environment of the 21st Century (p. 36).

Regardless of these concerns, SEF theory was confirmed as an appropriate framework that allowed the researcher to view how math anxiety is constructed and perpetuated by examining the interrelationships between the math anxiety phenomena and the educational setting in which the traditionally underserved population of women was immersed. In addressing the limitations specified by Symonds and Hargrave (2014), prior research has affirmed that, in order for individuals to meet their psychological needs fundamental for “healthy development and well-being” (p. 266), they must satisfy the constructs of autonomy, competence, and relatedness as identified in SEF theory (Jenkins-Guarnieri et al., 2015). These constructs link engagement to the interactions of teacher and peer relationships that form the element of school fit within the SEF model (Zimmer-Gembeck, et al., 2006). Additionally, conducting an instrumental case study underpinned by the SEF framework, the researcher collected data from a variety of sources that represented the context of organization, society, and the students’ anecdotal experience in the classroom. This allowed her to uncover other variables/constructs affecting achievement through an analysis of the interpretations of administrative officials, faculty members, and students, using in-depth interviews and a
sophisticated coding process for analysis (Baxter & Jack, 2008; Stake, 1995; Yazan, 2015). This study, therefore, adapted and applied SEF theory through the lens of an in-depth instrumental case study (breaking new methodological ground) to better understand an adult’s relationship to higher education. Data collection stratified by race, culture, and gender assisted the researcher in identifying situations that create challenges and barriers to successful degree attainment for underserved women.

Fear of taking elementary statistics, a core curriculum subject, is a pervasive problem for the traditionally underserved adult female population attempting to improve their economic position(s) through higher education. Erosion of confidence and self-esteem can trigger the flight response and can ultimately result in highly competent females dropping out of college (Kerr & Kurpius, 2004). To identify and mitigate impediments to successful degree attainment, the researcher, in designing this study, identified that additional qualitative research was needed to uncover factors contributing to fear and anxiety levels in adult women enrolled in non-mathematical majors in preparation for or engaged in taking elementary statistics (Currie, 2014). She aimed to fill this gap. Thus, the goal of this research project was to incorporate SEF and solid qualitative data to analyze barriers and to contribute significantly to the design of teaching practices that address these obstacles.

Finally, the idea behind this study originated in a dissertation written by a mathematics professor from the school where the study was performed (Anonymous, 2014). Chapter 5 of that study suggested that, because of the abundance of outcomes on this topic using quantitative methodologies, future research was needed that included the collection and analysis of qualitative data to better understand math anxiety and its influence on students’ academic success or failure (Anonymous, 2014).
Therefore, this study explored the scholarly research into how a traditionally underserved and marginalized population of adult females experience math anxiety, how societal (home, community) and environmental (school) dimensions helped to perpetuate the problem within this population, and the compelling reasons for action to alleviate these circumstances. The researcher also skillfully identified mitigating factors to incite change agents to effect reforms and improve degree attainment in statistics and thus, ultimately, to increase the access by underserved women to lucrative STEM job opportunities for females.
Chapter II: Literature Review

Higher education academic achievement status in the form of degree confirmation comes with a challenging price tag and significant investment of time for many adult students. Academic institutions have the responsibility of providing all enrolled active students with meaningful and transferrable learning outcomes. As colleges and universities increasingly provide ease of access to degree programs and promote speed and flexibility to foster completion goals (McDonough & Robertson, 2012), organizations must carefully review current practices to ensure that all populations are provided with the essential tools and resources needed for successful degree attainment.

To achieve a higher education conferred degree, a student must successfully navigate through core requirements, many of which are labeled as barrier courses because of reported high failure rates (Shakerdge, 2016). These barrier courses are usually part of a STEM curriculum, and they are usually best handled when students possess a solid foundation in mathematics knowledge and confidence in their ability in this area. One factor that directly impacts learning and course completion, specifically for females, is math anxiety as an emotional response hindering performance, especially when self-efficacy is undermined (Schunk & Pajares, 2001). Although research demonstrates the narrowing of an achievement gap between men and women in mathematics, scant evidence exists that aims to uncover and explain factors that affect learning behaviors impacting the traditionally underserved, marginalized female population in relation to math achievement exacerbated by anxiety (Rinn, Miner, & Taylor, 2013).

This literature review focuses on themes derived from a synthesis of peer reviewed, seminal, and current research related to math anxiety, its origins, and manifestations. The review addresses scholarship on how females, who are more susceptible to math anxiety than males
(Cheema & Galluzzo, 2013, p. 110), construct a personal and academic, negative identity that is related to perceptions of self-efficacy and achievement ability originating in societal (family and community) and environmental factors (poverty). Finally, the review examines literature on the pedagogical approaches of academic institutions to mathematics and probes the ways in which those approaches do or do not translate into instructional methodologies that promote learning skills and effectiveness in this subject area. These factors and influences are analyzed in combination to identify challenges and barriers adult women who are a marginalized and traditionally underserved population face in overcoming math anxiety and successfully completing their degrees. The researcher also presents arguments to underscore the critical need to understand and control the factors driving math anxiety and to examine how a failure in elementary statistics for this female population can have far reaching educational and economic consequences.

Math Anxiety and Gender

Math anxiety is defined as a phobic reaction to academic courses that contain mathematical concepts as part of the course work (Ashcraft, 2002; Finlayson, 2014). Physical, cognitive, and emotional manifestations of math anxiety include tension, fear, reduced focus and concentration, memory gaps, mental disorganization, and worry (Nunez-Pena, Suarez-Pellicioni, & Bono, 2013, p. 36). Current studies have reaffirmed prior research outcomes that support math anxiety as a behavioral condition affecting focus and attention (Ashcraft, 2002; Young, Wu, & Menon, 2012; Wu, Willcutt, Escovar, Menon, 2014). This condition “is frequently linked to poor achievement in mathematics” (Finlayson, 2014, p. 99) caused by frustration, confusion, lack of persistence, and “shutting down” (Finlayson, 2014, p. 105). Students who suffer from math anxiety can experience embarrassment due to public exposure of math errors in a group.
setting (Bull, 2009), erosion of self-confidence and self-efficacy based on poor test results, and in many cases, a final outcome of failure (Nunez-Pena et al., 2013). As a result, these students are also more likely to avoid other elective math related course work, to extend time to degree completion, or to totally bypass or not even consider employment in the lucrative and highly available STEM careers (Ortiz & Sriraman, 2015).

The origins of math anxiety have been traced to early familial influences reinforced by educational delivery systems (Finlayson, 2014). According to researchers, these origins are “poorly understood” (Zirk-Sadowski, Lamptey, Devine, Haggard, & Szücs, 2014, p. 366), since how each individual experiences the phobia is varied and complex; therefore, each person’s perceptions of and reactions to math anxiety are different (Bledsoe & Baskin, 2014). Researchers have identified children as young as five years old expressing math anxiety as a reaction to learning (Ashcraft, 2001; Ruff & Boes, 2014; Young, et al., 2012). Childhood responses can foreshadow and shape an adult’s predisposition to math anxiety; behavior later in life is rooted in the memories of past experiences from family life and the early school environment. It is within this early childhood reality that perceived gender differences in learning are cognitively shaped. Progressively, these gender bias perceptions grow in importance and compound math anxiety, ultimately creating disparities in learning abilities between women and men.

Early historical beliefs about gender differences in learning competencies include the viewpoints that males have a more scholastically agreeable “active and curious learning style” (Vantieghem, Vermeersch, & Van Houtte, 2014, p. 359) while females are tagged as “passive, compliant, and malleable” (Vantieghem et al., 2014, p. 359). These beliefs contribute to the perception that females demonstrate inferiority to their male counterparts in learning ability in
certain subject areas (Vantieghem et al., 2014). However, recent global academic performance statistics help to debunk gender comparison myths by reporting an insignificant difference in achievement between males and females, especially in the “masculine” domains of mathematics and science (Vantieghem et al., 2014, p. 359). Indeed, “recent research demonstrates that in many countries gender differences in mathematics achievement have virtually disappeared” (Ross, Scott, & Bruce, 2012, pg. 278). The chief reason for this change is a societal upheaval during the late 20th Century which expanded the personal power of females in the aftermath of the U. S. women’s rights movement of the 19th Century.

This power shift included women gaining inroads into gender equity status in male dominated hierarchies of business and educational organizations. With the United States as a global leader, U.S. women provided a gender equality example for the world to follow (Robbins, 2010). As more females returned to academia to take advantage of this elevated status, they exercised their power to access all educational options far beyond home economics or teaching careers (Vantieghem et al., 2014, p. 360). Given more choices, women began to select course work in STEM disciplines, broadening their expertise into heretofore male-dominated fields (Vantieghem et al., 2014).

Even though current research has consistently reported positive improvement trends in female achievement in mathematics with zero differences in gender competence, there is limited academic success for females in mathematical outcomes. As a result, researchers continue to examine factors that may provide an explanation for this inconsistency in performance. Further observation has indicated that females are less likely than males to enjoy mathematics or to feel pride in successful achievement of math and science course work (Louis & Mistele, 2012). Lack of affinity for course outcomes dampens enthusiasm and motivation to further engage in other
mathematical opportunities, ultimately causing women to remain underrepresented in STEM coursework and career selection (Louis & Mistele, 2012).

To examine the anomaly between gender equality in achievement and lack of equal representation in STEM careers, additional studies have explored confidence levels and their relationship to a willingness of women to engage in mathematical operations, and the ways these processes represent barriers to achievement (McGraw, Lubienski, & Strutchens, 2006). Researchers have posited that achievement can impact confidence, since increased levels of confidence are usually honed by demonstrations of knowledge, especially in mathematical subjects. As the gender achievement gap narrowed, researchers forecasted a similar outcome on the gender confidence gap. However, despite these predicted correlations, the gender confidence gap remained severe (Ross et al., 2012).

In applying this unexpected outcome to mathematical performance, researchers have discovered that erosion of confidence linked to math anxiety chiefly affects women (Wu, et al., 2014). Researchers have validated a strong relationship between math anxiety and behavioral processes that affect female accomplishments (Wu, et al., 2014). When math anxiety is present, female academic performance becomes limited. Factors contributing to math anxiety as a driver of performance include control and perceptions of competence (self-efficacy) (Bandura, Barbaranelli, Caprara, & Pastorelli, 1996).

Gender differences in mathematics achievement inflamed by anxiety are measured by “adaptive perception of control, (i.e. uncontrollability)” (p. 366), a behavioral aspect where males significantly differ from females (Zirk-Sadowski, et al. 2014). To clarify, an individual who believes she or he has control over learning is less likely to allow behavioral disorders to inhibit performance. For females, as feelings of uncontrollability increase, a learned helplessness
evolves which exacerbates a “susceptibility to fear and anxiety disorders” (Zirk-Sadowski, et al. 2014, p. 368) Students engaged in mathematics who consider it an “emotionally charged” (p. 786) subject are more likely to react using pre-programmed behaviors of learned helplessness when participating in coursework (Burić, 2015).

The second factor affecting female achievement is an individual’s perception of competency viewed through the lens of self-efficacy. Behaviorists Bandura, et al. (1996) in the late 20th Century identified the impact of competency and self-efficacy beliefs on student achievement positing that, in order to successfully achieve, individuals must believe they have the power to control and influence their outcomes (Bandura et al., 1996). Validating and expanding on the ideas of Bandura et al., Yüksel and Geban (2015) found that the strength of self-efficacy is believed to have a significant effect on anxiety levels and is a determinant of academic success for undergraduate students, especially in complex courses that require mathematics. Researchers have also asserted that males tend toward a higher self-efficacy and confidence perception than females, due to societal influences found in early youth that have the power to either strengthen or weaken gendered self-beliefs related to competency (Mumcu & Aktaş, 2015).

Math anxiety is not genetically determined; rather, it is a behavioral trait resulting from influences that promote negative emotional responses when individuals are faced with situations where advancement requires completion of challenging steps through an unfolding process. Females have a greater susceptibility to math anxiety, resulting in a major impact to their learning ability, despite the progress towards the elimination of a gender achievement gap. Issues related to control that result in this reduced sense of competency and self-efficacy, which contribute to the confidence gender gap, originate in complex societal influences which are
perpetuated through the structure and policies replicated in many academic environments. The culture of the academic environment, compounded by societal influences and childhood experiences, combine to compound the challenges and barriers marginalized and underserved females face when enrolling in math courses in college to pursue degree attainment.

**The Underserved and Marginalized Female**

**Societal influences.**

*Identity: Personal and academic.* Identity, defined as the “condition of being oneself” (Identity, n.d.), is basic to how human beings make sense of and react to the world. Identity helps us to provide meaning to our personal experiences. Positive identity formation is considered a “catalyst” for motivation and self-efficacy (p. 2355) especially in achieving academic success (Matthews, Banerjee, & Lauermann, 2014).

Academic identity is defined as how the student experiences “value and belonging” (p. 2355) in an educational setting (Matthews et al., 2014). Formation of academic identity is forged by a student’s view of “performance related feedback” (p. 2356) from a power authority, usually an instructor, and how strongly that student deems the feedback and observations valid and thus perceives value from the interaction with the assessment originator (Matthews et al., 2014).

Researchers have posited that students require a balanced framework of personal and academic identities to be sufficiently motivated to succeed (Matthews et al., 2014).

Researchers have also attempted to link continual underachievement to personal and academic identity formation in traditionally underserved and marginalized populations. Scholarly literature has recognized how students labeled with an underrepresented and minority status are significantly influenced by social and cultural stigmas first experienced in childhood in a familial and/or community context which later extend into the academic environment.
(Matthews et al., 2014). Therefore, the factors affecting the construction of personal and academic identity is a likely predictor of performance and achievement, especially for females. Females are exposed, at an early age, to influences that skew identity perceptions and impact how they learn (Zirk-Sadowski, et. al., 2014). In the home, high expectations from parents or guardians for mathematical ability and achievement can lead to feelings of despair when children are reprimanded for errors or low scores (Whyte & Anthony, 2012) or when they are compared to siblings who exhibit a higher degree of mathematical competence (Finlayson, 2014). Young children, when observing a parent or guardian’s lack of competence when helping with homework, may determine a subject’s difficulty level based on parents’ expressions of their ineptness rather than on their own actual ability (Bowen, Hopson, Rose, & Glennie, 2012; Whyte & Anthony, 2012). In academia, female instructors may unwittingly scaffold these familial influences, having been exposed themselves to negative interpretations of ability (Whyte & Anthony, 2012).

The negative self-efficacy beliefs created in the home are often replicated within the classroom culture. Classroom culture is defined as “behaviors and norms that guide classroom interactions” (Whyte & Anthony, 2012, p. 8), and it is highly influential in contributing to an individual’s personal and academic identity. This culture is shaped by the instructor’s own beliefs about her/his self-efficacy, and the organization’s oversight which limits the agency of the instructor in their choice of instructional methodology.

Female instructors come to the classroom preparing for course delivery based on constructions of their own personal and academic identity. An instructor’s personal self-efficacy beliefs related to teaching ability are substantiated by demonstrated mastery in their field of expertise. Within the current mathematical pedagogy, instructors authenticate their mathematical
skill based on prior excellence in performing mathematical functions quickly and accurately. For many female instructors, this demonstrated competency helps to overcome any familial influences that taint perceived teaching ability; however, this competency is based on a linear positivist methodology more conducive to interpretation by males. As a result, the very self-defeating messages sent in the home environment about “I can’t do math” can readily be reinforced by the instructor’s own dysfunction in relation to her identity (and ability) and by forced participation in rigid and inflexible instructional methods.

Personal and academic identity is formulated and reinforced in the early childhood growth environments of home and school where researchers have claimed a “sense of marginalization” originates (Hughes, Nzekwe, & Molyneaux, 2013, p. 1979). Within these identity constructs, preconceptions, bias, and behavioral practices originate that can potentially inflict damage to self-efficacy beliefs for the traditionally underserved female, whether she is a student or an instructor. Dysfunctional beliefs and stereotyping are two major marginalization practices located in the home and in the school that have the potential to incite math anxiety and help create significant repercussions, lessening the quality of achievement for the traditionally underserved female population.

**Dysfunctional beliefs.** Dysfunctional beliefs are defined as abnormal ideas that can harm or create a negative impact. Dysfunctional beliefs are not context dependent; they are constructed in a person’s mind and do not actually exist within a situation. Family, society, academia, media, and pop culture popularize dysfunctional beliefs by promotion leading to acceptance of unrealistic, negative, and many times untrue interpretations (Karnaze, n.d.). Bandura et al. (1996) posited that a personal belief system has the power to impact an individual’s capacity to enact optimal coping strategies of resilience, persistence, goal setting,
and response to failure. Therefore, development of a personal and academic identity rooted in a highly suggestable belief system, when exposed to dysfunctional beliefs, may be inadequate when an individual is dealing with potential future challenges.

In the home, dysfunctional beliefs are usually initiated by familial influences and can be a result of a parent or guardian’s early experience with mathematics. If this past experience is negative, the parent or guardian will create a dysfunctional belief to help justify their own challenges with learning and then pass this explanation along to a child as truth. For example, parents or guardians who experience low mathematics achievement may excuse that same behavior in their children, citing their own lackluster performance as a standard. By accepting lower standards, parents/guardians promote beliefs that their child may be “incapable of learning mathematics” (p. 7), or they can provide an “excuse to stop” (p. 7) which can also result in dampening a risk-taking spirit in a child (Whyte & Anthony, 2012).

In academia, several dysfunctional beliefs originate due to false biological interpretations, unawareness of differences in gender learning styles, or how a curriculum best fits an individual’s perceptions when processing information (Bhatti & Bart, 2013). These beliefs, when reinforced by pedagogy, have the capacity to interfere with the learning process (Ross et al., 2012) and include: (a) the existence of a “math brain” (p. 8) where male math superiority is located (Whyte & Anthony, 2012); (b) math ability is rigid and fixed; (c) problems are solved quickly and mainly by computation; and (d) math knowledge is unique and not transferrable from other domains (Ross et al., 2012, p. 279). Academic support of these beliefs can be rooted in and perpetuated by a traditional or positivist mathematics learning environment which follows a methodology using rote learning, timed testing, single answer assessments, and concrete problem solving; these skills favor the aptitude of the male gender (Ross et al., 2012). Current
Guidelines for Assessment and Instruction in Statistics Education (GAISE) mathematical reforms suggest a transition to a more constructivist methodology (GAISE College Report, 2016) which maintains that learning and knowledge is “constructed by the individual” (Nandwa, Wasike, & Wanjala, 2015, p. 32) and includes active learning strategies that include peer collaboration with math problems grounded in reality and multiple correct answers (GAISE College Report, 2016; Ross et al., 2012). Researchers have discovered that implementation of a constructivist approach in a math classroom allows a peer group dynamic to enhance exploration and identification of mathematical solutions; analysts have continuously asserted that this approach better supports a female learning style (Freeman et al., 2014).

Between familial and academic pressures, there exists a new resource that influences females and their acceptance of dysfunctional beliefs. The exponential growth of social media, an outcome of a 21st Century technological explosion, provides easy access to communications, socialization, and self-fulfillment (Eroglu, 2015). Facebook, the most commonly used social media site across the globe, is now recognized by researchers as an addictive behavior amongst female higher education students, with individuals experiencing withdrawal symptoms when they attempt to reduce the amount of hours spent in the application (Eroglu, 2015; Thompson, & Lougheed, 2012).

Maintaining these online friendships becomes a critical function of everyday life, as students find self-fulfillment in seeking like-minded individuals to share and validate personal ideas and beliefs (Eroglu, 2015; Thompson et al., 2012). For example, within Facebook, an “I hate Math” group was created to promote math failure as a socially acceptable outcome since “likes” on the page demonstrated that math failure is experienced by many people, and through a “communal camaraderie” (Aydin, 2012, p. 1097), it provide credibility to unsuccessful outcomes
(Whyte & Anthony, 2012). As females find plausibility in dysfunctional beliefs, blatantly sanctioned in social media, they become more vulnerable to other types of demotivating influences. For the traditionally underserved and marginalized female population, stereotyping and stereotype threat are the primary demotivating influences that have the greatest potential to impact motivation and achievement.

**Stereotyping and stereotype threat.** Stereotyping, the act of ascribing a stigma to group’s social identity (Flore & Wicherts, 2015), is a common experience for a marginalized or traditionally underserved population. Marginalized females, who have inscribed in their identity formation in childhood the perception of inferiority in math, are highly influenced by stereotyping, and have a high propensity to conform to negative behavioral interpretations proposed by the stereotype. This conformity, known as “stereotype threat” (Flore & Wicherts, 2015, p. 25) significantly affects performance in a stigmatized population (Galdi, Cadinu, & Tomasetto, 2014).

In mathematics, overriding cultural and gender stereotypes found in the United States include “girls don’t do math” (Cvencek, Meltzoff, & Greenwald, 2011, p. 766), females “lack mathematical ability” (Ross et al., 2012, p. 280), or STEM domains are bastions for male intelligence, while females are better suited to humanities (Kurtz-Costes, Copping, Rowley, & Kinlaw, 2014). A chief contributing factor for the endorsement of these erroneous beliefs is that in adolescence, females excel at verbal skills earlier while males favor mathematics and science (Kurtz-Costes et al., 2014). Math-adverse females exposed to stereotyping experience frustration and fear; this practice also creates a significant hurdle for those females who embrace math.

Within this context, females who succeed in mathematics are stereotyped as “cold, assertive, and independent” and fulfilled by pursuing a career (Kao, 2014, p. 20), in direct
opposition to the traditional gendered view of being “warm, caring, and sociable” (p. Kao, 2014, p.21), characteristics defined as part of the nurturing role. To gain acceptance and retain superiority, many mathematically strong females will align themselves with masculine characteristics and preferences that support gender stereotypes (Kao, 2014). For those females who choose a teaching career, exposure to stereotyping not only affects the female teaching methodology, it creates confusion for the female student seeking compatible learning approaches and resources from female instructors.

Stereotype threat is the judgment of an individual’s skills and ability based on a negative perception. For example, female underperformance in mathematics can be explained by the dysfunctional belief that males are superior in math (Spencer, Steele, & Quinn, 1999). Therefore, those individuals exposed to and negatively affected by stereotyping, especially in youth, are more susceptible to believing for most of their lives that the stereotype condition is based on truth, and that it is therefore credible. Prior study outcomes related to evaluation of females achievement in mathematics who are exposed to a stereotype threat (Flore & Wicherts, 2015, p. 26) found that females are more likely to score lower in mathematics and ultimately less likely to choose a STEM career (Flore & Wicherts, 2015).

Students from minority and traditionally underserved populations who are subjected to stereotyping and/or who buy into stereotype threat are more likely to avoid engagement in college life including socialization, peer collaborations, and creation of a supportive resource network (Martinez-Vogt, 2015). This self-enforced isolation leads to feelings of exclusion and helplessness, and, since there is little or no supportive resource network, it oftentimes results in students dropping out (Martinez-Vogt, 2015). Additionally, when these preconceived stereotypical ideas are reinforced and perpetuated by individuals in positions of relative power
(parents and instructors, especially female teachers), there is a resulting student “self-silencing” resulting from a fear of challenging authority which thus severely curtails a student-instructor relationship and eliminates the possibility of the students raising questions and presenting objections to instructional content (Martinez-Vogt, 2015, p. 2). As a student becomes isolated from peer and instructor resources, individual perceptions have the potential to become skewed by the negative influences found in society; this dynamic ultimately undermines self-efficacy beliefs.

**Achievement vs. self-efficacy.** Another societal influence experienced as an aftermath to identity construction is the female’s perception and struggle with performance-based achievement which is influenced by self-efficacy beliefs. Self-efficacy is defined as an individual’s personal judgement of their skills and abilities, which is altered by factors of: (a) perceived mastery of complex tasks; (b) observations of others’ unsuccessful experiences or peer models; (c) feedback quality and persuasiveness; and (d) heightened levels of anxiety, stress, and other adverse physiological states that affect learning (Lin, G. Y., 2016, pp. 545-546). When these factors are negatively perceived, performance and achievement is diminished.

Researchers affirm that, in the 21st Century global environment, female presence in STEM course work and careers has “dramatically increased” in many nations, except for those countries promoting strong gender stereotypes (Miller, Eagly, & Linn, 2015, p. 631). Based on these outcomes, researchers are seeking to understand gendered differences and are identifying intervening behaviors that affect achievement and that create the gap between female ability and performance in the U.S. population (Vantieghem et al., 2014). In a global context, researchers have determined that a female’s academic performance is equal to males, especially in mathematics, in those countries that support gender equality; however, when gender equality is
compromised, this performance is adversely affected. Researchers have attributed this decline, in part, to an individual’s doubts about self-efficacy, which results from overall societal gender inequality (Lin, G. Y., 2016).

In the United States, many studies that examine the relationship between gender and self-efficacy have indicated that males demonstrate a higher degree of self-efficacy, especially in tasks which are highly complex – for example, in elementary statistics (Lin, X., 2016). Consequently, females are more likely to hold deficient self-efficacy beliefs shaped by identity factors. As a result, they experience a decline in academic performance especially when confronted with the complexities of elementary statistics. As academic performance declines, self-confidence is affected. and persistence in the face of adversity is compromised.

Self-efficacy beliefs are strongly linked to academic persistence (Lin, 2016). Students with high self-efficacy beliefs are more likely to persist and find solutions to challenging situations, especially in academics related to STEM (Lin, 2016). Although prior studies have affirmed that the gender variable alone does not influence persistence statistics (Stewart, Lim, & Kim, 2015.), the traits needed for persistence (high locus of control and strong self confidence in facing complex tasks) are more common for males who are not as heavily exposed to or influenced by societal factors of dysfunctional beliefs and stereotyping practices (Stewart et al., 2015).

Within the mathematics classroom, the female instructor exists as a mentor and provides a role model for the traditionally underserved and marginalized female student; this instructor would ideally have a positive influence on persistence and retention rates. Researchers have posited that, for the underrepresented population, exposure to a positive role model is a critical component that provides a solid example of goal achievement and incites motivation (Hughes et
However, for those females who have overcome academic challenges and barriers to attain higher education degrees and who secure lucrative career positions, negative self-efficacy beliefs continue to impact long-term female performance because of the erosion of confidence in personal competency. Successful women who are exposed in childhood to dysfunctional beliefs and stereotyping practices may persist in underrating their successful performance as substandard because they believe that they will be ultimately be unmasked as frauds (Robbins, 2010). This outcome is known as the “imposter syndrome” (Robbins, 2010, p. 1) and is prevalent when educational authority systems characterized by patriarchal hierarchies and steeped in gender bias and prejudices sets standards through which the genders are rated and compared (Robbins, 2010). Researchers have validated that, in the 21st Century, “myths about women’s competence or its lack still abound” (p. 1) and are “perpetrated by men to defend their privileged turf” (Robbins, 2010, p. 1). A female instructor, riddled with doubts about competence and self-efficacy, is at risk of not being able to provide the traditionally underserved and marginalized female student with authentic mentorship and role modeling that could help her overcome stereotyping and dysfunctional beliefs (Hughes et al., 2013).

Societal influences that help formulate a female’s personal and academic identity are the primary catalyst for achievement because females commonly view success through the predetermined lens of self-efficacy. Exposure to dysfunctional beliefs and stereotyping limits a positive identity construction, ultimately affecting a woman’s ability to react intelligently and powerfully to assertions of gender bias, perpetuating self-defeating behaviors.

Math anxiety is learned behavior that is cultivated in early childhood at home and in society through the construction of a personal identity that is exposed to false negative beliefs about gender equality. As the child enters the academic environment, their personal identity is
extended to include an academic identity influenced by a linear, patriarchal structure that
constricts curriculum to a traditional approach that is less favorable to female learning. Failure
to mitigate these obstacles leaves the traditionally underserved and marginalized female
population vulnerable to the environmental influences of poverty that perpetuate economic
deficiencies and that also pose additional challenges to successful degree attainment.

**Environmental Influences**

The War on Poverty in the United States began in 1964 with the enactment of legislation
to address educational gaps for the poor, especially children (Sparks, 2014). Although federal
policies and programs have helped to improve services (immunization, school breakfast and
lunch, national healthcare, college Pell Grants, and other services), President Johnson in his 1964
State of the Union address warned that money and jobs were only be a “symptom of the
problem” (Sparks, 2014, para. 4) and that the real culprit was “our failure to give our fellow
citizens a fair chance to develop their own capacities” (Sparks, 2014, para. 4). Fifty-two years
later, many females continue to live in poverty and are considered at risk to access, persist
through, and graduate from higher educational programs, which ultimately stunts their
opportunities to improve career options and to build economic stability (Drotos & Cilesiz, 2014).

**The feminization of poverty.** Within the United States, 14.8% of the population lives in
poverty; 21% of these individuals are children under the age of 18 living predominately with a
female as head of household (Eichner & Gallagher-Robbins, 2015, p. 1). In 2014, the US
Census Bureau reported the persistence of a “feminization of poverty” (Merino & Lara, 2016, p.
1) stating that the poverty rate for women has remained at “historically high levels” (Eichner &
Gallagher-Robbins, 2015, p. 1) where “more than one in seven females live in poverty” (Eichner
& Gallagher-Robbins, 2015, p. 1).
The “feminization of poverty” (Merino & Lara, 2016, p. 1) refers to the disproportionate representation of women as heads of households living in poverty (Merino & Lara, 2016). The factors contributing to this phenomena include: (a) gender disparity in levels of income (gender wage gap) (Alter, 2014); and (b) an increase in single mothers as head of household responsible for the care of minor children (Alter, 2014).

Gender disparity in levels of income, despite equal pay legislation, continues to be a problem in the United States. Despite the fact that many females are returning to higher education and graduating, women still earn only “77 cents for every dollar a man earns” (Gorski, 2013, p. 45). Also, during periods of economic instability, men and women alike are affected by unemployment; however, as the economy improves and employment opportunities multiply, women continue to be plagued by higher unemployment rates, and they are “73% more likely to live in poverty” (Gorski, 2013, p. 45). Despite the current bleak reality of gender wage disparity, as more females achieve economic gains through attainment of higher education degrees, they amass more power to influence future legislative actions to enforce gender equality in pay.

Poverty as a barrier to degree attainment for females, especially for females represented in minority and ethnic groups (Eichner & Gallagher-Robbins, 2015), is prevalent, especially for single mothers as heads of households with dependent children (SMHH), a statistic that has increased nationally during the 21st Century (Lovell, 2014). In fact, in 2014 the national poverty statistic for SMHH was 40%, compared to the male headed family statistic of 22% (Eichner & Gallagher-Robbins, 2015). Motivation to succeed for these females is tied to the desire to escape poverty conditions, but these women also aim to become role models for their children, promoting education as a necessary and desired outcome (Lovell, 2014). SMHH females living in poverty while pursuing higher education degrees face multiple and weighty challenges that
affect persistence. Retention rates of SMHH students are dependent upon additional support resources (childcare, remedial coursework, financial counseling) which also include the critical need for a positive academic experience that fosters understanding, mentorship, and growth (Lovell, 2014). Many underrepresented and underserved female students in the 21st Century understand that, to improve their economic status, they must successfully complete a higher education degree, despite exposure to many prevailing challenges, barriers, and socioeconomic obstacles. In fact, women in increasing numbers are completing undergraduate degrees and enrolling in master’s programs (Bidwell, 2014). However retention and persistence rates for females also remain high, due to significant barriers that continue to exist and that severely impede females from attaining academic success. As previously discussed, these barriers originate in childhood and are commonly reinforced by the culture and practices of the academic organization.

The Academic Organization

The academic organization, researchers have determined, has historically promoted policies and procedures that support “institutionalized sexism,” despite many legislative mandates over the past 50 years designed to improve conditions for marginalized females so they can acquire knowledge and credentials that will support them in obtaining STEM careers (Hughes et al., 2013, p. 1979). Although there is a limited availability of highly trained prospective applicants for STEM job opportunities, especially from minority and traditionally underserved populations, the academic organization has been slow to embrace learning strategies that would help females to easily participate in and navigate through barrier courses. Elementary statistics is a foundational requirement and a mathematics course that must be successfully completed for degree attainment in many fields. As it is currently taught, it is highly stigmatized
and feared by students (Currie, 2014; Firmin & Proemmel, 2008; Keeling, 2011). In general, the course unfortunately boasts an exceptionally high failure rate. However, although the academic community is well aware that reforms were strongly suggested by the American Statistical Association (ASA) in 2005, academic organizations have lagged in their efforts to improve instructional methodology for this core course. In fact, many educators and the Mathematical Association of America (MAA) are concerned with high failure rates in mathematics courses and consider this outcome as a major factor in school dropout rates (Shakerdge, 2016).

**Elementary statistics.** Elementary statistics is considered to be an academic “barrier course” (Bronstein, 2008, p. 32) because students perceive a formidable degree of difficulty in succeeding in it prior to taking the course, which results in emotional distress in the classroom (Bronstein, 2008). This attitude is reinforced by the location of elementary statistics as part of the mathematics discipline and by the predominance of instructors with advanced degrees in mathematics teaching it. Oftentimes, students will avoid enrollment in the class until their course schedule provides no other options (Bronstein, 2008). Although both women and men generally experience this same response prior to accessing the course, once the course is in progress, achievement vs. self-efficacy issues, as previously outlined in this chapter, fueled by math anxiety, create a significant gender divide in performance. The type of experience provided by academia in elementary statistics that hinders degree attainment for the traditionally underserved and underrepresented female student is rooted in classroom culture, teaching methodology, and the disciplinary placement of elementary statistics in the curriculum.

**Classroom culture.** Within the classroom environment, the instructor often has complete authority and freedom to select a teaching strategy that ultimately creates the classroom culture (Roseth, Garfield, & Ben-Zvi, 2008). The traditional mathematical classroom culture has its
roots in behaviorist theories that rely on positivist methodologies that employ a prescriptive approach of an ordered and structured lesson plan with little consideration of how best to engage the learner (Boghossian, 2006). This approach is predominately narrowed to the confines of the text and is delivered without personal insights or interpretation (Boghossian, 2006).

Additionally, in the assessment grading process, a behaviorist classroom relies on the instructor’s personal evaluation of correctness, which, when based on a positivist methodology, “conditions” (p. 716) learners that a subjective interaction is not part of an appropriate or correct answer (Boghossian, 2006). As a result, learning outcomes are assessed on knowledge acquired from a reliable outside source -- usually deriving from the text or from the instructor’s lecture (Boghossian, 2006).

**Traditionalist vs. constructivist learning styles.** Elementary statistics is a core curriculum subject taught by instructors from the mathematics discipline and required for many academic degree programs (Artzt, Sultan, Curcio, & Gurl, 2012). This predilection for mathematical instructors is rooted in the complexity of mathematics computation and the positivist understanding statistics involves, and it is supported by traditionalist pedagogy (Evans, 2007). Research has demonstrated that the incidence and severity of math anxiety is linked to this positivist and traditionalist teaching methodology (Finlayson, 2014). This model delivers instruction through: (a) a focus on basic mathematics skill honed by memorization; (b) a strict adherence to curriculum and text book information; (c) the establishment of the instructor as the authority figure with a passive audience; (d) assessments that are timed testing instruments with one correct answer; and (e) the discouragement of peer collaboration (Finlayson, 2014, p. 100). Researchers have validated that failure rates in mathematics can “increase up to 55%” when instructors employ a traditionalist, positivist instructional methodology, especially a lecture
format, and when they discount a students’ learning styles and interactive approaches (Cilli-
Turner, 2015, p. 833; Freeman, et al., 2014; Saxe & Braddy, 2015, p. 3).

A progressive model of education for all disciplines promotes a constructivist methodology that proposes the implementation of active learning strategies that engage collaborative and peer group interactions, where students report feeling more comfortable with less anxiety (Gorvine & Smith, 2015) A critical component of the 2005 GAISE reform methodology for elementary statistics focused on learning that employs a student-centric constructivist methodology that promotes collaborative learning with statistical literacy/numeracy as a final goal outcome. A constructivist methodology is not a prescriptive approach to course design; rather, involves the implementation of techniques that provide students the greatest opportunities for learning (Baviskar, Hartle, & Whitney, 2009). Recent research that supports the 2005 GAISE reforms has suggested that elementary statistics has been “well suited” (p. 834) to benefit from a change in instructional methodology to support statistical literacy as a facet of a constructivist methodology (Cilli-Turner, 2015).

Statistical literacy, the ability to apply reasoning and critical thinking skills to analyzing data, has become an integral part of learning outcomes in elementary statistics for those academic organizations that adopted the 2005 GAISE recommendations for a new framework for elementary statistics teaching and learning reform (Bargagliotti, Jacobbe, & Webb, 2014). As a result, teacher preparedness has increased in complexity from focusing on isolated mathematical concepts with concrete answers to incorporating mathematical functions that solve real-world problems and result in ambiguous, complex, and oftentimes multi-faceted answers. Current research, however, has posited that many teachers tasked with statistical course delivery “do not have the content knowledge necessary to teach statistics at the level suggested in the 2005
GAISE framework” (Bargagliotti et al., 2014); as a result, reform implementation has been delayed.

In 2016, the ASA’s GAISE committee created a report as an update to the 2005 GAISE reform suggestions. The report highlighted changes in the educational landscape for elementary statistics and made additional recommendations for future practice. According to the report:

- There is an increase in students studying elementary statistics, and since elementary statistics is a core curriculum subject, this coincides with the reported increase in number of individuals returning to school;
- Student exposure to statistical concepts is occurring in elementary schools, and statistics have become part of the academic standards of the K-12 Common Core curriculum;
- Academic focus on educational outcomes has increased due to pressure from the business and government sectors for employees who have the ability to extract insights from data garnered by applying analytical skills;
- Availability of advanced technology exists that is designed for improvements in statistical teaching and learning, including designated software packages;
- Growth in alternative course methodologies is occurring, including online, hybrid, and flipped classrooms which foster innovation in course delivery; and
- Dissatisfaction with traditional methodologies is growing from academic administrators, instructors, and students (GAISE College Report, 2016, pp. 4-5)

Researchers have documented that traditionalist practices cause frustration for students and instructors; however, some statistics professors persistently ignore GAISE reforms. The 2016 updated GAISE draft report recommendations suggested qualification guidelines for statistics teachers that include knowledge of elementary statistical concepts linked to literacy
application plus mandatory training in available technological resources and active learning strategies that support diverse learning styles (Cilli-Turner, 2015; GAISE College Report, 2016). This shift in attention to learning styles is crucial to supporting females in successfully navigating the content of a barrier course like statistics.

The issue of pedagogy and its relationship to learning styles has been extensively explored by researchers attempting to understand the gender self-efficacy gap that exists in high task-performance in barrier courses (Hughes, et. al, 2013). Researchers documentation of current trends report that “tailored instruction” (p. 1) designed to fit learning styles can positively influence performance for this population (Bhatti & Bart, 2013). These trends suggest that female learning styles differ from male styles significantly as females are generally flexible, prefer instruction based on reality, consider “multiple approaches to a problem” that incorporate peer collaboration and reflection on outcomes; males, meanwhile, are claimed to be “rational, unemotional, solitary and prefer abstract ideas (Bhatti & Bart, 2013, p. 2).”

**The teaching and learning of elementary statistics.** The 21st Century mathematics curriculum in higher education is focused on the collection, evaluation, and interpretation of data to provide students with the ability to think critically and demonstrate credibility when formulating evidence-based arguments (Ben-Zvi & Garfield, 2008). Employers expect that higher education graduates, as participants in an available hiring pool, will be fully prepared to synthesize data with a high degree of skill for accuracy in decision-making (Ben-Zvi & Garfield, 2008). To achieve this outcome, the original 2005 GAISE reforms model suggested an increased focus on statistical literacy or numeracy to promote outcomes which require emphasis on correlating problems to real world experience, using active learning strategies that support student-centric activities (Everson, Zieffler, & Garfield, 2008). The 2016 GAISE reform update
validated the continued need to “teach statistical thinking” (p. 6) through active learning strategies that work with real-life data within a relatable context; the reforms also recommended the creation of a “variety of statistical courses” designed to address the diverse needs of students (GAISE College Report, 2016).

Currently, in many academic organizations, elementary statistics is considered a foundational course that teaches students to explain the function of collected data by utilizing mathematical formulas to compute and isolate a statistic. As a female elementary statistics instructor for fifteen years with a non-mathematical degree, my experience at universities, community colleges, and business schools has provided me with a strong level of knowledge and analysis of statistical text book resources and their impact on pedagogical engagement practices.

The selection of a statistics text book is constrained by the academic organization’s hierarchy, usually the department chair. Many of the text books commonly used in basic statistics courses do not emphasize the application of mathematical formulas to real-world experience, also known as statistical literacy or numeracy (Rossman, 2015). In my experience, the content of text books for statistics courses predominantly focuses on the depiction of formulas with complexities not easily deciphered by the non-mathematical student. Students predisposed to feelings of math anxiety thus commonly experience heightened feelings of panic and anxiety after initially reviewing the text. As a result, how well students assimilate understanding falls fully under the domain of the instructor’s instructional methodology, usually chosen within the limitations set by the academic organization. The MAA has reported that mathematical courses using a traditional methodology have failure rates “55% higher than rates observed under more active approaches” (Saxe & Braddy, 2015, p. 3). This significant failure rate has caused a shift by some universities from passive instructional techniques that focus on
text books as a main resource to active learning strategies that promote engagement and team collaboration (Shakerdge, 2016).

The elementary statistics instructor is usually from the mathematics discipline and holds an advanced degree in mathematics. As a result, students who are non-mathematics majors are usually not well-versed in concepts that an instructor views as second-nature to mathematics instruction and learning (Lunsford & Poplin, 2011). Researchers have asserted that educators must be able to not only teach by creating the statistic, but by also anticipating and addressing how a student will “decode” (p. 2) this information through the lens of individual perception and unique learning styles (Green & Blankenship, 2013).

In an effort to create a progressive model of statistics education aligned with the 2005 GAISE suggested reforms, researchers Green and Blankenship (2013) created an elementary statistics course that blended content containing a statistical literacy methodology with a traditionalist pedagogy; they administered it to pre-service statistics instructors. Green and Blankenship (2015) asserted that, although the 2005 GAISE reforms provided a plan for reform, lack of a concrete plan would slow implementation. The purpose of their study was to create awareness for educators of the role they play in integrating student understanding with pedagogy, and how best to accomplish that goal (Green & Blankenship, 2013). The outline contents of the course included: (a) informal assessments with peer evaluations; (b) in-class exercises graded “solely for completion” and used as a participation grade (p. 6); (c) in-class discussion using pre-selected and assigned outside materials (journal articles, online media, news items) with a reflective requirement on student assessment of the material; (d) journal recording as a “safe place” to identify recurring themes leading to misconception and frustration (p. 7); and (e) formal assessments and exams. By combining statistical literacy/numeracy with pedagogy and
by linking themes uncovered by reflective journaling, the researchers hoped to establish
groundwork to create a new model for the teaching and learning of elementary statistics that
would be positively recognized and amply adopted. The results of the study were positive, with
preservice instructors increasing their own understanding of statistics and recognizing that an
instructor’s methodology has a significant influence on student performance, both components
that were influenced by reinforcing conceptual understanding rather than isolated concepts
(Green & Blankenship, 2013)

Green and Blankenship (2015) followed up their research of preservice teaching
methodologies with another study documenting outcomes of statistics courses administered to
students using active learning strategies promoted by the 2005 GAISE reforms. The researchers
reported positive outcomes including a change in perception that statistics was not strictly
mathematics as instruction but that it was focused on establishing “connections” (p. 324) to real
world scenarios rather than simply delineating “disparate mathematical facts” (Green &
Blankenship, 2015, p. 324). Additionally, despite the reduced association to the more linear
mathematical concepts of statistics, students were well prepared, if they chose, to proceed to
graduate statistical courses that were more mathematically concentrated (Green & Blankenship,
2015).

Higher education institutions throughout the country continue to revise curriculum for all
domains to include basic skills of writing, public speaking, and critical thinking as demanded by
future employers (Lazowski & Stopper, 2013). Academia has recognized the value of including
course outcomes not typically promoted, for example, writing skills in mathematics where
students’ assessments include questions that require interpretations through analysis (Lazowski
& Stopper, 2013). Curriculum revisions to an elementary statistics course have been
increasingly based on the 2005 GAISE reform guidelines and have included practices that better support a female learning style. These original reforms include (a) statistical thinking with an emphasis on conceptual learning, (b) active learning strategies using real-life contextually appropriate data, (c) use of technology to assist with calculations, and (d) assessments that contain feedback for improved understanding (GAISE, 2015). The GAISE reform strategies promote active learning as part of a constructivist methodology and thus foster increased achievement for the traditionally underserved and marginalized female by supporting their more favored learning style, creating an optimal academic environment for success in women’s degree completion (Fowler & Thomas, 2015).

Learning strategies should encourage and support females in eliminating the choice to drop out of school; colleges should provide mechanisms to increase the chances of underserved students to acquire higher paying positions, particularly in the very lucrative and highly paid STEM careers where labor statistics report that females and other minorities are severely underrepresented (Davison et al. 2014).

**Criticality of the Problem**

Math anxiety as a barrier to achievement for the traditionally underserved female population is recognized and validated by many prominent researchers. Math anxiety originates in the early construction of identity, both personal and academic, and is perpetuated by the academic organization. Dysfunctional beliefs and stereotyping/stereotyping threat are factors that sustain these negative perceptions that ultimately interfere with performance. Poor performance becomes linked to a limited belief in self-efficacy and influences future academic and career choices. For those females who actively pursue mathematics in the teaching profession, their competence is measured by how well they adapt to a patriarchal view of course
instruction, thus adding another layer of confusion and difficulty for the traditionally underserved female population in their classroom.

Within the environmental context, females as heads of households occupy a significant place within the nation’s poverty statistics. Poverty adds to the burden and challenge for the traditionally underserved and marginalized female population, as many females occupy low skill positions with meager remuneration, which continues to perpetuate the cycle of poverty. As these women access education to improve their economic situation, facing the challenges of flawed identity construction and limiting social factors, they become faced with a core curriculum that promotes math anxiety with limited access to viable role models, increasing their burden and limiting their options for success.

Math anxiety is determined to be a credible obstacle to degree attainment for the traditionally underserved female which results in significant long term consequences. Major ramifications to unchecked math anxiety are lack of representation in STEM careers and an increase in the U.S. poverty rate, particularly for the underserved female population.

Researchers have claimed that dysfunctional beliefs and stereotyping, which favor male approaches to learning academically over female ones, dampen the confidence of females, promote math anxiety, discourage participation in academic courses where mathematical outcomes are a chief requirement, and constitute a major factor in the lack of equal representation in STEM careers (Kao, 2015). In 2011 the President’s Council of Advisors on Science and Technology warned that the United States’ premier competitive edge in the global marketplace was at risk due to the insufficient numbers of students electing STEM majors for the pursuit of STEM careers, most notably in the traditionally underserved female and minority populations (Louis & Mistele, 2012, p. 1164). In 2011, the U.S. Department of Commerce
Economics and Statistics Administration reported that over the past decade STEM related job openings were slated to increase “3 times faster than non-STEM occupations” (Langdon, McKittrick, Beede, Khan, & Doms, 2011, p. 1); unfortunately, the United States faced difficulties in supplying the necessary academically prepared candidates to fill these positions (Ortiz & Sriraman, 2015). Researchers who have studied retention and persistence rates in STEM disciplines have posited that (a) underrepresented and minority students are not equally represented in STEM majors; (b) the need exists for early intervention and remedial strategies to assist students with complexities of STEM course work; (c) availability of internship opportunities will reduce anxiety and increase motivation; and (d) the need for STEM instructor professional development to hone student retention and engagement strategies is widespread (Ortiz & Sriraman, 2015, p. 58).

Poverty is a major barrier for successful degree attainment for the traditionally underserved marginalized female population. However this challenge, if not overcome, continues the cycle of poverty through the next generation. Researchers have found that the increase of females as head of household with young children results in “more poverty, more income inequality, and less salutary child development” (Haskins, 2015, p. 129). In the family structure where the head of household is bound to poverty, uneducated, and working in unskilled positions, children are less likely to have access to quality educational resources (McKinney, 2014). In the global environment, poverty is considered a human rights issues where 50% of the world’s children live in poverty (p. 204) which is “inextricably bound to the poverty experience by their parents” (p. 203) and “closely linked to women’s poverty” (McKinney, 2014, p. 206).

As the educational system promotes reforms which favor the traditionally underserved female population identified through the outcomes of quantitative and qualitative research, the future of
children can improve to the extent that females as care providers are better able to secure degrees and lucrative positions especially in STEM career opportunities (McKinney, 2014).

Contrary evidence. Several notable researchers have pointed to other factors challenging the idea that fear and anxiety in courses like statistics have a significant impact on inhibiting degree attainment and success for adult females. These factors include the documented narrowing of the achievement gap in mathematical computation ability for females and the increasing number of women represented in STEM majors.

Contrary to the emotional distress issues related to females’ performance in mathematics, researchers have continuously cited the narrowing of the achievement gap in mathematical assessment outcomes between the genders as evidence that problems such as math anxiety are not a severe as commonly stated. In a 2015 research study conducted by Stoet & Geary (2015) that assessed achievement in mathematics across the globe, “girls outperformed boys in 70% of participating countries” (p. 137) despite political and cultural inequities. Additionally, Ross et al. (2012) reported that females receive higher scores on report card grading in mathematics because females are known to “exert more effort” (p. 279) and are more apt to follow rules. As female mathematics performance steadily improves, improvement in self-efficacy has been expected as the next logical result (Ross et al., 2012).

Unfortunately, mathematic performance for the traditionally underserved and marginalized female population is still powerfully and adversely affected by societal factors that foster math anxiety and that erode self- efficacy perceptions. In academia, this population’s self-efficacy beliefs are further compromised by traditionalist instructional methodologies that ignore optimal learning resources which exacerbate low self-confidence and self- esteem. This commonly results in low scores or failure, and in many cases, in dropping out of school. As a
result, females are relegated to employment positions requiring low skills for minimal pay. For those women living in poverty, lack of academic achievement insures the cycle will continue due to a scarcity of economic resources; their children thus lack a convincing role model that can prove that success is possible.

In the 21st Century competitive environment, academic organizations commonly cite in their annual reports that female enrollment in STEM majors is steadily increasing (Smith, 2011). In 2008, female engineering majors increased 3% overall from 1989, and, more recently, large universities reported that 40 -45% of female degrees were being conferred in math and science majors (Olson, 2014; Rice, Lopez, & Richardson, 2013). STEM careers typically attract the best and brightest students, as financial compensation is assessed as one of the highest for this career, and qualified candidates are considered “prestigious” hires (Smith, 2011, p. 994). Also, employers who target STEM majors are increasingly focused on hiring candidates from underrepresented populations including females, minorities, the poor, and students with disabilities (Lee, 2014).

Researchers have affirmed an increase in global achievement for females in mathematics in gender-equal countries; however, in the United States, these scores are linked to high self-efficacy beliefs. The United States is considered a nation where gender inequality is prevalent, and researchers have found that high-achieving female students in the United States have utilized role models to avoid stereotyping practices and to learn better coping strategies (Ross et al., 2012). Also, narrowing an achievement gap should result in increased female recruitment for STEM positions, but actual employment numbers in these fields are stagnant (Smith, 2011). The reason for this stagnation is found in stereotyping practices which constitute the chief hypotheses for why females do not aspire to STEM career opportunities (Flore & Wicherts, 2015). When a
person lacks feelings of competency, other alternative career choices become more attractive (Davison et al., 2014). Researchers have affirmed that math-gender stereotypes formulated in adolescent females that influence perception of mathematics expertise become a predictor for success in college math and choice of career path (Steffens, Jelenec, & Noack, 2010).

In reaction to the “dire shortage of STEM workforce” (Lee, 2014, p. 262) the National Science Foundation’s Committee on Equal Opportunities in Science and Engineering (CEOSE) was created in 1980 to explore the reasons for underrepresentation and bias and to identify strategies to help alleviate the problem (Lee, 2014). In its most current Biennial Report to Congress, the CEOSE admitted that despite the achievements of underrepresented groups in STEM majors, “progress has been insufficient to meet increased needs and challenges” (CEOSE, 2013, p. 1).

**Conclusion**

Research points to the need for more empirical evidence to explain the causal relationship between personal identity that guides motivation and academic identity to influence performance, particularly in barrier courses such as math and science because of the way these courses set up an additional roadblock to successful academic outcomes, especially for underserved women (Matthews et al., 2014). Current studies have suggested the need for additional research that examines the multiple dimensions and intersectionality of identity for specific subject areas (eg. math, science)” (p. 2371); scholars claim it is crucial to “strengthen the empirical literature on achievement motivation among historically marginalized populations”(Matthews et al., 2014, p. 2359).

Researchers have also validated a significant problem related to math anxiety and its effect on female achievement. In fact, there is a plethora of quantitative research dedicated to
examining this problem through the lens of descriptive and inferential statistical analysis. Despite these past studies, researchers have noted that, within the existing research, there is very little empirical evidence that can meaningfully explain the causes of math anxiety (Ashcraft, 2002; Geist, 2010). They have suggested that future studies using qualitative methodologies are needed to address this gap (Burnes, 2014; Currie, 2014; Finlayson, 2014).

This study on math anxiety and the traditionally undeserved and marginalized female population was conducted using a qualitative methodological approach. Prior quantitative research on female identity formation and math anxiety had elicited responses based on very narrow questions translated into number values and interpreted through statistical measurement, as quantitative research focuses on collecting “measurable and observable data on variables” (Creswell, 2015, p. 14). Qualitative research focuses on insights from individuals unique viewpoints, gleaned from interviews and survey questions designed for a greater depth of response (Creswell, 2015). Quantitative research analysis is limited to the “mathematical analysis” (p. 19) using statistical interpretations while qualitative research allows for a more subjective interpretation of emerging themes and patterns (Creswell, 2015). Qualitative research recognizes the unique individual experience of anxiety and can identify a broad range of effects exclusive to each student affected (Plano Clark & Creswell, 2009 Creswell, 2015). Thus, the many prior studies undertaken using a quantitative method indeed statistically validated that math anxiety is linked to performance and self-efficacy for achievement in the female population; however, since the problem continues to create barriers for academic success, researchers have suggested additional studies be conducted from a qualitative perspective to more comprehensively explore this issue. This study effectively responded to this analysis of the gaps in the literature.
Finally, the 2005 GAISE reform movement and research from scholars such as Green and Blankenship (2015) have validated success in adopting active learning strategies that are more conducive to female learning. Further research using a qualitative case study approach, such as this analysis, can more accurately help uncover the non-statistical contributing factors involved in this phenomenon and can provide insights to better serve members of the underserved female population in their quest for a higher education degree, an economically sustainable career path, and a secure future.
Chapter III: Methodology

Overview

Math anxiety as an impediment to learning is the subject of many quantitative research studies. This study continued the investigation into the underlying cause of math anxiety using a qualitative case study to explore the experiences of the traditionally underserved and marginalized female population in an elementary statistics course. A single instrumental case study was the best fit for this research since math anxiety is a “contemporary phenomena” (Yin, 2014, p. 16) that was examined in-depth within its existing context (Yin, 2014) and which required additional data and findings to support or critique existing research (Iacono, Brown, & Holtham, 2011). This single, in depth, empirical inquiry of a phenomena utilized data designed to elicit “richly descriptive” (Merriam & Tisdell, 2016, p. 37) themes extracted from the “bounded system” (Merriam & Tisdell, 2016, p. 38) of administrators, faculty, and students within the context of the academic environment (Merriam & Tisdell, 2016); the data was interpreted through the lens of Stage Environment Fit theory (Zimmer-Gembeck, et al., 2006).

Research Questions

Research questions. The following three research questions guided this study:

1. What factors contribute to math anxiety in a population of female adult higher education students who are disadvantaged simultaneously by gender, race and or/ethnicity, economic status, and educational background as they pursue non-mathematical majors requiring enrollment in an elementary statistics course?

2. How do higher education administrators, faculty, and students believe math anxiety influences performance for a traditionally underserved and marginalized female adult student population in an elementary statistics course?
3. What strategies are identified by higher education administrators, faculty and students to help relieve math anxiety for a traditionally underserved and marginalized female adult student population in an elementary statistics course?

**Study Paradigm and the Role of the Researcher**

The constructivist-interpretivist paradigm was the best fit to underpin this study since case study research is generally grounded in constructivism criterion (Ponterotto, 2005). The paradigm suggests that assumptions (Ponterotto, 2005) of hidden, multiple, and credible realities exist that can be uncovered through dialogue between the researcher and participants. Furthermore, constructivism purports that the truth or meaning sought is “constructed” and understood through the process of how individuals “make sense of their lives and experiences” (Merriam & Tisdell, 2016, p. 24). In this methodological context, the researcher must have a “dynamic interaction” with subjects (p. 130) because participants’ reality is based on societal cultures, customs, and other racial and ethnic disparities, a critical factor in the paradigm (Ponterotto, 2005). In comparison to positivist methodology, an approach favored in quantitative research where the focus is on allegedly uncovering “reality”(Cupchik, 2001) by gathering facts through rigid instrumentation, the constructivism--interpretivism paradigm considers feelings, emotions, values, and beliefs as identified and communicated by individuals and/or groups (Creswell, 2015; Cupchik, 2001). A case study construed through the lens of a constructivism--interpretivism paradigm expects the researcher to “acknowledge, describe, and bracket his or her values, but not eliminate them” (Ponterotto, 2005, p. 131).

This researcher, as a female, non-mathematical major and instructor, assumed the dual role of “insider-researcher” (Unluer, 2012, p. 1) with the advantages of an in-depth understanding of the phenomenon being examined, “an intimacy which promotes the telling and
judging of the truth” (Unluer, 2012, p. 1), and who can successfully navigate through the politics of the academic organization (Unluer, 2012).

**Research Design: Qualitative Research**

Because elementary statistics is considered a mathematics course, a significant number of past studies have addressed math anxiety related to performance and the teaching and learning of elementary statistics using quantitative research methodology. Prior outcomes derived from these quantitative studies related to math anxiety have been largely limited to statistical measurement (Creswell, 2015), and researchers have suggested that further qualitative investigation is required to understand the phenomenon (Currie, 2014).

Math anxiety is an emotional response; data collection and analysis that include identification of themes gleaned from narratives and lived experiences of participants can lead to an in-depth discovery of individual perceptions of causes related to math anxiety. Qualitative research can potentially unearth the unique, personal beliefs and motivational factors that drive behaviors -- elements not easily determined in a quantitative survey method (Creswell, 2013). Through qualitative discourse, the researcher and participants engage in a dialogue that is reflexive – a bidirectional relationship where both parties influence cause and effect (Creswell, 2015). The researcher crafted this study in response to outcomes of prior quantitative studies (Currie, 2014; Siebers, 2015) that have advocated that qualitative research is needed to fully expand on and delve into the reasons and costs of anxiety related to success or failure in mathematics, particularly statistics (Currie, 2014).

**Research Tradition**

As previously stated, the instrumental case study was the methodology chosen for this study because this approach is utilized when “researchers are interested in insight discovery,
rather than hypothesis testing” (Merriam, 1998, p. 29). Three seminal researchers, Robert K. Yin, Sharan B. Merriam, and Robert E. Stake developed different perspectives, techniques and strategies that “diverge, converge and overlap” (Yazan, 2015, p. 134) to form a basis for case study methodology. Robert Yin’s methods are aligned with the positivist/post-positivist paradigm; Yin (2015) maintains the proposition that reality is “objective and predictable” (Yazan, 2015, p. 1269) and that objectivity is preserved by limiting the researcher’s involvement and reliance on validity with multiple replications in data collection methods (Yazan, 2015). Although the Yinian approach is most frequently cited in scholarly literature (Boblin, et. al., 2013), this researcher chose the case study methodology of Merriam and Stakes to guide the process of data collection and interpretation for this study (Baxter & Jack, 2008). This is because the approach developed by Merriam and Stake, because it is rooted in the constructivism--interpretivism paradigm, promotes flexibility in design that is easily adaptable to change; it fosters agility in interpretation and validates researcher-subject interaction.

Math anxiety and its relationship to performance for the traditionally underserved and marginalized female population is best observed and understood through a case study approach from Merriam and Stake’s perspective linking methodology to constructivism, using communication rather than statistical resources. Stake (1995) posited that “knowledge is constructed rather than discovered” (p. 99), and Merriam expanded on this constructed knowledge to include “individuals interacting with their social worlds” (p. 6) with the researcher serving in a role as an active participant (Merriam, 1998). Additionally, Stake and Merriam have advocated for the use of qualitative data gleaned from observation, interviews, and document reviews (Yazan, 2015) and for data triangulation by incorporating a variety of sources which provide a description of reality within the context of the phenomenon under investigation.
(Boblin et al., 2013). In this study, the researcher sought to uncover data from each individual’s background and academic experience; she also aimed to analyze environmental factors that were contributing to the underlying circumstances leading to anxiety and desired to explore competing perspectives of administrators and faculty. The researcher interpreted the results through her personal identification lens of being a female, non-mathematical major, and an instructor of elementary statistics that consistently had used a reformed curriculum based in constructivist approaches.

**Participants**

The site chosen for this study was located in a highly diverse urban center in the Northeastern region of the United States experiencing high crime statistics and economic stress whilst undergoing a combination of revitalization efforts accompanied by gentrification. A full 26.5% of this city’s urban dwellers were living in poverty at the time the study was conducted (Pennsylvania Poverty Rate by County, 2014), and the public school system was in drastic need of reform. The city, at the time, also housed several nationally-acclaimed and costly, public and private institutions of higher education. Many of the city’s residents, nevertheless, were ill-equipped academically and/or financially to attend these schools.

This school, located within the city boundaries, had the mission of serving, with a relatively high degree of success, those populations experiencing a variety of social, cultural, and economic challenges that had the potential to negatively impact degree attainment. The enrollment, demographic, and diversity statistics for the study site displayed a complex authentic representation of the traditionally underserved population. The college was enrolling 73% female undergraduate students, and 64% of total undergraduate students were enrolled in a part-time class schedule. The age range of students at the time the study was conducted was: 18-19
years, 15%; 20-21 years, 7%; 22-24 years, 13%; 25-34 years, 17%; 35-44 years, 12%; 45-64 years, 24%; and over 65, 12%. This data is displayed in Table 1.

Table 1

*Age Range of Students at the Time the Study was Conducted*

<table>
<thead>
<tr>
<th>Age in Years</th>
<th>N</th>
<th>Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>18-19</td>
<td>339</td>
<td>15</td>
</tr>
<tr>
<td>20-21</td>
<td>158</td>
<td>7</td>
</tr>
<tr>
<td>22-24</td>
<td>294</td>
<td>13</td>
</tr>
<tr>
<td>25-34</td>
<td>384</td>
<td>17</td>
</tr>
<tr>
<td>35-44</td>
<td>271</td>
<td>12</td>
</tr>
<tr>
<td>45-64</td>
<td>542</td>
<td>24</td>
</tr>
<tr>
<td>Over 65</td>
<td>271</td>
<td>12</td>
</tr>
</tbody>
</table>

The ethnic/racial diversity included: African American, 68%; Asian, 1%; White, 21%; and Hispanic, 8%. The faculty members demographics were distributed as follows: African American, 33%; White, 67%, with no other races identified. This data is displayed in Table 2.

Table 2

*Ethnicity/Racial Diversity of Students and Faculty*

<table>
<thead>
<tr>
<th>Ethnicity/Race</th>
<th>Students N</th>
<th>Percent of Students</th>
<th>Faculty N</th>
<th>Percent of Faculty</th>
</tr>
</thead>
<tbody>
<tr>
<td>African American</td>
<td>1537</td>
<td>68</td>
<td>53</td>
<td>33</td>
</tr>
<tr>
<td>Asian</td>
<td>23</td>
<td>1</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>White</td>
<td>475</td>
<td>21</td>
<td>107</td>
<td>67</td>
</tr>
<tr>
<td>Hispanic</td>
<td>182</td>
<td>8</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Other</td>
<td>44</td>
<td>2</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>
A full 83% of the total population was receiving some type of financial aid with 33% receiving assistance from the school in the form of grants or scholarship awards when the researcher collected her data. Additionally, the administration anecdotally had been acknowledging an unusually high failure rate in elementary statistics. This academic environment, at the time, was providing many remedial personal and professional services and was constantly seeking solutions to elevate students’ retention and graduation rates. This organization strived to provide an ideal opportunity for college access to a highly representative sample from a traditionally underserved and marginalized population, within the confines of an academic organization. Indeed, in this context, the site offered the researcher the opportunity to glean key insights from administrators and faculty, as well as students.

**Sample size and justification.** According to Patton (2015), a purposeful sampling strategy for a case study should be derived from a typical organization (not unusual or extreme) where the participant profile is “typical, normal, and average” (Patton, 2015, p. 268). This study collected a representative sample from administrators, faculty, and students from an average higher education organization. The sample for the group of administrators and faculty was decidedly purposeful (in order to engage those participants who could best help the researcher understand the phenomenon being examined) and small (due to the limited number of available staff) (Creswell, 2015). The student sample was also purposeful and small (6-10 participants) as recruitment was limited to adult females during a single semester session course offering of elementary statistics. The sampling approach for administrators and faculty was simple and random; the approach for selecting students constituted a non-probability purposive sample because the participants were considered a “subset of the larger population” (Sommer, n.d., para 9) where experiencing math anxiety was an unknown and not easily identified phenomenon.
The researcher used a case study methodological approach which advocated a small sample size (less than 10 participants) (Zucker, 2009). The case study focus, in general, attempts to “maximize what we can learn” (Stake, 1995, p. 4) by triangulation of techniques from data acquired from individuals affected by influences from society, the environment and the organization. In this study, these techniques included interviews, document review, and surveys, resulting in multiple and, in some cases, unique and rich descriptive perspectives. The researcher originally opted to include a focus group in the data collection process; however, there were no students who agreed to participate. Additionally, the researcher assumed her role as a biographer and openly exhibited interest in participants’ experiences over a lengthy time continuum. As a result, discourse with participants was interpreted within a historic organizational framework that allowed the researcher to understand how the participants “make sense of their experiences in this world” (Zucker, 2009; Yazan, 2015, p. 137). Indeed, insights garnered from these techniques are useful for exploring and assessing educational innovations, evaluating existing programs and course delivery systems, and informing and revising academic policies; findings from this study can thus act as a springboard for further research (Merriam, 2009).

Case study as a popular qualitative research methodology is used most frequently in education, but it lacks legitimacy and support from the research community because its detractors cite an absence of structure, credibility issues related to researcher bias, and final reporting limitations (Hyett, Kenny, & Dickson-Swift, 2014; Yazan, 2015). One major limitation to case study methodology and its use of a purposeful sampling approach is the inability to provide statistical generalizations across a large population based on the study results (Yin, 2014). However, according to Flyvbjerg (2006), the conventional wisdom about the lack
of an ability to generalize results is a “misunderstanding” (p. 1) since examination of real world examples provides insights into reality rather than depending exclusively on the results of rule-based testing used in quantitative research. Flyvbjerg (2006) has also posited that examining a problem from both a quantitative and qualitative perspective provides more insightful outcomes to craft a roadmap for improvement.

**Recruitment and Access**

The researcher previously worked at the study site, and she first requested permission to conduct the study from the Vice President for Academic Advancement. After approval was received, the researcher strictly followed the Internal Review Board (IRB) protocol from Northeastern University and the protocol of the organization that served as the site for the study (Appendix A). Although this researcher was a former faculty member there, she did not teach elementary statistics as a core curriculum subject, immensely reducing any subject bias.

Recruitment for participation in this study involved a three-prong process. Administrators and faculty from the mathematics discipline who were teaching elementary statistics as a core curriculum subject were sent an email requesting their participation. Those who agreed were directed to reply to the email. Student recruitment was simultaneously initiated via email from a list of students registered for an upcoming elementary statistics provided by the Vice President for Academic Advancement, about two weeks prior to the course initiation. Female adult students (age 25 and over) registered for elementary statistics were notified of the opportunity to participate in the study. All initial email invitations to participate that received positive responses (from administrators, faculty, and students) were followed up with an appropriate consent form (Appendix B) as outlined by Creswell (2015). Finally, every
participating individual from each group was offered a one-time $20.00 gift card as a participation incentive provided after the data collection process was completed.

**Protection of human subjects: Do no harm.** To ensure protections against any negative consequences of participating in this research and to guarantee additional protections of minimized risk, respect, beneficence, and justice as outlined by the National Institute of Health (NIH Office of Extramural Research, 2011), this researcher strictly followed the safeguards related to informed consent and participant de-identification. The approval of two Internal Review Boards provided participants with added security and confidence that assured that no breach in confidentiality would occur for individuals participating in the research project.

**Informed consent.** Administrators, faculty, and student participants solicited by email received an informed consent form (Appendix B) that included:

- Name and purpose of the research project
- Information about the researcher
- Acknowledgement of voluntary participation with right to withdraw at anytime with all personal contributions destroyed
- Procedures
- Safeguards regarding confidentiality; de-identification of all identities through coding
- Guarantee of no costs to participant
- Notice that participants’ questions would be answered by the researcher throughout the process and that they would also have the option to address any issues before the institutional IRB at the institution where the research was being conducted, at the researcher’s home institution, and at the researcher’s workplace (Creswell, 2015, p. 148).
Compensation for participation in this study had the potential to be construed as a possible ethical issue due to perceptions of unethical behaviors of undue influence or coercion (Grant & Sugarman, 2004). Researchers have posited that incentives offered can potentially compromise beneficence, respect for persons, and justice, and thus they are unethical (Grant & Sugarman, 2004, p. 726). However, caveats exist specifying the types of research designs where compensation is considered unethical. These include cases where the following conditions are present: (a) participant is dependent upon researcher; (b) high risk factors; (c) research is demeaning; and (d) compensation is excessively large to promote participation in an activity that is against better judgement or one where the participant is adverse (Grant & Sugarman, 2004, p. 732). None of these qualifying conditions for ethical challenges applied to this study. The researcher chose to offer a monetary incentive to promote participation and increase the sample size; prior approval by two IRB reviews ensured that all ethical standards were rigorously upheld.

**Internal review board (IRB).** Two IRBs retained approval jurisdiction over the study. The hosting research site instituted an approval process mandated by the in-house IRB with submission of a formal research proposal application form (Informal Consent, 2014) (see Appendix A). The application for permission to conduct the study included a completed IRB checklist (see Appendix A for checklist) that identified all requirements for IRB approval. Additionally, the IRB research site chairman acted as the intermediary and contact point for any participant issues (Informal Consent, 2014).

The second IRB was located at Northeastern University (NEU), the program responsible for the study. The NEU IRB duplicated the same safeguards of the hosting institution and also emphasized certain conditions: (a) no data was collected until IRB approval is granted; (b) it
highlighted the importance of the adviser as the principal investigator in the researcher relationship; (c) it maintained the possibility of audits from the adviser, the IRB, or the federal government; and (d) it assured minimal risk to participants through the attestation form signed by the researcher ensuring confidentiality of personal identifiers (Bennett, 2012).

**Data Collection**

Historically, data collection from prior research into math anxiety has been mainly quantitative, using the highly reliable and valid Mathematics Anxiety Scale –Revised (MAS-R) (Bai, Wang, Pan, & Frey, 2009; Hopko, 2003). The MAS-R scale consists of 14 questions designed to elicit a numeric response from a 5-point Likert scale ranging from 1 (strongly disagree) to 5 (strongly agree), indicating the strength of an individual’s math anxiety (Bai et al., 2009; Hopko, 2003). Limitations of this research methodology relate to the instrument’s creation age (approximately 30 years ago) and more recently updated curriculum design and delivery systems (Hopko, 2003). Additionally, quantitative research has failed to consider prior research outcomes of gender differences in how males and females are exposed to -- and their personal ongoing experience with -- math anxiety as influenced by society, environment, and the organization (Hopko, 2003). For this study, the population included a traditionally underserved and marginalized group of female individuals and, according to Rubin and Rubin (2012), “the researcher must pay close attention to issues of dominance and submission, especially when gender is involved” (p. 21). This qualitative study included instruments designed from the questions included in the basic MAS-R scale, with modifications for qualitative research that allows participants to “talk back” (Rubin and Rubin, 2012, p. 21) and “give voice to those who have been silenced” (Rubin and Rubin, 2012, p. 21). Additionally, insights from administrators
and faculty helped to provide a perspective from the vantage point of power. The researcher was the sole person involved in the data collection process.

This study utilized data gleaned from interviews, documentation reviews, and surveys. These instruments were designed based on a feminist constructivist methodology through which the interviewer allowed a relationship with the participant to develop and encouraged open dialogue where truth and challenges to status quo assumptions were invited (Rubin & Rubin, 2012).

**Interviews.** The instrument for conducting interviews was created using a semi-structured approach with open-ended questions provided in advance of the interview and contained in the interview protocol (Appendix C) (Rubin & Rubin, 2012). Each administrator, faculty, and student who agreed to participate was interviewed separately for approximately 45 minutes. The researcher provided a choice of several off site locations as an interview site, or the participant was also able to choose the research site’s campus for the interaction.

Interviews were conducted with administrators, faculty members, and students and were recorded using the software Rev.com with a digital recorder as back up. The audio files were uploaded to the software program MAXQDA12 for transcription and coding. All audio files were destroyed after transcription was completed. Please see Appendix C for interview protocols that provide information about the interview questions and guarantees of confidentiality.

**Documentation review.** A documentation review includes documents that are easily accessible and usually conducted to gain “insights relevant to the research question” (Merriam & Tisdell, 2016, p. 181). In order to assess past performance in the elementary statistics course, a statistical pass/fail report of all students (unidentified) was reviewed for a three year period prior to the course. The researcher intended to validate the high failure rate for elementary statistics;
failure rates and anxiety are positively correlated because, when students believe that prior course outcomes are failures, personal self-efficacy, and ultimately performance, are affected.

**Surveys.** The researcher used surveys with open-ended responses as a process to elicit freely expressed opinions and to obtain the rich data provided by qualitative research. A pre- and post-course survey was deployed using email to student participant volunteers as identified by the registrar’s office. The survey’s purpose was to capture emotional responses as students anticipated taking a required barrier course (pre course survey see Appendix D) and to document how those perceptions were fulfilled, or not, after the course was completed (post course survey see Appendix D). The pre-course survey provided the basis for a proposed focus group (mid course) with interactive questioning that expanded on, improved, and/or provided validity to the first emotional response as communicated on the pre-course survey. Two check boxes indicating the participant’s willingness to participate in an individual interview and/or be part of the mid-course focus group were included within the content of the pre-course survey. It was from this survey that the researcher identified no interest in the focus group. All participants’ identities were coded using a pseudonym. Once the responses were uploaded into the coding system with appropriate pseudonyms, the surveys were destroyed.

Generally, when research is done on an issue related to a marginalized group, it is usually reported from the perspective of the more powerful voices of those with authority rather than from the perspective of those with the experiences (Olson & Hirsh, 1995). Assessing the viewpoints of this population through an invitation to participate in a dialogue that guarantees anonymity, and utilizes different data collection methodologies, contributed in this study to a form of “knowledge production” (Olson & Hirsh, 1995, p. 193) that allowed the feminist voice to become the dominant perspective (instead of that defined by the power of males or instructors).
(Olson & Hirsh, 1995, p. 194); as a result, the researcher believes she did obtain a more meaningful understanding of women’s experiences and got closer to uncovering the truth of those experiences within the academic context (Hirsh & Olson, 1995). According to bell hooks, this interruption to silencing can be emancipatory, thereby guaranteeing “education as a practice of freedom” (Specia & Osman, 2015, p. 195).

**Data Storage**

Storage and management of the data was based on ethical obligations to provide confidentiality to participants and the ability to provide for “unanticipated events” (Data storage and data security, n.d., para 2).

The data collected in this study included recorded interviews with administrators and faculty, two student surveys (pre and post course delivery), with in-depth, recorded follow-up interviews with any students who consented. The surveys were administered online and did not contain any demographic identifiable information. All interviews with administrators, faculty, and students were voice recorded and identities were protected with pseudonyms assigned before the interviews began.

All data collected was stored on the researcher’s home computer (at an off-site location) which was backed up to an external hard drive. This data included pre- and post-surveys and transcription, and coding of themes from the interviews through a coding software program. All electronic data and coding software program information was stored in password protected files, and access was restricted to the researcher and her NEU academic advisor. Password protection and access restrictions applied to the computer and external hard drive. The interviews and focus-group voice data recordings were stored off site from the research location and were destroyed after transference to the online transcription software. All of the researcher’s hard
copy notes and journal entries were written using the assigned pseudonyms and were locked in an offsite storage box until they were transcribed into a computer program. Once the hard copy information was transcribed, the written copies were destroyed.

**Data Analysis**

For this study, the researcher followed the overlapping and divergent philosophies of Stake and Merriam to synthesize and make sense of the participants’ experiences. Data analysis was conducted in three dependent and interactive stages: journaling, transcription and coding, and interpretations. These stages did not constitute a separate process; according to Stake (1995) “there is no exact starting point” (Stake, 1995, p. 145) since data collection and analysis should begin at the same time, with journaling as the overarching influence for analysis. Journaling is a critical component to analysis as, according to Saldana (2009), there must be a period of reflection before the actual coding process begins.

**Transcription.** The transcription process for interviews was completed by audio recording using Rev.com through which the interviews were recorded and uploaded to coding software. The student pre- and post-survey, open-ended questionnaires originated in an Excel file for ease of import into the coding software. All transcriptions were uploaded into MAXQDA12 for first and second cycle coding. Rev.com and MAXQDA12 have security protections that guarantee the confidentiality of information uploaded to their systems.

**Coding.** Saldaña (2009) posited that a selected coding method is influenced by the answers that are sought through the research questions. The researcher for this study utilized In Vivo as a first cycle coding. In Vivo coding is the application that is based on the interviewee’s “voice” (Saldaña, 2009, p.93) and, preliminarily, it was used to identify strong emotional connections to the responses. The research questions in this study were designed to elicit an
emotional response from administrators and faculty invested in the success of their students and from students who were engaged in a highly negatively-charged barrier course. As a second step, In Vivo coding evolves into an Axial coding process where emergent themes can be synthesized to uncover the relationships that connect the data (Jensen, 2014). Axial coding as a second step allows researchers to organize data by determining which in vivo codes are dominant and those that signify a minor relationship to the research questions (Saldana, 2009). Through the process of axial coding, the researcher utilized Merriam’s promotion of a “concurrent and interactive” (Merriam & Tisdell, 2016, p. 145) coding process that uncovered themes that had the potential to impact the need for further design changes.

**Interpretation.** This researcher utilized two analytical methodologies to analyze results: (a) Stake’s Categorical Aggregation which allows for direct interpretations of meaning developed by the researcher through the concurrent journaling process; and (b) Merriam’s Constant Comparative Analysis, an inductive methodology that involves the coding and constant recoding of data as new information is added, comparisons are made, and patterns emerge (Merriam & Tisdell, 2016). Additionally, from researcher insights and the dominant themes uncovered from the coding process, the researcher utilized a Conceptually Clustered Matrix (p. 174) which aligned participant responses clustered by role (administrator, faculty, and student) with themes which emerged based on the two research questions, for example: Research Question 1: factors that contribute to math anxiety and Research Question 2: perception of how math anxiety affects performance (Miles, Huberman, & Saldaña, 2014). The matrix also allowed flexibility for expansion to include unforeseen results or design changes to be added for analysis (Miles et al., 2014). Finally, themes uncovered from journaling and coding processes were slotted into the Stage Environment Fit theory diagram (see figure 1) to fully interpret how the
academic organization was impacting math anxiety through relationships with administrative policies, instructional methods and philosophies, and peer interactions.

**Trustworthiness**

According to Lincoln and Guba (1985) and Merriam and Tisdale (2016), assessing trustworthiness in a qualitative research study is critical in maintaining validity, reliability and credibility. Lincoln and Guba (1985) affirmed that researchers must safeguard trustworthiness and address threats to external and internal validity by employing techniques of credibility, transferability, dependability, and confirmability when implementing qualitative research. The techniques used in this study to establish trustworthiness included triangulation, rich description, external auditing, and reflexivity.

In the study design, the researcher used *triangulation* or the collection of data from multiple data sources (Lincoln & Guba, 1985). Triangulation helped to ensure credibility through consistency when reviewing the data collected from administrators and faculty interviews, and student surveys, validating that the themes uncovered were indeed substantiated by different sources and perceptions (Merriam & Tisdell, 2016). To foster transferability to other contexts, the study has provided a rich description of the setting and of participants, complemented by interview quotes that offer evidence for a comprehensive explanation of findings and outcomes. Dependability in this study was attained using an *external inquiry audit* by an unbiased individual, in this case, the researcher’s academic advisor, to challenge the “process and findings of the study” (Lincoln & Guba, 1985). The external auditor was well versed in appropriate research techniques and provided a careful review of the study as well as thorough feedback regarding the study’s instrumentation and methods; thus, this individual acted as a reliable external validity resource. Finally, the researcher maintained reflexivity by completing a self-
reflective journal during the data collection and analysis processes to record thoughts and feelings and to help neutralize personal assumptions, bias, and other preconceived ideas that had the potential to affect the validity of the study, thus assuring confirmability (Lincoln and Guba, 1985; Merriam & Tisdell, 2016).

Other techniques employed to ensure validity included time-frame elongation (history), selection criteria, and an analysis of how participants involved in the study actually mirrored the population at large (Creswell, 2015). The time frame for the data collection phase of this study was fixed over a 12-week period that included a two-week registration period, one eight-week semester, and a two-week post period where final grades were determined. This helped the researcher to avoid maturation or changes in the population. Participants were selected from a voluntary random request with no prior knowledge of susceptibility to math anxiety. This voluntary random request has been documented in accordance with the completed training course “Protecting Human Research Participants” from the National Institutes of Health Protection, and the Internal Review Board procedures from the research site and from Northeastern University. The organization where the study was conducted is representative of a diverse population drawn from the metropolitan area and surrounding suburbs; as a result, outcomes can be generalized across other similar schools, or used to generate additional research. Although the researcher previously worked at the college that is the site of this study, she was not part of the faculty who taught elementary statistics as a core subject, strongly limiting the possibility of bias from pre-conceived perceptions about instructional methodologies.
Chapter IV: Report of Research Findings

The purpose of this research study was to understand the influence of math anxiety among adult female non-mathematical majors from traditionally underserved populations and the impact of it on their performance in an elementary statistics course. Using the case study methodology of Stakes and Merriam (Merriam, 1998; Merriam & Tisdell, 2009; Merriam & Tisdell, 2016; Stake, 1995; Yazan, 2015), this chapter presents an analysis of themes derived from data retrieved from a documentation review and qualitative research. The data was collected from a single site, an inner city college located in a large metropolis in the eastern part of the United States. Data informing the study include aggregate pass/fail grading for the elementary statistics course over a three year period (7/1/2013 to 7/1/2016), which was assessed to validate the criticality of a failure problem in elementary statistics, particularly for females. Additionally, the experiences and interpretations of the phenomena of math anxiety were documented by collecting data from administrators, faculty, and adult female students; the information was analyzed based on a triangulation of data received from three sources:

(a) students’ pre course survey;
(b) students’ post course survey, and
(c) in-depth, individual interviews with administrators, faculty, and students.

Interview and survey data was collected to provide insights into the three research questions posed in the study:

1. What factors contribute to math anxiety in a population of female adult higher education students who are disadvantaged simultaneously by gender, race and or/ethnicity, economic status, and educational background as they pursue non-mathematical majors requiring enrollment in an elementary statistics course.
2. How do higher education administrators, faculty, and students believe math anxiety influences performance for a traditionally underserved and marginalized female adult student population in an elementary statistics course?

3. What strategies are identified by higher education administrators, faculty, and students to help relieve math anxiety for a traditionally underserved and marginalized female adult student population in an elementary statistics course?

Participants

The participants for this study were recruited by email and included three administrators, three faculty members, and nine female adult students. Each participant was assigned a pseudonym to assure full confidentiality. The three administrators included two females with over 10 years longevity with the organization and one male with approximately five years employed at the institution. At the time of the interviews, one female administrator was serving as a department chair; the other two administrators’ duties were directly tied to the overall running of the organization. Faculty participants included one female with over 20 years teaching experience at the institution, and two males who were serving as adjunct faculty. One male of the males worked full-time as a high school vice-principal, and the second held a position in city government. The students who participated were all females over the age of 25. From the total of nine students recruited, all nine completed the pre-course survey, seven students agreed to and participated in an interview, and six students offered final feedback by completing the post-course survey.

Population Analysis of Failure Grading

Prior to the study, administrative reports and officials at the research site cited a high failure rate in elementary statistics, especially for females. Data was collected related to a three
year period (7/1/2013 to 7/1/2016) of students’ final grades in elementary statistics, sorted by
gender. The grading data reviewed was from a total of 932 students of which 72% were female
and 28% were male. Aggregate data related to failure and withdrawal to avoid failure by gender
is presented in Table 3.

Table 3

*Grading Data for Failure and Withdrawal to Avoid Failure by Gender over a Three Year Period*

<table>
<thead>
<tr>
<th>Failure Data</th>
<th>Female N</th>
<th>Percent of Female</th>
<th>Male N</th>
<th>Percent of Male</th>
</tr>
</thead>
<tbody>
<tr>
<td>End of Semester Failures</td>
<td>196</td>
<td>74</td>
<td>70</td>
<td>26</td>
</tr>
<tr>
<td>Failed Twice</td>
<td>25</td>
<td>76</td>
<td>8</td>
<td>24</td>
</tr>
<tr>
<td>Failed and Withdrew</td>
<td>8</td>
<td>67</td>
<td>4</td>
<td>33</td>
</tr>
<tr>
<td>Withdrew Twice</td>
<td>4</td>
<td>80</td>
<td>1</td>
<td>20</td>
</tr>
</tbody>
</table>

The research site’s current overall enrollment was consistent, with the distribution of
72% female adult students vs. 28% males enrolled in a single course and mirroring the overall
failure rate of 74% females vs. 26% males in elementary statistics. School policy at the time
only allowed two retakes of the course after earning a failure grade which is illustrated by the
“failed” and “withdrew” statistics – 67% females vs. 33% males – and by statistics related to
twice time withdraws -- 80% females vs. 20% males. Finally, the data records a statistic of 76%
of females vs. 24% males of twice failing the course and reaching the limit a student can take the
class.

**Themes Identified**

The major theme that emerged to answer Research Question 1 was: negative perceptions
are a cause of math anxiety for females. The sub-themes were:
(a) how individual perceptions define reality,
(b) student preparation and skills affect perceptions, and
(c) communication challenges affect perceptions.

The major theme emerging from Research Question 2 addressed math anxiety as a barrier to learning with an intersecting subtheme of students’ self-defeating behaviors of reluctance and procrastination.

Analysis of the data led to the emergence of effective strategies to reduce math anxiety to answer Research Question 3. The subthemes that emerged were:

(a) availability of instructor,
(b) student engagement especially through technology, and
(c) identification of at risk students.

Themes and subthemes sorted by Research Question are displayed in Table 4.
Table 4

*Themes and Subthemes Sorted by Research Question*

<table>
<thead>
<tr>
<th>Major Theme</th>
<th>Subtheme</th>
<th>Subtheme</th>
<th>Subtheme</th>
</tr>
</thead>
<tbody>
<tr>
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<td>Negative perceptions are a cause of math anxiety for females</td>
<td>Individual perceptions define reality</td>
<td>Student preparation and skill affect perceptions</td>
<td>Communications challenges affect perceptions</td>
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<tr>
<td>RQ 2. How do higher education administrators, faculty, and students believe math anxiety influences performance for a traditionally underserved and marginalized female adult student population in an elementary statistics course?</td>
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<tr>
<td>Math anxiety creates a barrier to learning</td>
<td>Students self-defeating behaviors of reluctance to ask for help and procrastination</td>
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<td>RQ 3. What strategies are identified by higher education administrators, faculty and students to help relieve math anxiety for a traditionally underserved and marginalized female adult student population in an elementary statistics course?</td>
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<tr>
<td>Effective strategies to reduce math anxiety</td>
<td>Availability of instructor significantly affects students relationship to subject matter</td>
<td>Student engagement through technology</td>
<td>Identification of at risk students</td>
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</table>

Notes. RQ = Research Question
Research Questions and Themes

**Research question 1:** What factors contribute to math anxiety in a population of female adult higher education students who are disadvantaged simultaneously by gender, race, and/or ethnicity, economic status, and educational background as they pursue non-mathematical majors requiring enrollment in an elementary statistics course?

The major theme associated with Research Question 1 is: Negative perceptions are a cause of math anxiety for females.

Three subthemes emerged explaining in detail how perceptions are formed and how they can bolster the impact of math anxiety. From most frequently cited to least cited, they included:

1. Individual perceptions define reality;
2. Student preparation and skills affect perceptions; and
3. Communication challenges affect perceptions.

Through the intersection of these three subthemes, the researcher formed a fundamental understanding of how math anxiety is caused and enabled in females.

**Negative perceptions are a cause of math anxiety for females.** This emerged as a major theme related to factors that contribute to math anxiety. The interviews provided a conduit to explain the perceptions of experiences by students and how they were interpreted by administration and faculty. Administrator Abby explained: “I think the confidence level and student anxiety around math have a lot to do with it [hindering their success].” Faculty member Fern remarked, “[Y]ou can read their body language”. Students described many experiences that helped shape feelings of anxiousness, with seven of the students expressing that taking math was a difficult and emotional experience.
Individual perceptions define reality. Administrators voiced their concern that a student’s perceptions may be skewed and anxiety heightened as they first enter higher education. One explained, “We do not help students understand what it means to be a college student.” Another administrator agreed stating, “We don't convey what we expect of them as a college student.” Adult stress and anxiety is heightened when exposed to a new learning environment, particularly when individuals are already balancing careers and families (Kinkead, Miller, & Hammett, 2016).

Another perception issue was related to students’ understandings of the “utility” of learning elementary statistics. Administrator Hannah said she observed “…a disconnect between elementary statistics and a student's program of study” and that “[a]s adults, we need to know why we're learning what we're learning and how it's going to fit into our lives.”

Faculty interviewed provided rich insights into student perceptions based on the comprehensive relationship of instructor-student in which anxiety and barriers students faced were commonly addressed. The three faculty member participants who were teaching elementary statistics at the time of their interviews stated that they allowed the students to articulate negative perceptions early in the course, to help mitigate threats to performance. According to the faculty, many students took this opportunity to “…flat out say, ‘I have this issue.” Faculty Phred said he felt that females are more honest in this respect than males; they are quicker to speak up and say, “I don't know this. I'll give it my best effort but I'm still not sure that I can do it.” For anxiety issues related to gender perceptions, the faculty described key differences. Faculty member Fern, for example, articulated that “men are more willing to jump in” and the women commonly responded "I'm not sure I want to do this." She identified that
“anxiety might play a part in that.” According to faculty member Phred: “Many females will just tell you flat out, ‘I'm scared to death of this course.’”

The students’ responses were analyzed based on a pre-course survey, followed by an interview, and ending with a post-course survey. The pre-course survey specifically asked the question about perceived causes of math anxiety. Fifty-six percent of the students who answered the survey admitted to math anxiety. In Table 5, 50% identified past school experiences as the cause; 33% perceived the course work as difficult; and 17% articulated the old stereotype that girls are not good in math. Table 5 provides the details from the pre-course survey.

Table 5

<table>
<thead>
<tr>
<th>Perceived Causes of Math Anxiety Identified on Pre-Course Survey</th>
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<tbody>
<tr>
<td>Pre Course Survey Question: If you think you have math anxiety what do you think caused it?</td>
</tr>
<tr>
<td>Past School Experiences</td>
</tr>
<tr>
<td>Course Work Perceived Difficult</td>
</tr>
<tr>
<td>Girls Not Good in Math</td>
</tr>
</tbody>
</table>

The students who answered the pre-course survey further elaborated their responses related to perceptions during the interview. They referenced past school experiences as having a significant impact. Student Brianna, for example, expressed that in early education “I went through a couple of grades without being in a right math level, and then when I got to college, that's when it caught up with me.” Even those students with positive experiences in elementary and middle school – which in some cases resulted in students receiving honors -- reported that “it's just that when I got to college, I felt as though that what I learned in high school wasn't up to par with what the expectations were coming into college” and “I found out that college was a
whole different ball game.” These students expressed surprise and discouragement at having to take additional math classes labeled “remedial” despite their achievements in high school.

Student Brittany admitted that, because she was placed into a remedial course, she felt that she had done something wrong. These observations intersected with one administrator’s suggestion that the college should provide a reality-based on-boarding process, offering an explicit roadmap regarding the expectations inherent to the higher education environment.

Faculty and students observed that the perception that statistics course work is difficult was commonly passed anecdotally from one student to another. This was echoed by faculty members’ observations. Faculty admitted to the complexity of the course stating that “to be quite honest with you, some of the equations can be very complex, the computations are tedious,” and “students get lost [because] they’re still hung up on, ‘How did I get this column of numbers?’.”

Although only 17% of students completing the pre-course survey specified that math anxiety is more prevalent for females, several of the comments reflected both family-encouraged stereotypical beliefs that males are better than females at mathematics and the ways in which society continues to promote this mindset. Student Brianna commented:

I think men are really good in math. Most of the people who are good in math ever since I've been attending college [are] men. I think that men, for some reason, they just relate to the numbers more easily then, because it's always men math teachers. [In] math, you see a lot of men faculty members.

Student Sadie, meanwhile, admitted that: “I honestly think that ... it's horrible ... but I really feel as a female you always hear from the time you're a child, oh girls are bad at math. I think that's part of the problem.”
Several of the students also mentioned negative influences from family members: One said she had heard her grandma say, "Well, math's hard for girls." The students also vocalized how they perceived that society continues to view and perpetuate gender roles in mathematics. Student Shanna stated:

I don't think that we're supposed to be good at math as women. They don't expect us to be good at math, that's what's been drilled in our heads. Women aren't good at math; men are good at math because men measure things, and where women don't do that. We're fluff and buff and pretty ... I kind of get the idea that those type of people should be the poetic or the more say literature or English type of people.

*Student preparation and skills affect perceptions.* Administrator Adam cited that 43% of students were obligated to engage in remedial course work before they could take the college’s statistics course. “I think it's just lack of the skills that they had in high school,” he stated, and “by the time then that it gets to college, they're trying to catch up.”

When placed in a remedial course, some students experienced a reduction in self-esteem which led to frustration and discouragement. Student Sadie related this experience, stating, “I had thought all of my math was done. Once my advisor told me I had to take math again that knot in the pit of my stomach came up.” Student Stella, meanwhile, remarked, “When I got to college, I had to take it all over again. I've had to take so many math courses that every time the word math is even uttered, I'm like really? I have to take another one?” Student Brittany recalled:

I did very well in elementary school and high school. I even graduated high school with 2nd honors…that's kind of discouraging too, when you take the placement tests and, you know, you think you're doing well and it comes back that you have to take remedial
courses, then it kind of puts you off schedule, like, “Oh gosh. Have to take these courses. That's going to prolong my time in college, you know. I have to take these extra courses before I even get to the courses I need to take for my major.

Faculty member Phred commented that many students were not prepared for the challenges of college mathematics:

I thought that some students were not prepared to do statistics. They would take a look at some of those formulas, like the standard deviation, or even the mean, those Greek letters. They were just absolutely thrown by all that stuff. Just those formulas alone, really reinforced their notion that they couldn't be doing statistics…We use operations that many of them forgot. They see, for example, the standard deviation formula, and just get blown away by the different operations, and how do I approach something like this.

The student survey questions also provided insights into how anxiety affected performance. Those students who cited on the pre-course survey that they did indeed have math anxiety commonly indicated on the post-course survey that they had changed their perception and did not have math anxiety in the way they had perceived the variable was described. But 33% said they did experience some anxiety during the course which they believed affected their performance. Table 6 provides details that compare the pre and post course survey responses to illustrate this result.
Table 6

*Student perception of having math anxiety identified on pre and post survey*

<table>
<thead>
<tr>
<th>Response</th>
<th>Pre Course Survey</th>
<th>Post Course Survey</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Percent N=9</td>
<td>Percent N= 6</td>
</tr>
<tr>
<td>Pre and Post Course Survey Question: Do you think you have/had math anxiety?</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Yes</td>
<td>56</td>
<td>66</td>
</tr>
<tr>
<td>No</td>
<td>44</td>
<td>0</td>
</tr>
<tr>
<td>No with student comment that they were emotionally affected</td>
<td>0</td>
<td>33</td>
</tr>
</tbody>
</table>

*Communication challenges affect perceptions.* A noted cause of math anxiety that surfaced during data collection and analysis was related to a general understanding of the formulas and rules in the coursework. Administrators observed that math majors, who are a very small percentage of an elementary statistics class, were generally able to assimilate the material more quickly because they were already familiar with the verbiage. However, the student unfamiliar with the language of statistics, the administrators noted, can become disheartened, and thus she encounters yet another barrier to learning. Student Shanna’s interview illustrated this dynamic:

> I'm trying to figure out what they're talking about to begin with and they're giving me 5,000 different examples of the same thing. And they're all just a little bit different so they really don't tell you exactly what you're looking for.

In higher education, elementary statistics is generally taught by math faculty, many of whom are foreign born, which can create another layer of complexity to effective communications because
of language and cultural approaches to teaching. Faculty member Fern commented on this issue, stating,

[If] they have anxiety over that barrier between teacher-student, and that sometimes is cultural… they [the teachers] feel they can't question the student, sometimes that's a cultural thing, I want to be sure that they've been contacted by somebody that they would feel comfortable to say it to.

In addition to the cultural communications barrier, a traditionalist teaching methodology was also identified as significantly impacting student achievement. As faculty member Fern observed, “[Y]our typical math class is, you sit there and watch and take notes while I do some problems on the board, which, in itself has some issues.” Fern said this approach was ineffective for her during college and that her personal experience was that “when I was a student, taking notes, I didn't understand those notes when I got home.” Instructor Phred, however, asserted that traditional methodology and note taking is important and is an essential skill students need to develop and use effectively.

Student participants consistently reiterated that they felt that statistics was like a “foreign language.” Shanna stated, “[I]t's a completely different language…I find myself a lot of times saying, what are they even asking for, like I don't even know what this means.” Sadie said she “tends to forget the formulas.” Susie reflected that her anxiety was heightened when the teacher became frustrated with the class for their lack of understanding. She remarked: “I think, from being belittled, I think sometimes he gets like: ‘This is the simple stuff. You guys don't get it?’ Like, ‘No, we don't.'” Susie further identified barriers the students described facing, particularly that “it's the communication style, you know?” These comments reflected an intersection
between students’ level of preparation and their actual skill set, both of which were perceived to be negatively affected by the communications style of the instructor.

**Research question 2:** How do higher education administrators, faculty, and students believe math anxiety influences performance for a traditionally underserved and marginalized female adult student population in an elementary statistics course?

The major theme for research question #2 was: Math anxiety creates a barrier to learning, with a subtheme of students engaging in self-defeating behaviors. Sub-themes included, in order of frequency of citation: (1) reluctance to ask for help, and (2) procrastination.

**Math anxiety creates a barrier to learning.** Faculty members commented that they received an overwhelming response from those students who articulated feelings that "Oh my God. I'm so nervous. I'm gonna fail." Faculty member Fern, for example, stated that math anxiety, as a mindset, “gets into your sense of self. It becomes part of you. It can be such a barrier. It can be pervasive. It's an incredible construct that can take over.”

**Self Defeating behaviors of (a) reluctance to ask for help and (b) procrastination.** One of the strongest identified self-defeating behaviors emerging from coding and analysis in this study was the students’ reluctance to ask for help. Although the college research site is notable for its wide range of on campus and online resources available to assist students, analysis of the data suggested that these resources were being widely underutilized, thus diluting their effectiveness. Administrators’ comments illustrated this. For example Administrator Hannah stated:

I can tell you that more of our students do not take advantage of support and resources that are in place for them than those that do, and I don't know why that's the case…we don't know whether it's an issue of pride or independence.
Some faculty members suggested several reasons they believed underlined students’ apathy when choosing to access school resources. Administrator Abby, for example, said she felt students were ashamed to admit that they did not understand because other students did not have the same level of difficulty. She echoed their mindset stating that she believed the students were thinking, "Other students got it, I don't, so I'm not going to advocate for myself the way that I need to.” Administrator Adam, meanwhile, suggested: “So many students need support and need the help and they view it as a weakness or something.” Another source of avoiding seeking help, according to administrators, was time itself, especially for adults – students were immersed in a go-it-alone culture of balancing priorities of work, home, and school as a standard part of their everyday regimen. Administrator Hannah stated, “There are those students who are accustomed to doing really hard things…on their own, and not asking for help.”

One notable intersection uncovered was an administrator’s comment that perhaps the institution was failing in communicating to the students that asking for help was reasonably expected; She said this component may in part be derived from students’ lack of preparedness to enter the college environment: “Not always that it's acceptable to ask for help. We don't convey that we expect that of them as a college student.” This reasoning aligned with the formation of a student’s perceptions when entering higher education unprepared for the college environment. Administrator Hannah provided a description of her expectations that illustrates this intersection:

It's not scary. This is part of being an adult college student, and like other challenges in life, students need to face this math course head on to have an understanding that they are, most, most, more than capable, that it's not going to be easy, it's not going to be a walk in the park, but with some discipline and utilizing support services and having a good relationship with your instructor, that this is doable.
The students’ experiences did not necessarily coincide with this perception.

For example, students admitted to and provided reasons why they were reluctant to ask for help. Brittany commented, “I don't like to be a burden. I don't want anyone to feel like they're putting effort into helping me and I'm not getting it… I don't want to be looked like I'm an idiot or anything.” Stella, meanwhile, described, “I am winging it week by week, and I just keep thinking that, we'll do it week by week.”

The pre- and post-course surveys asked students to identify where they believed they would go to get help (pre-course) and where they actually went to get help (post-course). On the pre-course survey, 78% identified they would go to their professor; 44% thought they would use school resources; 33% stated they would go to their peers; and 22% thought they would use internet resources. The post-course survey results were surprising and unexpected in comparison: 50% had asked the professor for help, and 50% utilized the textbook. None of the students accessed the college’s resources. Table 7 illustrates these results.

Table 7

Student Response to Where to Access Help on Pre Course and Post Course Survey

<table>
<thead>
<tr>
<th>Response</th>
<th>Pre Course Survey Percent</th>
<th>Post Course Survey Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>N=9</td>
<td>N = 6</td>
</tr>
<tr>
<td>Professor</td>
<td>78</td>
<td>50</td>
</tr>
<tr>
<td>School Resources</td>
<td>44</td>
<td>0</td>
</tr>
<tr>
<td>Peers</td>
<td>33</td>
<td>0</td>
</tr>
<tr>
<td>Internet</td>
<td>22</td>
<td>0</td>
</tr>
<tr>
<td>Family</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>Text</td>
<td>0</td>
<td>50</td>
</tr>
</tbody>
</table>

Pre and Post Course Survey Question: Where will you go/went to get help
The second self-defeating behavior identified in the research that affects female students suffering from math anxiety is procrastination. Administrator Abby identified how procrastination negatively affects learning statistics: “Every week builds upon a skill set that they need to pass. If they wait, they put themselves right in the hole from the very beginning.” Other administrators identified students’ lack of commitment which they claimed led to procrastination, especially when students living often on the edge were balancing competing priorities. “We still deal with tenacity and commitment issues from many of our students that are balancing so many priorities,” one administrator commented.

The elementary statistics faculty said they believed procrastination was not solely related to assignments, but that it included actual delays in taking the course. Faculty member Phred explained:

  Many of them, when I asked them, they would tell me this was the last course in the sequence. They finally had to take it. They put it off as long as they could. It was either drop out, or finally take statistics. That's when they decided they had to bite the bullet and take it.

This type of procrastination response was even more problematic when combined with a student’s fear of failure. Faculty member Phred elaborated, stating that he thought the students experienced though processes such as:

  I've put the course off as long as I can. I finally have to take it. I don't know if I can pass it. Some of them have told me [that they] have taken it two or three times before this.

Students also validated faculty perceptions of why procrastination creates a barrier to success. Student Brianna commented:
I waited until the end and it caught me at the end. It caught me at the end, so the first time I took statistics I actually failed it. Then, I enrolled the class and then withdrew from it and enrolled in the class and withdrew from it. I think that happened for like maybe two or three semesters. So, I finally got it together and took it and passed it.

Similarly, student Stella linked how perceptions she formed from others led her towards procrastination: “I left it for one of my last classes, because yeah, I've heard people talk about Statistics. It's the worst thing.”

**Research question 3.** What strategies are identified by higher education administrators, faculty and students to help relieve math anxiety for a traditionally underserved and marginalized female adult student population in an elementary statistics course?

One major theme and three subthemes emerged related to the third research question. The major theme addressed effective strategies to reduce math anxiety, and the three subthemes included: (a) availability of the instructor significantly affects students’ relationship to the subject matter, (b) student engagement through technology, and (c) identification of at-risk students.

**Effective strategies to reduce math anxiety.** Administrators, faculty, and students provided insights into how to mitigate math anxiety through strategies that involve relationships with instructors, proper application of technology, and identification of at-risk students. Faculty noted the need for an environment that fosters communication and collaboration, and administrators reflected that the organization needed to provide a “safety net” to ensure that students were aware of all the resources available to help them.

**Availability of the instructor affects students’ relationship to the subject matter.** Administrators interviewed for this study recognized the importance of assigning faculty who
understand students with math anxiety: “The anxiety issue...having the right faculty member who's in tune with that can help.” Others suggested strategies that intersect with the student’s preparation for higher education. As one administrator stated, “I think we have to do a better job of better preparing the student... and how they should navigate it in terms of online, on campus, or flexibility.” Administrators also cited efforts in recent years to assist students with the creation of first year academic coaches and advisors who monitor attendance patterns. Finally, Administrator Hannah provided a message for the student body regarding how to deal with fear:

It's not scary. This is part of being an adult college student, and like other challenges in life, students need to face this math course head on to have an understanding that they are more than capable, that it's not going to be easy, it's not going to be a walk in the park, but with some discipline and utilizing support services and having a good relationship with your instructor, this is doable.

Another strategy related to teaching methodology. Faculty members expressed that they were acutely aware that constructivist teaching methods were optimal in achieving educational goals in elementary statistics. Faculty member Phred commented:

When I changed my approach to be more hands-on and more conversational about what they were doing to collect the statistics. I think there was more buy-in on their part throughout the rest of the semester, to deal with the data that they had actually, physically, collected.

Faculty member Fern, meanwhile, reflected on how the teaching and learning of statistics had changed over the course of her 20-year teaching career:

Now statistics, with the elaborate software setups, statistics is very broad with the whole design of the experiment, the collecting of the data, understanding the types of data,
understanding the analysis, their outputs and their influence as opposed to can you do the computation. I think people who are teaching statistics now have to realize it's more than what we were taught.

One outcome of the analysis was the students’ preference to find assistance in a text book rather than accessing direct college support services. Prior to the start of the course, on the pre-course survey, students responded to the question: *Where will you go to get help* with a mixture of resources: (1) Professor 78%, (2) School Resources 44%, (3) Peers 33%, (4) Internet 22%, (5) Family 1%, and (6) Text book 0%. On the post-course survey however, the same students were evenly divided between the professor and the text book. Table 7 displays this response.

During the interview phase that occurred after the pre-course survey and prior to the post course survey, many students commented on the importance of teacher availability, school resources, and technology, but few identified the text book as a positive resource. Students remarked that although textbooks have evolved to include e-books and online resources linked to text book concepts, mathematics textbooks are often difficult to understand, and many students described using them as akin to learning a foreign language.

All of the survey participants viewed the instructor as a critical component of the statistics class who is charged with creating and implementing a delivery system that overcomes students’ perceived challenges and that fosters learning. Administrators at the research site prided themselves for recruiting instructors who were the most highly prepared and sought after candidates, and who would also serve as role models and mentors to the students. Administrator Adam stated:

We got him. He was a graduate of Philadelphia. Anyway, we got him. He's a math tutor part-time. Now he's a first year coach and everything. That is just another layer to help
that student get through initially in that first year to overcome those challenges. He can help them with the math piece as well as coaching, advising, and everything.

In sync with this observation, most faculty interviewees were extremely proud of their role in providing strategies for success, and many applauded the college for its encouragement in this area. Faculty member Fern stated:

I am fortunate to be at an institution where we were pushed early on to think about learning styles, to think about individuals who might have strengths and weaknesses, and balance out their grade based on that …When you have that hands-on time with the students, it's very good for helping to identify each person's unique gaps in their understanding and help them build on that.

Faculty also recognized the need to make students “feel comfortable” and to encourage them to “ask questions and utilize peer resources.” Faculty member Phred stated:

I always encourage my students to yes, ask questions, yes, come to me with your problems. I also try and encourage them to collaborate with each other. I think that's been a huge success in the students who are willing to do that.

In short, comments provided by administrators and faculty members validated the existence of a multitude of resources to assist students; however, despite the availability, students were not willing or were reluctant to access these resources.

Those students who were motivated to utilize school resources reaffirmed the need to have a positive interaction with the instructor, as shown in Table 5. Student Brittany’s emotional comment provided insight into the value of the instructor: “I went to my instructor a lot and she was very helpful by going over certain problems in class with us, and I passed, thank
God.” And student Sadie remarked “He's even good in the sense where he'll tell me, Calm Down. You're gonna be fine. You'll get it.”

The students also remarked on situations when an instructor did not meet their needs. Several remarks overlapped with the communications theme: “Most math courses, they usually use a foreign teacher or something when they teach statistics.” Student Shanna explained her experience and outcomes when the teacher was not engaged:

Unfortunately the teacher has been very hands off. I sent an email in the beginning of the semester asking a question, I got no response. Figured it out on my own. I know that other students had complained about sending him an email because they were struggling and he hasn't helped them at all. So unfortunately he's really not present.

**Student engagement through technology.** This second subtheme highlights the importance of using technology in education. Faculty interviewees at the research site encouraged the use of Skype, smartphones, and text messaging software, for example, *Remind*, a program through which students are continuously updated on their phones. Faculty member Phred shrewdly stated: “I found that they can't help themselves. They can't not answer a text message.”

A significant number of students today are extremely savvy when using technology because of its widespread use at home and in the workplace. However, some students expressed concern that using an unfamiliar software program, for example, even certain iterations of Excel, or SPSS, added an additional layer of stress to the course work which, in some instances, brought them more anxiety and frustration than actual benefit. Student Stella remarked, when asked about using Excel: “I have a mental block with it.” Brittany commented: "Okay, I'm familiar
with Excel, but I'm not familiar with plugging up the prime list into Excel. So, I had been behind with my homework.”

**Identification of at-risk students.** To decrease the failure rate in elementary statistics, administrators and faculty stressed the importance of identifying those students who may be at risk for failure, especially since an overwhelming amount of comments during the data collection process suggested that many adult students are reluctant to ask for help. This theme also overlaps with ensuring that students are adequately prepared for the college environment. Thinking proactively, administrator Abby suggested:

I think the confidence level and student's anxiety around math have a lot to do [with performance]. That coupled with their lack of background or foundational skills, I think can hinder their success.

Administrator Hannah addressed this issue as well, stating that she felt identification of at-risk students could be accomplished by “testing incoming students to get a sort of baseline understanding of their proficiency in math and English.”

Faculty members, meanwhile, had a clearer insight into early identification of at-risk students. As instructor Fern related:

I think also if somebody's not approaching you and you know they're not doing very much, you calling them repeatedly isn't necessarily going to help, so that's usually where I get an advisor or the tutor center so that they're getting outreach from other people that they might feel more comfortable talking to than me.

**Summary of Findings**

Within this study, the themes and subthemes identified through the process of data analysis helped to acquire in-depth insights about the impact of math anxiety on female adult
Research Question 1 related to the factors that contribute to math anxiety. Data analysis suggested that student’s negative perceptions influence anxiety levels. Students commented that their perceptions, negative and positive, were formed and shaped by early experiences especially when as a student they first encountered the college environment. Administrators and faculty agreed that they need to help students assimilate by providing an orientation with an onboarding
process that encourages positive associations and a clearly defined roadmap for students to easily find assistance.

Another factor identified as affecting perception was student preparation during elementary, middle, and high school. In the study, administrators voiced that through placement testing, they recognized that many students did not have the skills to manage the rigors of a higher education curriculum. Administrators noted that the assigning of remedial class work was meant to be a positive step in elevating a student’s skill level; however, students reflected that a remedial requirement came as a surprise and deflated their confidence and self-efficacy. They had believed they were highly skilled, especially after receiving honors from their secondary education experience.

Communication was also identified in the analysis as significantly affecting perceptions. Poor or faulty communication from faculty and administrators, and even to a certain level amongst peers, the data revealed, led to inaccuracies, thus skewing perceptions. Cultural and linguistic barriers, as well as the complex verbiage of the math formula or computations, also contributed to serious setbacks when a student did not fully understand the message an instructor was attempting to convey. Students explained that they had minimal comprehension when the instruction of complex statistical concepts was garbled because the instructor had English as a second language, and/or the use of teaching aids that did not conform to a student’s accustomed learning style, technology included.

Research Question 2 related to how anxiety influenced performance. Data analysis distinguished a main theme of anxiety creating barriers to learning. The repercussion of anxiety led to the creation of dysfunctional and self-defeating behaviors including, in order of ranked importance: (1) reluctance to ask for help, and (2) procrastination. Despite the acknowledgement
of this problem by administrators and faculty, and the above-par quality and quantity of resources provided by the institution, it was difficult to discern a pathway through these issues to provide mechanisms to support communication that could potentially help to alleviate this problem.

Research Question 3 related to effective strategies used to help moderate anxiety issues in elementary statistics, which emerged as a main theme in data analysis. The availability of the instructor was identified as a critical component to the student’s comfort level to seek help and find mechanisms for success. Faulty admitted that implementing advances in technology can be a double edged sword, especially when there was a steep learning curve for instructors and students, because this unfamiliarity and the time learning to use to program consumed commonly negated the positive effects of improving the speed of the calculation process.

Administrators, faculty, and students recognized the benefits of early recognition of at-risk students. This subtheme intersected with that of skewed student perceptions resulting from poor preparatory skills and a lack of a meaningful orientation program that encouraged help-seeking behaviors. Although there were processes in place at the site for testing to identify at-risk students, these mechanisms also led to an increase in anxiety levels and self-defeating behaviors for students who were assigned to remedial coursework or identified as being in this category.

A final result that emerged from interviews with administrators was the need to transform teaching strategies. In an effort to improve the failure rate of adult students taking elementary statistics courses, the research site had taken the initiative to modify its curriculum and move elementary statistics from the overall college general education requirements to each discipline’s core curriculum. Therefore, elementary statistics at that site was slated, at the time of data
collection, to be taught within the student’s chosen career path, with discipline-focused instructional materials. Administrator Adam described justifications for this structural shift in course placement and instruction:

I think in order to make it more relatable, more understanding, and grasp the content, you have to get it so the students can really understand it and want to understand it and apply it somewhere. Just broadly putting it across the curriculum like a one size fits all option I don't think works.

**Conclusion**

The purpose of this case study was to elicit information from administrators, faculty and students to provide clearer insights into causes of math anxiety, which presents challenges to degree attainment, and that would identify strategies to mitigate negative outcomes for adult females. This case study, crafted methodologically from the philosophies of Robert Stake and Sharan B. Merriam, utilized collection techniques of document review and interviews. A pre and post course survey was included to help provide meaning to student interview data.

The results of the study indicate that all groups surveyed perceived that math anxiety has a profound effect on students’ perceptions of self-efficacy, leading to self-defeating behaviors. Administrators, faculty and students agreed that specific interventions can be applied to help alleviate student distress.
Chapter V: Discussion of Research Findings

The purpose of this qualitative case study was to advance prior quantitative research examining the influence and effects of math anxiety on female non-mathematical college majors from traditionally underserved populations and the impact of it on their performance in elementary statistics. Stage Environment Fit (SEF) theory was chosen to support this study because this theoretical model assisted the researcher in identifying and understanding the policies and processes within an academic institution that were either reinforcing or neutralizing the effects of math anxiety on this population.

This study employed the case study methodology of Stakes and Merriam because their approach allowed the researcher to: (a) promote the interactive voice and intuition of the researcher as an interpretive part of the analysis; (b) use the literature review to direct the emergence of a theoretical framework to underpin the study from which research questions are designed; (c) incorporate a flexible design that included interviews and document review, allowing for critical changes to surface and thus redirect data collection and analysis through an active research process; and (d) use triangulation and disclosure of researcher bias as validation tools (Merriam, 1998; Merriam & Tisdell, 2009; Merriam & Tisdell, 2016; Stake, 1995; Yazan, 2015).

Three research questions specific to adult females emerged from the literature review. Prior research validated that academic institutions have the responsibility of providing all enrolled active students with meaningful and transferrable learning outcomes and of ensuring that all populations have access to the essential tools and resources needed for successful degree attainment. Additionally, as the literature review documented, math anxiety is a research-validated psychological, social, and emotional response that negatively affects the cognitive
process in females and which has its roots in early childhood stereotyping practices that are commonly supported by parents and the educational system. Finally, there is a current reform movement in the teaching and learning of mathematics that recognizes the debilitating force of math anxiety and highly recommends changes in the traditionalist instructional methodologies to include a more constructivist, interactive, applied, and student-centric approach. This approach is currently being adopted by many higher education organizations, which supports the relevance of this study.

The three research questions that informed this study are:

- What factors contribute to math anxiety in a population of female adult higher education students who are disadvantaged simultaneously by gender, race and or/ethnicity, economic status, and educational background, as they pursue non-mathematical majors requiring enrollment in an elementary statistics course?

- How do higher education administrators, faculty, and students believe math anxiety influences performance for a traditionally underserved and marginalized female adult student population in an elementary statistics course?

- What strategies are identified by higher education administrators, faculty, and students to help relieve math anxiety for a traditionally underserved and marginalized female adult student population in an elementary statistics course?

Based on the three research questions, interview and survey questions were crafted to elicit in-depth, rich descriptive responses from the participants.

The major themes and subthemes that developed from the questions and from the data collection and analysis process were identified in Table 2 in Chapter 4. This chapter presents a summary and discussion of major findings using themes and subthemes related to each research
question, the literature review, and the theoretical framework. It also outlines implications for practice and recommendations for future research.

**Discussion of Significant Findings by Research Questions, Themes and Subthemes**

**Research question 1.** Respondent answers to Research Question 1 provided insights into how perceptions contributed to math anxiety in females. As Azarian (2016) defined, perceptions are interpretations that ascribe meaning to an individual’s environment and influence behavior. These interpretations are formed through sensory and mental impressions derived from internal factors and influenced by the external environment. Anxiety is a condition that is fueled and affected by a person’s perceptions, resulting in a distortion of reality that can potentially alter and/or fundamentally shape personal belief systems (Azarian, 2016). Research has indicated that enrollment in a statistics course generates a significant amount of anxiety for students, particularly females, and that this anxiety is affected by a student’s perception of their competence (Kinkead, et al., 2016).

The findings from this study revealed that adult female students come to the higher education system with anxiety due to exposure to a new learning environment, and that anxiety is heightened by concerns about their skill level in barrier courses. Indeed, a significant number of female students in this study reported coming to higher education fearful of mathematics due to negative influences found in early school experiences. However, these findings have also uncovered that some students come with an inflated sense of competence, due to accolades received in a prior school experience that do not adequately correlate to the skill level required for college math. Administrators in the academic environment in which the research was conducted recognized that this anxiety may have resulted from the fact that many students were entering college without a proper orientation and that the existing on-boarding program and
placement testing were not adequate enough to fully explain the rigors of higher education learning or to mitigate students early flawed perceptions about competency.

Within this study’s findings, students reported being disheartened when their lackluster early placement test scores determined that they needed to complete courses, particularly in mathematics, labeled *remedial*, before they could embark on their main course of study. Research has revealed that indeed, remedial courses work best for incoming students when they are directly designed to improve on academic skills needed for higher education course work (Chen, 2016). Although the goal of remedial coursework is to prepare the *underprepared*, prior research outcomes have questioned the efficacy of remediation in improving academic standards, suggesting the need for additional research (Chen, 2016). Furthermore, some studies have suggested that persistence in higher education is negatively affected when students are assigned remedial coursework, due to the demoralizing effect that such a requirement incurs which distorts a student’s sense of self-efficacy and ability (Chen, 2016, p. 30).

The findings of this study also identified problems students face and negative perceptions they form when an instructor shapes learning outcomes using a traditionalist methodology. Many of the teachers interviewed for this study were not comfortable with student-centric learning and active engagement strategies commonly featured in other coursework. The reliance on solid mathematical calculations based on formulas, a characteristic of the traditionalist classroom and mathematics instruction, is not generally viewed as a location for the use of constructivist teaching methods. Students interviewed suggested that their anxiety was “heightened” when they became confused with the teaching approach and when the teacher was unable to diagnose why they were having difficulty learning. In traditionalist classrooms, like the majority of the ones that formed part of this study, no additional support was sought after
from peers, nor were collaborative approaches in the classroom used or encouraged. Frequently, students’ misunderstanding of the material due to the instructor’s communications style went unresolved.

**Research question 2.** The insights that emerged from Research Question 2 focused on how math anxiety led to barriers created by self-defeating behaviors of procrastination and reluctance to ask for help. The findings from this study have suggested that, when students had doubts about self-efficacy early in their college career, they were more inclined to engage in self-defeating behaviors.

In this context, the study revealed incongruity between student and faculty responses describing the reasons why students were reluctant to ask for help, even in the face of failure. Administrators and faculty attributed this problem to a failure of their onboarding process and admitted the need to revamp the orientation. Students, meanwhile, claimed the problem stemmed from their relationship with the instructor when asking for help; they were critical of the teacher’s linguistic and cultural differences and commonly described course verbiage barriers that exist in elementary statistics, for example using unfamiliar mathematical rules to explain problems without providing an explanation of the application of concepts. In addition to problems arising from the relationship with their professor, a surprising finding was that students relied equally on textbooks to answer their questions, compared to seeking help from peers or by accessing other school resources.

Procrastination is defined as the avoidance or delaying of an important action (Dictionary.com, n.d.). Researchers have posited that procrastination has a significant negative effect on performance, especially for adult students who balance multiple, competing, priorities (Khiat, 2017). For adult students affected by math anxiety, procrastination in finishing and
submitting assignments has been identified by researchers as a major challenge (Kinkead et al., 2016); it also surfaced as a significant obstacle to success in this study. Furthermore, procrastination extended beyond hesitation to complete assignments. Indeed, students delayed as long as possible in taking elementary statistics in their overall course of study. Elementary statistics is traditionally taught in a general education curriculum where the courses are sequenced for students to finish before they take courses in their major. Although students are counseled to finish their general education requirements in the first two years of coursework, this sequencing policy is not usually mandatory. Similar to what other researchers have documented (Boysan & Kiral, 2017; Onwuegbuzie, 2004; O’Sullivan, Robinson, Keogy, & O’Neill, 2017), students in this study commonly postponed taking the required course until the end of their academic term, adding an additional layer of stress when graduation became imminent and contingent on a passing grade in a barrier course.

**Research question 3.** Research question 3 highlighted the role of the academic organization in identifying and implementing best practices to reduce anxiety and reinforce learning for students. These best practices included (a) “having the right faculty;” (b) student engagement through technology; and (c) identification of at-risk students.

**Having the right faculty.** The findings from administrators interviewed suggest that full-time faculty employed to teach mathematics subjects at the research site generally had an advanced degree in mathematics, and part time or adjunct faculty were content experts in their field, usually recruited from finance-related industries; this verified that the instructors were academically qualified to teach the subject. However, faculty and students commented on the need for instructors to be willing to establish a rapport with their students that recognized anxiety and fears inherent in taking the elementary statistics course and that provided explanations of
possible applications to major course content. One major finding from the study was that students perceived the learning of elementary statistics to be the same as learning a foreign language; consequently, they expected that, as part of their relationship, the professor would provide tools to help them navigate this critical challenge.

Researchers have posited (Dunn, Carey, Richardson, & McDonald, 2016) that the ideal statistic teacher should recognize the basic problem of linguistics in an elementary statistics course and prioritize the learning outcomes to focus on outcome analysis rather than mastery of formula-based computations. Incidental learning, a focus on meaning associated with “authentic tasks” rather than process (Dunn, et al., p. 19) and statistical literacy, “understanding the basic language of statistics” (Dunn, et al., p.8) are two terms that relate to an elementary statistics teaching strategy designed to improve understanding rather than requiring an exact computation answer for grading purposes.

Prior research recommends that elementary instructors focus their methodologies when teaching elementary statistics (or any mathematics course) on communications strategies that will complement a diverse pool of learners. This practice links basic mathematics terminology with visual engagement and student-centric models that aim to help to improve understanding for those students who are not mathematics majors or who, in the case of many adult students, have not engaged in a formal mathematics class in a long time (Thomas, et. al., 2015). When communication challenges are not addressed, researchers have concluded that students lack the ability to understand text content, misconstrue instructions or directions on assessments, are unable to process instructor feedback for improvement; as a significant finding in the study, they become reluctant to participate or ask for help (Dunn, et. al., 2016).
**Student engagement through technology.** In today’s academic environment, the use of technology has become a mainstay for administrators, faculty, and students. Faculty reported using software to assist students to remember assignments and due dates and to foster engagement through ease of technological contact. However, the findings revealed that while technology has become a standard practice in many courses, faculty and students needed time that was not available during the length of a course to adjust to a steep learning curve that occurred when students were required to use unfamiliar or newly introduced software programs. As a result, the positive enhancement effects of technology often had the potential to become another roadblock to learning, especially in mathematics. Research has supported the outcomes of this study which revealed that technology adoption by faculty is usually slow, especially for educators who are resistant because of their own low skill level, doubts about self-efficacy, and lack of a tech-savvy background (Reid, 2017). Prior research outcomes have reported that many instructors have expressed concerns about leaving their comfort zone to incorporate new uses of technology; they have also perceived that students would be aware of this lack of knowledge (Reid, 2017). The three instructors interviewed for this study promoted the use of limited technology, especially reminder software, text messaging, and access through Skype. They did not, however, extol the success of programs used to assist with computations, such as Microsoft Excel. Indeed, many of the students interviewed had similar fears about adapting to new software and complained that, when their instructor utilized Excel to help understand formula calculations, it became yet another barrier to achievement.

**Identification of at-risk students.** The findings in this study suggest that administrators and faculty should devise strategies to identify those students most at risk for failure who may ultimately drop out due to math anxiety, especially since students have self-reported their
reluctance to ask for help. Current strategies focus on pre-college enrollment testing, but as stated before, although this methodology is useful in a student’s early progress, there is no mechanism in addition to self-reporting and grading that tracks student achievement timely enough to provide interventions.

Prior research supports faculty identification of students who are considered weak in the foundations of mathematics to apply appropriate interventions (Lake, et al., 2017). However, further supporting the findings from this study, researchers have also validated the added need of improving the “mathematics learning-model” and the integration of innovative communications and technology tools (Lake, et al., 2017, p. 215).

Discussion of Findings in Relationship to the Literature

Scholarship related to math anxiety has tended to focus on gender predisposition due to societal influences that influence the formation of females’ academic identities during the early years of education. These influences, researchers have asserted, have led to dysfunctional beliefs that: (a) a “math brain” existed where male math superiority is located (Whyte & Anthony, 2012, p. 8); (b) math ability is rigid and fixed; (c) problems are solved quickly and mainly by computation; and (d) math knowledge is unique and not transferrable from other domains (Ross et al., 2012, p. 279). These beliefs, the literature claimed, were then exacerbated by stereotyping, ultimately affecting a female student’s self-efficacy and achievement, which combined led to women creating flawed academic identities. This development of a flawed identity was further encouraged through the academic organization’s reliance on traditionalist teaching methodologies that focus primarily on computations rather than process improvement (Cilli-Turner, 2015; Gorvine & Smith, 2014; Nunez-Pena, et al., 2013).
The findings from this research study support the idea that dysfunctional beliefs constitute a negative influence, thus skewing the formation of a female’s academic identity. Several students described situations in their home life relationships where male superiority in mathematics was a foregone conclusion. Students also perceived being directed to choose less challenging majors, for example in the arts, because of societal and family perceptions of the limited ability of the female college student.

Female students interviewed for this study described their academic organization as an influential force in creating and sustaining barriers to degree attainment. Female students verbalized that, in their school experiences, many of their mathematics instructors were male, thus reducing the number of available female mentors. Research has posited that the availability of a positive mentor is significant in persistence and retention rates for undergraduate students, particularly if the mentor is of the same gender (Cornelius, Wood, & Lai, 2016); however, a severe scarcity of qualified female mentors in higher education faculty exists (Block & Tietjen-Smith, 2016). The female students interviewed for this study perceived that their relationship with their instructor had critical importance to their successful completion of an elementary statistics course. In mathematics, instructors were viewed as content experts, and the students said they were more likely to seek their expertise rather than that of a peer. Additionally, administrators interviewed for this study admitted that, although they recognized the need for quality educators, gender equity did not seem to be a factor in faculty recruitment.

Another finding linked to the academic organization’s response to math anxiety was related to the adherence to traditionalist teaching methods. Each faculty member interviewed was free to employ their own style of student engagement, which had the propensity to lead to an inconsistency in course methodology, with some faculty opting for more student-centric
approaches and some utilizing past traditionalist practices. Recognizing a high failure rate, administrators did indeed admit that elementary statistics may be better placed in the discipline of a student’s major course of study rather than in the mathematics department.

In addition to society and the academic organization, the environmental impact of poverty is known to have a detrimental effect on degree attainment for females. The disproportionate predisposition to poverty for females has led many to seek improved economic status through higher education. In 2016, the overall poverty rate in the United States was reported as 12.7% (40.6 million people) for a family of four; a women’s poverty rate was reported at 14% (22.9 million people); and the gender wage gap (average earnings for full time non-seasonal working women compared to men) was cited as 80.3 cents to the dollar (Basic Statistics, 2017). Almost all of the students taking the pre-course survey responded that their chief reason for attending college was for financial security through improved career options; 60% lived in a family with dependents.

Overall, the participants in this study reinforced that perceptions have a significant impact on academic success. Perceptions are generally skewed by early influencers at home; during elementary, middle, and high school; and by society’s views of females’ ability to attain higher education degrees. For the females interviewed in this study, academia contributed to the persistence of stereotyping and dysfunctional beliefs by being slow to respond to effect changes that would attend to the specialized learning needs of these students who struggle with mathematics. In general, for those females who cannot successfully complete barrier coursework, the incidence of poverty can be severely exacerbated.
Discussion of Findings in Relationship to Conceptual Framework

Stage environment fit theory (SEF) was the framework selected to underpin this study because SEF theorists posit that student engagement in learning leading to the completion of a higher education curriculum is linked to the degree to which students perceive their physiological needs (constructs) of autonomy (control), competence (self-efficacy), and relatedness (belonging) are satisfied within an academic organization (school fit) (see Figure 1) (Jenkins-Guarnieri et al., 2015; M. T. Wang, 2012; Zimmer-Gembeck et al., 2006) This case study utilized SEF to investigate and analyze how, and the extent to which, an academic organizational structure, social climate, and instructional processes, as evidenced through teacher and peer relationships, supported or inhibited students’ ability to achieve academic success (see Figure 2), especially when students were influenced by math anxiety. Figure 2, found in Chapter 4, outlines this case study’s data analysis outcomes; it was created to mirror the SEF framework model and to link the SEF constructs to attitudes expressed from participants through the data collection and analysis process.

Autonomy, as the first construct of SEF, relates to the freedom of choice that empowers students to seek support from resources supplied by the academic organization to help improve their skills and to hone proficiency (Jenkins-Guarnieri et al., 2015). Within this context, academia fosters encouragement to convince students that the assistance that is offered will ultimately increase their competence. The findings from this study demonstrated that, although there were multiple opportunities and services available for students to access, the organization was unsuccessful in convincing students to seek help. Student reluctance to seek help and procrastination emerged as subthemes related to how anxiety affects performance through self-defeating behaviors. Administrators and faculty expressed frustration at the lack of student
engagement to seek help and admitted that this outcome was partly related to the school’s failure to provide a positive onboarding and orientation program. However, they also indicated that there was no specific reason identified for this underutilization of resources, and indicated the need to study the problem further.

The second construct of competence relates to a student’s perception of skill when performing a task. Competence is directly affected by perceived changes in autonomy. Thus, those students who are reluctant to seek help from available resources from their sanctioned environment thus dismiss an opportunity for mastery of a perceived complex subject. They are then more likely to experience negative self-esteem and self-efficacy issues, and they question the quality of their abilities and competence.

The findings of competence in this study were strongly linked to student perceptions that were skewed by math anxiety, which served as an overarching debilitating and influential force. The findings suggest that many students are unprepared for the college environment, due in part to insufficient training in elementary, middle, or high school curriculums. Some students interviewed for this study began to question their self-efficacy when they perceived that their high quality of competence, which was validated by high school accomplishments, was sabotaged by a college placement test that indicated the need for remedial course work.

Finally, according to the findings, the student participants’ competence was challenged when the academic organization failed to provide materials and instructors capable of surmounting cultural and linguistic barriers to communicate effectively, especially in mathematic course work where the formulas and calculations are frequently compared to learning a foreign language. Indeed, contemporary national reform efforts have focused on creating a mathematics curriculum with Universally Designed Mathematics Instruction (UDL) that considers the needs
and experiences of a diverse student population with differing learning styles and abilities and that focuses on standardization in language, modeling, vocabulary, and many other evidence-based practices. By standardizing mathematical communications, instructors will employ the same type of methodology resulting in students being able to easily recognize and decode complex mathematical concepts over different mathematical courses, for example, algebra, statistics, calculus, etc. (Thomas et al., 2015). The findings from this study revealed that administrators and faculty recognized the need to address communications barriers with students by taking the first step towards increased clarity by moving elementary statistics from the mandatory general core curriculum to part of the student’s major discipline. At this institution, and in line with national guidelines in the field, this change allowed elementary statistics to be taught using language and examples familiar within the students’ major course of study and reinforced in other coursework common to the curriculum of the major.

The third construct -- relatedness -- is described within the SEF theoretical framework as a reciprocal arrangement between the student and his or her various relationships with teachers and peers, fostered within the academic environment. The findings suggest that students placed emphasis on their relationship with their instructor as a bridge to feeling comfortable seeking help and accessing other available resources. As stated previously, administrators and faculty interviewed for this study failed to understand why female students affected by math anxiety appeared unwilling to create connections with faculty or to actively utilize a plethora of resources designed to improve their chances for academic success. The findings also indicated that these female adult students did not heavily rely on peer interactions as a source of support. Research on this topic has indicated that non-traditional students face particular challenges in creating and sustaining peer relationships, partially due to the fact that many adult learners lack
confidence in their math abilities (Jameson & Frusco, 2014). These challenges that limit peer support are related to time constraints resulting from the reality that adult students commonly juggle school, careers, and generation gaps when attending a college or a university with traditional age students; this population needs instructors to provide flexibility in completing course work and meeting deadlines (Lin, X., 2016).

The central tenet of SEF places the onus of responsibility on the academic organization to provide the safe space (school fit) where positive relationships with instructors and peers encourage engagement through promotion of autonomy, competence, and relatedness. Even female students who have demonstrated competence in barrier courses can suffer from math anxiety leading to motivated forgetting, a condition where forgetfulness is sparked when self-efficacy is threatened by unfamiliar concepts that are not adequately explained (Ramirez, McDonough, & Jin, 2017).

Given the overarching issue of math anxiety affecting female students, from the findings in this study linked to current research, failure of the organization to provide a safe space results in support of female students’ negatively biased self-efficacy perceptions. This in turn leads to self-defeating behaviors of reluctance to ask for help and procrastination, and ultimately, loss of students through drop out or failure.

**Recommendations for Practice**

The global economic marketplace requires competent human capital drawing from a myriad of STEM graduates who have obtained the skill levels, emotional stability, and varied insights to successfully maintain a high economic standard for world business transactions (Kassae & Rowell, 2016). The *World Economic Forum* has documented a gender imbalance in STEM careers, with females representing 60% of graduates of colleges and universities but
earning only approximately 35% of degrees in STEM (Munoz-Boudet, 2017). Additionally, for those women who earn STEM degrees, only “one in seven actually works in that area” (Munoz-Boudet, 2017, para. 3). Math anxiety is cited as a major cause for this scarcity (Vakili & Pourrazavy, 2017).

This chapter highlights recommendations for higher education organizational practice in understanding and mitigating the effects of math anxiety for the traditionally underserved and marginalized female to reduce the barrier to degree completion and to increase participation in STEM careers. Since math anxiety is usually well established when these students enter higher education, the recommendations focus efforts on recruitment and retention strategies designed to target areas of major concern identified in this study. These recommendations include:

- Early preparation strategies designed to help students mitigate math anxiety:
  - Improved student orientation to life in higher education.
  - Placement of elementary statistics within discipline-related coursework,
- Retention strategies designed to help students negotiate coursework while dealing with math anxiety:
  - Early identification of and ongoing support for at-risk students.
  - Updated instructor qualifications as recommended by the 2016 GAISE revised college report.

**Early preparation strategies.** One significant finding to emerge from this study was that many students were totally unprepared for the rigors and demands of higher education, especially in mathematics (Kassaee & Rowell, 2016). Students became disheartened when presented with placement scores that required additional remedial course work before they could proceed with their actual course of study. Researchers have also asserted that a student’s first
year is critical in setting a tone for the following years (Kassaee & Rowell, 2016, p. 77). The academic organization has the obligation to their enrolled students to coach and counsel them with realistic expectations and to be aware of any emotional duress caused by perceived difficulties not yet encountered.

**New student orientations.** New student orientations have increasingly become a formal part of the college and university onboarding process. Successful acclimation to higher learning, according to researchers, is linked to higher levels of motivation to succeed and higher graduation rates (Kassaee & Rowell, 2016). Many schools have adopted one-credit, pass/fail, first-year experience courses mandated for all incoming students new to the organization, including transfer students. The course content usually includes an orientation to the college campus, coaching in time management and study skills, team building, and identification of any future development or performance issues. Additionally, these courses help the academic organization introduce the fledgling student to resources such as academic advising, clubs and societies, and college events; they also commonly include introductions to more senior students who act as peers and mentors. Research has suggested, however, that these courses have a minimal positive effect on students’ successful accomplishment and ultimate graduation (First Year Experience Courses, 2016).

As administrators become increasingly aware of the negative impact of math anxiety on incoming students and the negative connotations ascribed to remedial coursework, it is recommended that, instead of a generalized first-year experience course for students assigned remedial courses, the remedial curriculum should be woven into generalized courses. Thus, the remedial coursework acts as a *bridge* that provides an introduction to higher education while targeting areas where students are proven as lower skilled, such as mathematics, which is prone
to historic and significant challenges, particularly for certain populations. Isolating problem areas and re-labeling demoralizing titles could help students perceive a lower placement test score and subsequent placement in remedial course work as an integral part of the college experience rather than as a sign of failure or incompetency. This recommendation stems from this study’s findings where a significant number of students reported they were reluctant to ask for help despite an onboarding process that introduced them to the campus, faculty, and available resources.

Placement of elementary statistics in the major discipline. Elementary statistics is well-known as a highly-feared, highly-failed barrier course in higher education. For most disciplines, the course remains in the general education core curriculum, usually found in the first two semester offerings and taught by mathematic professors, and a student must successfully pass it to move onto their field of study. The failure rate for higher education mathematics is reported to be as high as 50% for non-mathematical major students (Kalajdzievska, 2014, p. 376; Shakerdge, 2016).

Recommendations from the 2016 GAISE college report specify that instructors should aim to promote statistical literacy by utilizing data sets in tandem with a student’s course of study to improve the understanding of statistical outcomes (Wood, Mocko, Everson, Horton, & Velleman, et al., 2017). Some academic organizations, in an effort to remove the generality of instruction, have placed elementary statistics within the offerings of a student’s major course of study. The benefits of placing elementary statistics in a major curriculum include:

- A better acclimation to the college environment, generally because several other general education courses and remedial work have been taken in the first year offerings. Courses in the discipline are not usually available until the second year.
• As students take other course offerings in their major, they become more familiar with vocabulary and concepts within their core course of study, easing communication barriers.

• Instructors in a major discipline are not usually from a mathematics field; they usually have a broader educational focus and are content experts in their discipline.

• Students within a major course of study have many of the same instructors for different courses and are able to develop a comfortable, interactive relationship with their professors. This increases their propensity to ask for help.

• Text books that include relevant data sets in elementary statistics models are usually tailored to be discipline-specific, providing students with meaningful scenarios and the ability to correlate and apply results to problems familiar to them. This recommendation stems from the results documented in this study where administrators, faculty, and students recognized the need for utility and application to foster stronger conceptual understanding. Prior research outcomes have indicated that, when students have the ability to connect assignments to reality, they are more likely to embrace education and approach mastery in any type of coursework (Akcay, 2017).

Elementary statistics in general education courses is usually taught by mathematics professors, and it provides minimal linkage to a student’s area of interest except for the small percentage of mathematics majors taking the course. Despite educators’ growing recognition of the need for change in this area, it will be a very long time before the stigma and fear associated with elementary statistics can be truly eliminated, but moving the course to the comfort zone of a core discipline’s offerings with familiar instructors is an excellent and viable first step.
Retention strategies. Researchers have concluded that the two undergraduate groups most likely to drop out of higher education are females and under-represented minority students, many who have difficulty with mathematics and/or analytical skills (Sithole et al., 2017, p. 47). Indeed, poor preparation in the development of mathematic skills is cited as a significant contributing factor. Students not comfortable or confident with their mathematics ability will predictably underperform, leading to failure or dropout. (Sithole et al., 2017).

Early identification of at-risk students. The study findings suggest many students are unwilling to self-report their need for additional resources to assist them with difficult course work. Research has posited that it is the responsibility of the academic organization to be cognizant of and identify new students who are academically weak, especially in mathematics skills, in the first year. (Lake et al., 2017). This identification should focus on two areas: (a) skill proficiency; and (b) formulation of an appropriate intervention suited to the individual needs rather than to the characteristics of the at-risk group in general (Lake et al., 2017). Past practice has demonstrated that higher education has been responsive to assisting these students, at least initially, by assessment of skills and assignment of remedial coursework.

As previously discussed, student perceptions related to remedial work can be demoralizing and, rather than improving skills, this approach can have a reverse effect on progress. Also, as cited above, it has been recommended that the first year experience course be revised to include remedial assistance. However, prior research outcomes have also recommended that the existing broad-based remedial coursework itself should be revamped to incorporate a more targeted and integrated approach to help strengthen proficiency (Lake et al., 2017). This approach can help administrators and faculty to first identify specific skill deficits and then design interventions that transform into customized, skill-based strategies for
overcoming challenges and strengthening the weaker areas of proficiency (Lake et al., 2017). This provides an opportunity to detect deficiencies related to math anxiety and to apply individual customized interventions before additional damage to self-efficacy or poor performance occurs.

A second recommendation is the use of technology-based solutions to allow administrators, faculty, and other staff involved in student success to identify at-risk students as soon as – or even before – problems arise. For example, Starfish, an early alert program, allows faculty and staff to “raise a flag” as soon as concern for a student is noted, often signaled by attendance, poor performance, or other behaviors. When a flag is raised, all academic departments involved with the student can be alerted. For example, if a student drops to a low average in one course, other instructors and academic advising can be notified. Conversely, a “kudos” flag can be raised which allows the student to receive praise for a job well done. Kudos is used to strengthen a student’s self-efficacy, especially in barrier courses when improved performance is duly acknowledged.

Another example of technological solutions is the utilization of data dashboards for administrators and instructors to assess student grading by courses and instructors. These dashboards facilitate comparisons across at-risk populations of student loan data or of any criteria selected (Gose, 2017). In a 2013 study, students reported that their success in several mathematics remedial courses was due to “the instructor you were assigned” (Gose, 2017, p. A8). Upon investigation, administrators recognized that the lack of standardization in teaching methodologies allowed for a wide variety of methods and assessments that did not always adequately support student learning outcomes. Dashboards help to quickly identify patterns that
can lead to conversations about problems areas, especially in noting grading disparity when comparing identical coursework delivered by different instructors (Gose, 2017).

Currently, many universities have focused on retention rates because of loss of academic dollars needed to fund their programs. For adult students, graduation rates hover between 42.1% for part time -previously attended, and 58.5% for full time – attending for the first time, in four-year public institutions receiving Pell grants (Lederman, 2017). By improving remedial curriculum for weak-skilled students and managing instruction quality for faculty early in the new student orientation, administrators receive the added benefit of improved student persistence and ultimately higher retention rates.

**Updated instructor qualifications from the 2016 GAISE Revised College Report.**
Research has asserted that many students are unprepared for the rigors of higher education mathematical courses because they have been taught in middle and high school by instructors who were assigned courses outside their major area of expertise (Sithole et al., 2017). Relative to higher education, the ASA, in congruence with the 2016 GAISE revised College Report, has consistently recommended that improvement is needed on several platforms that address a myriad of the issues defined in this study by administrators, faculty, and students. This study bases its recommendations for future practice on ASA reports which include: (a) *Curriculum Guidelines for Undergraduate Programs in Statistical Science*; (b) *Statistical Education of Teachers* (SET), and (c) *Qualifications for Teaching Introductory Statistics* (Wood et al., 2017).

*Curriculum Guidelines for Undergraduate Programs in Statistical Science.* This document focuses on clear communications and the use of data from diverse models that “integrate real data with a context and purpose” (Wood, et al., 2017, p. 3). It recommends that all mathematics-based courses including statistics utilize relevant data sets so that in elementary
statistics, when the course is placed in the major course of study, attaching data sets that promote relevance is easily achieved.

*Statistical education of teachers.* This report provides recommendations and guidelines for preparing future elementary statistics instructors with a focus on the preparation of elementary and middle school teachers. This recommendation, created from the *Mathematical Education of Teachers* report (Franklin et al., 2015) suggests professional development with a prescribed curriculum in statistical education and a mandatory number of credit hours for completion before a teacher can be qualified to teach statistics. This study suggests that administrators, who are responsible for the recruitment of faculty for elementary statistics, require specific mastery of criteria, including those set forth in the SET report.

*Qualifications for teaching introductory statistics.* This report recommends that prior to teaching an elementary statistic course, instructors must have experience facilitating at least two statistical methods courses that include a higher level of data analysis (Wood, et al. 2017). This recommendation accepts the preceding criteria, but adds that the instructor must have proven to be successful through the use of a teaching strategy assessed by administrators and other faculty, based on course observations and student feedback.

Math anxiety as a consequence of stereotyping, flawed education experiences in elementary, middle, and high school, and an imperfect integration into a higher educational environment contributes significantly to the maintenance of the challenges to successful degree attainment for the underrepresented and marginalized female. The recommendations listed above would provide an excellent base from which to address math anxiety and provide support to all students who are impacted by this issue.
Limitations

According to Atieno (2009), the overarching chief limitation inherent in qualitative research is the lack of certainty when applying study outcomes to the wider population. Unlike quantitative analysis, which measures validity through statistical significance, qualitative research does not tout a similar, corresponding scale.

In the world of research, qualitative studies commonly spring from previous quantitative research, motivated by a concern to more fully understand the phenomena that underpin the complexity but paucity of numbers (Atieno, 2009). This case study was informed by a quantitative descriptive research project which studied math anxiety in adult graduate business students (Currie, 2014). That project suggested further examination through qualitative methodologies of the statistically significant findings under which a specific gender’s self-efficacy of women self-reporting was found to be affected by math anxiety (Currie, 2014).

This case study expanded on the Currie project; however, several limitations were found in that qualitative case study that affects this research study. They are: (a) small sample size, (b) single case study, and (c) researcher bias.

**Small sample size.** In the recruitment of participants who responded to an email request, the response rate from administrators was 75% (three individuals); the response from faculty was 100% (three faculty members). The student response rate for this study was 21%. Nine students agreed to participate through a response in a web survey. The school that served as a site for the research study was a small, inner city college with a limited number of administrators and faculty involved in student outcomes in elementary statistics. Female students were found to be very reluctant to participate – a major contributing factor to the size of the student sample. However, despite the small sample size, the average response rate for online surveys from external sources
is known in general to be 24.8% (Fluid Surveys University, 2014). Additionally, of the nine students who agreed to participate, six students (66%) completed the three data collection sources of the pre- and post-course surveys and interviews.

**Single case study.** The second limiting factor of this study was the single case methodology. By isolating data collection and analysis to one small organization, results lack a breadth and depth of insights that may be found by conducting comparisons to other schools. Within this study, the major themes and subthemes emerged based on the strength of repetitive answers from the respondents. By utilizing a multi-site case study, analysis could provide more compelling arguments and/or a wider variety and complexity of outcomes.

**Researcher bias.** The third limiting factor of the study relates to the researcher’s interpretation based on positionality as a female elementary statistics instructor who may have a personal bias towards the subject. According to Stake (1995), it is this personal connection that fuels the impetus for the study; however, researchers must guard against manipulation and bias that can affect research results (Lincoln and Guba, 1985).

**Recommendations for Future Research**

The goal of this study was to provide greater insights through qualitative data analysis into how math anxiety for females inhibits success in higher education degree achievement by creating challenges for passing elementary statistics, a core curriculum subject. The findings of this study suggest two primary recommendations for future research: (a) multi case study expanded over multiple academic organizations; and (b) comparison of results using a sample from organizations where elementary statistics is placed in the major discipline’s curriculum.

Building on the statistically significant findings from quantitative research that suggests math anxiety in females’ acts as an inhibitor to degree attainment, this single case study provided
more rich and descriptive insights into the origins, effects, and strategies that could help to abate
the occurrence of math anxiety. To enhance and strengthen these findings, researchers can focus
on the issues explored by using a multi-case study method where sampling would occur over
several academic organizations of the same type – for example, multiple samples from colleges;
universities, and two-year programs. This research could be further segmented into academic
organizations in the same geographic area – urban vs. suburban.

The advantages of elementary statistics placement as a core curriculum subject have been
recognized in academic organizations that have experienced high failure rates for this course.
These organizations have followed the suggestions from the GAISE 2016 report and have
repositioned elementary statistics in the core discipline’s curriculum. Future research could
rigorously repeat the study and measure pass/fail rates and math anxiety for females in
organizations where statistics is placed in a major discipline’s course work and compare
outcomes to past studies where statistics is not part of the core curriculum.

Conclusion

Over the past decade, research has evolved that is related to students’ relationship with
mathematics courses to more adequately define reasons for significant failure rates (Petrillo,
2016). Much of this research has focused on variables such as student demographics, gender,
and culture; teacher preparation, professional development, teaching methodology; and
2016, Lake et. al., 2017; Thomas et. al, 2017). Additionally, using the SEF theoretical
framework, researchers have posited that the academic organization impacts how students are
exposed to and influenced by these challenges.
Much of the previous research consulted to inform this study supports the conclusion that adult females and other marginalized groups are most susceptible to negative impacts to degree attainment especially when successful completion of a coursework is dependent upon competence in anxiety-provoking subjects such as those that are found in mathematics or elementary statistics (Jameson & Fusco, 2014; Onwuegbuzie, 2015). This study is original because it strives to focus research on math anxiety, its causes, effects, and mitigation techniques specifically targeting the traditionally underserved and marginalized adult female. Today’s adult female adopts multiple societal roles while competing against historic challenges to career advancement. As a nation that prides itself on the freedom of opportunity and equality for all, academic organizations would benefit and rise to their mission by using the results reported by continued efforts of researchers on this topic to further balance the scales for fairness in educational achievement across gender. Indeed, underserved females are, more than ever, critical contributors to the global social and economic balance of our society.
References


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mine/2014/10/31/women-more-likely-to-graduate-college-but-still-earn-less-than-men


http://doi.org/10.1080/10511970.2015.1046004


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Olson, G. A., & Hirsh, E. (1995). *Women writing culture*. SUNY Press. Retrieved from https://books.google.com/books?hl=en&lr=&id=7M8raAcjVTMC&oi=fnd&pg=PR11&dq=%22the+experience+of+people+of+color+and+gays+and+lesbians+and%22+%22their+own+position+as+socially+situated+subjects+of+knowledge.%22+%22is+part+of+modernity+...+a+kind+of+later+development+of%22+&ots=YCUxU833ro&sig=USPnIWo


Sithole, A., Chiyaka, E. T., McCarthy, P., Mupinga, D. M., Bucklein, B. K., & Kibirige, J. (2017). Student Attraction, Persistence and Retention in STEM Programs: Successes and


Appendix A: Internal Review Board Protocol Northeastern University and Study Site

For NU IRB use:

Date Received: 8/11/16 reviewed 9/19/16  NU IRB No. CPS16-08-12
Review Category: Approval Date

APPLICATION FOR APPROVAL FOR USE OF HUMAN PARTICIPANTS IN RESEARCH

Before completing this application, please read the Application Instructions and Policies and Procedures for Human Research Protections to understand the responsibilities for which you are accountable as an investigator in conducting research with human participants. The document, Application Instructions, provides additional assistance in preparing this submission. Incomplete applications will be returned to the investigator. You may complete this application online and save it as a Word document.

If this research is related to a grant, contract proposal or dissertation, a copy of the full grant/contract proposal/dissertation must accompany this application.

Please carefully edit and proof read before submitting the application. Applications that are not filled out completely and/or have any missing or incorrect information will be returned to the Principal Investigator.

REQUIRED TRAINING FOR RESEARCH INVOLVING HUMAN SUBJECTS

Under the direction of the Office of the Vice Provost for Research, Northeastern University is now requiring completion of the NIH Office of Extramural Research training for all human subject research, regardless of whether or not investigators have received funding to support their project.

The online course titled "Protecting Human Research Participants" can be accessed at the following url: http://phrp.nihtraining.com/users/login.php. This requirement will be effective as of November 15, 2008 for all new protocols.

Principal Investigators, student researchers and key personnel (participants who contribute substantively to the scientific development or execution of a project) must include a copy of their certificate of completion for this web-based tutorial with the protocol submission.

Certificate(s) Attached
☐ Certificate(s) submitted previously – on file with the NU’s Office of Human Subject Research Protection

A. Investigator Information

Principal Investigator (PI cannot be a student) Dr. Sara Ewell

Investigator is: NU Faculty  X  NU Staff ________ Other ________
College: Choose an item. *Northeastern University*
Department/Program: College of Professional Studies
Address: 360 Huntington Avenue (BV 20), Northeastern University, Boston, MA
Office Phone: 617-373-6459 Email: s.ewell@neu.edu

**Is this student research?** **YES** __X__ **NO** _____ If yes, please provide the following information:
Student Name: Luanne Amato Anticipated graduation date: _____
Undergrad: ___ MA/MS: ___ PhD: ___ AuD: ___ EdD: __X__ DLP: ___ Other Degree Type: ___
College: Choose an item. *College of Professional Studies*
Department/Program: Doctor of Education (EdD)
Full Mailing Address: 3161 Weston St., Philadelphia, PA 19136
Telephone: (215) 333-2019 Primary Email: amato.l@husky.neu.edu
Cell phone: (267) 934-6104 Secondary Email: ________________

**B. Protocol Information**

Title: Math Anxiety: The Impact On Traditionally Underserved And Marginalized Adult Female Undergraduate Students In Elementary Statistics

Projected # subjects: 17 total (up to 10 students for pre and post course surveys/interviews/focus group; Interviews = 3 administrators, 4 faculty Approx. begin date of project: 10/1/2016 Approx. end date: 12/31/2016

It is the policy of Northeastern University that no activity involving human subjects be undertaken until those activities have been reviewed and approved by the University's Institutional Review Board (IRB).

- **Anticipated funding agency/source for project (or none):** None
- **Has/will this proposal been/be submitted through:**
  - NU's Office of Research Administration and Finance (RAF): __NA__
  - Provost: __N/A__
  - Corp & Foundations: __NA__
  - Other: __N/A__
- **Grant Title:** __N/A__
- **Grant ID:** __N/A__

**C.**

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<th>Will Participants Be:</th>
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<th>Does the Project Involve:</th>
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<td>Blood Removal?</td>
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</table>
Northeastern University
Students? X
Institutionalized persons? X
Prisoners? X
Cognitively Impaired Persons? X
Non or Limited English Speaking Persons? X
People Living outside the USA? X
Pregnant Women/Fetuses? X
Other? (Please provide detail) X
Investigational drug/device? X
Audiotapes/videotapes? X

Please answer each of the following questions using non-technical language. Missing or incomplete answers will delay your review while we request the information.

D. What are the goals of this research? Please state your research question(s) and related hypotheses.

The goal of this research is to expand on previous quantitative studies using qualitative data from a case study exploring math anxiety and its’ effect on performance. This study narrows the student population to the marginalized and traditionally underserved adult (over age 25) female and also includes perspectives from administration and faculty. Data synthesized from interviews, focus groups, and open ended surveys will add a more rich description and understanding to already existing statistical outcomes from quantitative research that validates the problem of math anxiety as a barrier to success in higher education degree attainment.

There are three research questions that guide the direction of data collection and analysis:

Research question 1. What factors contribute to math anxiety in a population of female adult higher education students who are disadvantaged simultaneously by gender, race and/or ethnicity, economic status, and educational background as they pursue non-mathematical majors requiring enrollment in an elementary statistics course?

Research question 2. How do higher education administrators, faculty, and students believe math anxiety influences performance for a traditionally underserved and marginalized female adult student population in an elementary statistics course?

Research question 3. What strategies are identified by higher education administrators, faculty and students to help relieve math anxiety for a traditionally underserved and marginalized female adult student population in an elementary statistics course?

E. Provide a brief summary of the purpose of the research in non-technical language.

The purpose of this study is to gain a deeper understanding of how math anxiety has impacted successful degree attainment for a traditionally underserved and marginalized female population
through the rich description of student experiences and the perceptions of administrators and faculty. The goal of this study is to enrich and further develop theories related to negative effects of math anxiety and provide strategies to overcome this significant barrier to higher education degree attainment, thus improving economic conditions for females by increasing opportunities in lucrative and traditionally underrepresented Science, Technology, Engineering and Mathematics (STEM) job opportunities.

F. Identify study personnel on this project. Include name, credentials, role, and organization affiliation.

Principal Investigator – Dr. Sara Ewell, EdD Faculty, Northeastern University College of Professional Studies

Student Researcher – Luanne Amato, MBA - NEU doctoral student

Transcription services provided through Rev.com with backup digital recorder

External inquiry audit will be conducted by Dr. Sara Ewell to challenge process and outcomes of the study

G. Identify other organizations or institutions that are involved. Attach current Institutional Review Board (IRB) approvals or letters of permission as necessary.

The study will take place in an urban college located in the center of a metropolitan district (Peirce College). The college requires approval through the organization’s IRB facilitated by the Vice President of Academic Advancement. IRB approval from the organizational research site (Peirce College) was approved on 8/8/2016 Appendix A).

H. Recruitment Procedures

Describe the participants you intend to recruit. Provide all inclusion and exclusion criteria. Include age range, number of subjects, gender, ethnicity/race, socio-economic level, literacy level and health (as applicable) and reasons for exempting any groups. Describe how/when/by whom inclusion/exclusion criteria will be determined.

Administrators, faculty, and female students over the age of 25 will be recruited to participate in the study to gather data from a power perspective in comparison to the actual reality of students.

Male students have been excluded from this study as prior research validates that females are more affected by anxiety than males. Only adult female students over age 25 will be recruited to allow for increased personal experience in employment opportunities, educational experience, and societal interactions.

Describe the procedures that you will use to recruit these participants. Be specific. How will potential subjects be identified? Who will ask for participation? If you intend to recruit using letters, posters, fliers, ads, website, email, PsyLink description, HIT, etc., copies must be included as attachments for stamped approval. Include scripts for
Recruitment is a three prong process. To recruit administrators and faculty, I will utilize the college’s email to invite participation and follow up individually with those who have expressed interest in participating in the study and send a consent form. The researcher will be provided with a list of all students registered for an upcoming elementary statistics course(s) who will be contacted by the researcher through the organization’s email. If the student wishes to participate in the study they will independently contact the researcher by email after which an informed consent will be sent. Only those (administrators, faculty or students) who agree by signing the consent form (Appendix B) will be included in the study.

What remuneration, if any, is offered?

As a participation incentive, each participant (administrators, faculty and students) in the study will receive a $20.00 gift card to Dunkin Donuts or WaWa after the study is completed. Since there are multiple opportunities for a student to participate, a student will receive one gift card even if they participate in several data collection opportunities (survey, interview, and focus group).

I. Consent Process

Describe the process of obtaining informed consent*. Be specific. How will the project and the participants’ role be presented to potential participants? By whom? When? Where? Having the participant read and sign a consent statement is done only after the researcher provides a detailed oral explanation and answers all questions. Please attach a copy of informed consent statements that you intend to use, if applicable. Click here for consent form templates.

If your study population includes non-English speaking people, translations of consent information are necessary. Describe how information will be translated and by whom. You may wait until the consent is approved in English before having it translated.

Administrators and faculty will be approached by an organizational email from the researcher (Appendix E) with an invitation to participate in a 45 minute interview that can take place either on or off campus. Prior to the start of the interview, another consent form specific to the role of administrator or (Appendix C) will be presented to the participant with details of the interview, permission to record, safeguards to identity, and an invitation to ask questions, which the researcher will go over verbally before the beginning of the interview. The interview consent will be signed before the interview begins.

Students will be initially recruited by email (Appendix E) through a list of registered students for an upcoming elementary statistics course provided by the organization of students. Once the informed consent form is signed and returned the researcher will send a survey consent form (Appendix D) which includes check box for future participation activities of interview and/or
focus group. At the bottom of the pre course survey consent form is a link to take the survey. (This process will be repeated for the post course survey). If the student agrees to participate in an interview prior to the start of the interview, another consent form (Appendix C) will be presented to the participant with details of the interview, permission to record, safeguards to identity, and an invitation to ask questions which the researcher will go over verbally before the beginning of the interview. The interview consent will be signed before the interview begins. The interview consent process is the same as the focus group which includes an additional interview consent form and also where the researcher will go over verbally before the focus group begins (Appendix C).

The student pre and post survey consent forms provide contact information for all questions and prior to interviews the researcher will review the detail of the study, potential risk, and answer any questions or concerns that the participant poses prior to offering the informed consent for participant signature (Appendix C).

If your population includes children, prisoners, people with limited mental capacity, language barriers, problems with reading or understanding, or other issues that may make them vulnerable or limit their ability to understand and provide consent, describe special procedures that you will institute to obtain consent appropriately. If participants are potentially decisionally impaired, how will you determine competency?

N/A

*If incomplete disclosure during the initial consent process is essential to carrying out the proposed research, please provide a detailed description of the debriefing process. Be specific. When will full disclosure of the research goals be presented to subjects (e.g., immediately after the subject has completed the research task(s) or held off until the completion of the study’s data collection)? By whom? Please attach a copy of the written debriefing statement that will be given to subjects.

N/A

**J. Study Procedures**

Provide a detailed description of all activities the participant will be asked to do and what will be done to the participants. Include the location, number of sessions, time for each session, and total time period anticipated for each participant, including long term follow up.

Administrators will be asked to provide documents for de-identified student grading for elementary statistics for a three year period prior to 2016.

The researcher will request one 45 minute individual interview session with each administrator and faculty member. The interview will take place at the organization, or if the participant
prefers, an offsite location. Consents will be obtained that include purpose of the study and permission to record and transcribe the information. Also, the participant is asked for any questions they may have.

Those students who contact the researcher to participate and sign an informed consent will be:

- Sent an online pre-course survey (prior to the beginning of the elementary statistics course) with an appropriate consent form. The form will contain two checkboxes that indicate if the participant is willing to participate in an interview and/or focus group.
- Students who agree to an interview will chose their location either on campus or off site. One interview will proceed for 45 minutes and include a consent that details the purpose of the study and permission to record and transcribe the information. Also, the participant is asked for any questions they may have.
- Students who agree to a focus group will be advised of an off-site location for a 1.5 hour group and includes a consent that details the purpose of the study and permission to record and transcribe the information. Also, the participant is asked for any questions they may have.
- All students who have participated in the pre-course survey will be sent a post course survey (within one week of the conclusion of the course) with an appropriate consent form.

Who will conduct the experimental procedures, questionnaires, etc? Where will this be done? Attach copies of all questionnaires, interview questions, tests, survey instruments, links to online surveys, etc.

All processes related to this study will be performed by the student researcher alone with the exception of an audit of findings for dependability by the researcher’s advisor. Participants who agree to interviews or focus groups can select either on campus or the off site location arranged by the researcher. All data collected will be downloaded into a coding software program located at the researcher’s home office in a password protected computer. The computer is backed up through an external hard drive – also password protected.

Please see appendices for instruments.

Appendix C: Interviews and Focus Group Protocols
Appendix D: Pre and Post Survey Protocols

K. Risks

Identify possible risks to the participant as a result of the research. Consider possible psychological harm, loss of confidentiality, financial, social, or legal damages as well as physical risks. What is the seriousness of these risks and what is the likelihood that they may occur?

There are no identifiable risks to the participants. Identities will only be known by the researcher who will assign pseudonyms to all participants. All data will be uploaded into software on off
site password protected computer backed up by an external hard drive – also password protected. All data will be destroyed after uploaded to the coding software. If a participant opts to discontinue participation or withdraw from the study at any time, all of their contributions will be destroyed immediately and not used for reporting results.

Describe in detail the safeguards that will be implemented to minimize risks. What follow-up procedures are in place if harm occurs? What special precautions will be instituted for vulnerable populations?

All participants will be informed through informed consent and interview protocols both in writing and verbally that they are free to decline to answer any question, can opt to withdraw from the study at any time and their data will be destroyed, can ask questions at any time, and be guaranteed of confidentiality. See Appendices B, C, D

There are no vulnerable populations

L. Confidentiality

Describe in detail the procedures that will be used to maintain anonymity or confidentiality during collection and entry of data. Who will have access to data? How will the data be used, now and in the future?

All participants and data collection information will be known to and accessed by the researcher alone. All participants will be assigned a pseudonym upon signing of the informed consent form. Transcription software Rev.com and coding software MAXQDA 12 will be used for transcription and coding and each company maintains strict confidentiality standards. All data will be stored in an off-site location (researcher’s home office) in a password protected computer backed up by an external hard drive – also password protected. All data will be identified with the participant’s pseudonym and once loaded into the coding software, all data will be destroyed. Any notes recorded by the researcher will be entered into the computer and all paper will be destroyed once the information has been uploaded. The data collected for this study will be used for reporting results in this study. If a participant decides to withdraw from the study at any time, all of their contributions will be destroyed and not used in the results.

How and where will data be stored? How will electronic data be encrypted? When will data, including audiotapes and videotapes, be destroyed? If data is to be retained, explain why. Will identifiers or links to identification be destroyed? When? Signed consent documents must be retained for 3 years following the end of the study. Where and how will they be maintained?
All data collected will be stored in a password protected off site computer and backed up with an external hard drive. All transcriptions and notes will be destroyed after the researcher uploads to computer files through a scanner or download to coding software. All participants will be assigned a pseudonym upon signing of an informed consent, known only to the researcher. Signed consent documents will be retained for 3 years following the end of the study; any paper consents will be stored in a locked file at the researcher’s home office; all consents received electronically will be stored in a password protected computer with password protected external hard drive backup also located in the researcher’s home office.

M. If your research is HIPAA-protected, please complete the following;  
Individual Access to PHI

Describe the procedure that will be used for allowing individuals to access their PHI or, alternatively, advising them that they must wait until the end of the study to review their PHI.

N/A

N. Benefits

What benefits can the participant reasonably expect from his/her involvement in the research? If none, state that. What are potential benefits to others?

There are no direct benefits for participants. However potential benefits for others include:  
For Administrators: To provide a deeper understanding for high failure rates in elementary statistics and ideas for strategies to reverse the trend.

For Faculty: To help construct strategies in the classroom and other resources to help reduce math anxiety and improve learning outcomes.

For Students: To identify reasons for math anxiety and to reduce the tension associated with mathematics, with the understanding that the academic environment is also concerned and invested in improvements. To open up the possibility of opportunities in STEM related career choices.

O. Attachments

Identify attachments that have been included and those that are not applicable (n/a).

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<thead>
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<tr>
<td>x</td>
<td>Copy of fliers, ads, posters, emails, web pages, letters for recruitment *</td>
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<tr>
<td>N/A</td>
<td>Scripts of intended telephone conversations*</td>
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<tr>
<td>x</td>
<td>Copies of IRB approvals or letters of permission from other sites</td>
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<tr>
<td>x</td>
<td>Informed Consent Form(s)* (see our templates for examples)</td>
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<td>Debriefing Statement*</td>
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<td>Copies of all instruments, surveys, focus group or interview questions, tests, etc.</td>
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<td>Signed Assurance of Principal Investigator Form (required)</td>
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<td>x</td>
<td>NIH Human Subject Training Certificate(s) (required if not already on file at</td>
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**HSRP)

*(Approved forms must be stamped by the IRB before use)*

**P. Health Care Provision During Study**

Please check the applicable line:

___x___ I have read the description of HIPAA “health care” within Section 4 of the Policies & Procedures for Human Research Protection. I am not a HIPAA-covered health care provider and no health care will be provided in connection with this study.

_______ I am a HIPAA-covered health care provider or I will provide health care in connection with this study as described in Section 4 of the Policies & Procedures for Human Research Protection. This health care is described above under “Study Procedures,” and the Informed Consent and Health Information Use and Disclosure Authorization form will be used with all prospective study participants.

If you have any questions about whether you are a HIPAA-covered health care provider, please contact Nan C. Regina, Director, Human Subject Research Protection at n.regina@neu.edu or (617) 373-4588.

**Completed applications should be submitted to Nan C. Regina, Director, Human Subject Research Protection with the exception of applications from faculty and students of the College of Professional Studies, which should be submitted to Kate Skophammer, IRB Coordinator for CPS.**

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<td>Kate Skophammer, IRB Coordinator</td>
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<tr>
<td>Boston, MA 02115-5000</td>
<td>Phone: 617.390.3450; <a href="mailto:k.skophammer@neu.edu">k.skophammer@neu.edu</a></td>
</tr>
<tr>
<td>Phone: 617.373.4588; Fax: 617.373.4595</td>
<td><a href="mailto:n.regina@neu.edu">n.regina@neu.edu</a></td>
</tr>
</tbody>
</table>

The application and accompanying materials may be sent as email attachments or in hard copy. A signed Assurance of Principal Investigator Form may be sent as a scan, via fax or in hard copy.
De-identified Study Site IRB Approval

IRB Application - Research Proposal

Researchers Name: Luanne Amato

Date Submitted: 7/28/2016

Review Request for (select only one): ☐ Exempt ☐ Expedited ☐ Full

Investigator/Student’s Name: Luanne Amato
Address: 3161 Weston St. Philadelphia, PA 19136
Email (Peirce Email for internal IRB requests): lamato@peirce.edu
Phone Number: 267-934-6104
Additional Investigator(s): N/A

Faculty Information
Faculty Advisor’s Name: Dr. Sara Ewell  Northeastern University
Capstone Instructor’s Name:  Click here to enter text.

Title of Research Project:
Math Anxiety: The Impact On Traditionally Underserved And Marginalized Adult Female Undergraduate Students In Elementary Statistics

Dates of Research:
Projected Research Start Date: 10/1/2016
Projected Research End Date: 12/31/2016

Research Location - Facility/Institutional Area
Address:
On-site Contact Person’s Phone Number:  Click here to enter text.
On-site Contact Person’s Email:  Click here to enter text.

Organizational Permissions
Is review by another organization required? ☐ Yes ☐ No
If yes, other institution(s) requiring review of this proposal:
Northeastern University

Does the proposed research encompass direct Employer/Employee Relationship? ☐ Yes ☐ No

Form: IRB Application – Research Proposal
IRB Application - Research Proposal

Supervisor/Employee Relationship? □ Yes □ No

Status of letter of permission:
□ Letter of permission has been requested, but not yet received.
□ Letter of permission has been received and included as an attachment

Research Methodology
Description of Research Methodology: This case study, based on the qualitative methodology of Robert E. Stakes and Sharan B. Merriam, expands on past quantitative research that suggests that future studies be conducted to more deeply understand the effects of math anxiety and its impact on achievement; needed is the examination of variables such as underserved populations, gender disparities, segregation by race, and culture. This researcher utilized Chapter 5 from Linda Currie’s dissertation as the broad base for development of this dissertation.

Does the study require human participants? □ Yes □ No
Indicate type of interaction(s) with human participants (select all that apply)
□ Direct interaction/intervention/observation during data collection.
□ Retrospective participant record review/Review of archival or existing data: researcher is requesting 3 years of past data into aggregate pass/fail rates in elementary statistics courses.
□ Electronic survey
□ Anonymous Interaction
□ Other, please describe: Administrator, faculty and student interviews, one student focus group.

Estimated number of participants per type of data collection procedure: Administrators = 3; Faculty = 4; and Students = 10

Is the data collection process anonymous? □ Yes □ No
(*responses cannot be linked to the identity of the participants in any manner)
Participants of the study will only be known to the researcher and all identities will be protected by a pseudonym.

Does the study involve special or sensitive populations? □ Yes □ No
(children, prisoners, pregnant women, individuals with mentally/physical limitations and disabilities)
If yes, please describe population: Click here to enter text.

Form: IRB Application – Research Proposal
IRB Application - Research Proposal

Does the study encompass a supervisor/employee relationship? □ Yes □ No
If yes, please provide details: Click here to enter text.

Is this research being funded? □ Yes □ No
If yes, please provide details: Click here to enter text.

Indicate the type of risk participants will be exposed to (select only one)
☐ No anticipated or unanticipated risk/No known risk.
☐ Minimal risk: Briefly explain/provide a justification; more detail can be provided in the proposal. Click here to enter text.

☐ More than minimal risk: Briefly explain/provide a justification; more detail can be provided in the proposal. Click here to enter text.

Does the research include an incentive for participation? □ Yes □ No
If yes, please provide details: All participants including the registration staff who act as a gatekeeper for student recruitment will receive a $20.00 gift card to Dunkin Donuts or WeWa for their participation.

Investigator’s Assurances:

By signing below, I certify that the information contained herein is complete and accurate. I agree to conform to the procedures as described and to conduct the research with the highest respect for the participants’ right to be protected from risk and/or invasion of privacy. If changes to this information become necessary, I agree to seek prior approval from the IRB. As the researcher, I agree to keep my instructor and faculty advisor informed of my progress, and of any complications which may arise.

I understand that the research will not be initiated until written approval is secured from the IRB.

If the research protocol changes in such a way that the basis for exemption no longer conforms to the criteria of exemption, a new request for review will need to be submitted.

Luanne Amato (see pdf. Signed page)
Date: 7/28/2016

Form: IRB Application – Research Proposal
IRB Application - Research Proposal

Principal Investigator

Date: 7/28/2016

DO NOT WRITE IN THIS SPACE – FOR COMMITTEE USE ONLY

☐ yes ☐ no Approved as submitted
☐ yes ☐ no Approved pending changes, to be reviewed by IRB Principal*
☐ yes ☐ no Conditionally approved, changes to be reviewed by full IRB*
☐ yes ☐ no Not approved, must resubmit*
☐ yes ☐ no Suspension/termination of previously approved study

*See IRB Decision and Feedback form for details

Form: IRB Application – Research Proposal
Appendix B: Consent Forms

Consent Form/Administrator

Northeastern University, Department: College of Professional Studies
Name of Investigator(s): Principal Investigator: Dr. Sara Ewell  Student Researcher: Luanne Amato
Title of Project: Math Anxiety: The Impact On Traditionally Underserved And Marginalized Adult Female Undergraduate Students In Elementary Statistics

Informed Consent to Participate in a Research Study

We are inviting you to take part in a research study. This form will tell you about the study, but I, the student researcher, will explain it to you first. You may ask me any questions that you have. When you are ready to make a decision, you may tell me if you want to participate or not. You do not have to participate if you do not want to. If you decide to participate, I will ask you to sign this statement and will give you a copy to keep.

Why am I being asked to take part in this research study?

You have been invited to participate in this study because of your position of authority in creating and approving of policies and processes in an academic organization.

Why is this research being done?

The purpose of this study is to uncover the reasons for and effects of math anxiety on female students and to help develop strategies to overcome this problem.

What will I be asked to do? Where will this take place and how much of my time will it take?

If you take part in this study, I will ask you to:

- Participate in an interview for approx. 45 minutes. You will receive the questions in advance of the interview and I will provide an offsite location if you prefer.
- Provide documents for de-identified student grading for elementary statistics for a three year period prior to 2016.

Will there be any risk or discomfort to me.

I have minimized any risk by providing confidentiality through assignment of pseudonyms for identity purposes. Interviews will be recorded into Rev.com and uploaded into a MAXQDA12 software program on my inhome office computer. All recorded interviews will be destroyed after uploading to the computer. The computer is password protected and can only be accessed by myself as the researcher. If the interviewee is uncomfortable with the college setting as an interview site, I have secured an off site location near the college where the interview can be conducted.
Will I benefit by being in this research?

There will be no direct benefit to you for taking part in the study. However, the information learned in this study will be used to improve learning in elementary statistics by creating strategies to enhance understanding thus removing this barrier to successful degree attainment for adult females.

Who will see the information about me?

Your part in this study will be confidential. As the researcher I will be the only person to know identities. No reports or publications will use information that can identify you in any way or any individual as being part of this project.

To safeguard your confidentiality upon consent, a pseudonym will be assigned and utilized for all transcription and coding processes. Interviews will be recorded and once this data has been uploaded into coding software on a home computer, the interviews will be destroyed. All data will be stored on my password protected home computer.

Can I stop my participation in this study?

Your participation in this study is completely voluntary. You can refuse to participate in any or all portions of the study, and you can refuse to answer any questions. Even if you begin the study you can quit at any time. If you decide to quit the study all of your contributions will be eliminated and destroyed and your information will not be used for analysis and results.

Who can I contact if I have questions or problems?

If you have any questions about this study, please feel free to contact
- Luanne Amato, Student Researcher at amato.l@husky.neu.edu
- Dr. Sara Ewell, Principal Investigator s.ewell@neu.edu

Who can I contact about my rights as a participant?

If you have any questions about your rights in this research, you many contact Nan C. Regina, Director, Human subject Research Protection, 490 Renaissance Park, Northeastern University, Boston, MA 02115. Tel: 617-373-4588, Email: n.regina@neu.edu. You may call anonymously if you wish.

Will I be paid for my participation?

You will be given a $20.00 gift card to Dunkin Donuts or WaWa for participation. The gift card will be presented after the interview has been completed.

Is there anything else I need to know?

I agree to take part in this research.

___________________________________   _____________ ___
Signature of person agreeing to take part

___________________________________

Printed name of person above

Signature of person who explained the study to the participant above and obtained consent

_________________________________

Printed name of person above

Date

Date

IRB# CPS16-08-12
Approved: 10/3/16
Expiration Date: 10/2/17
Informed Consent to Participate in a Research Study

We are inviting you to take part in a research study. This form will tell you about the study, but I, the student researcher, will explain it to you first. You may ask me any questions that you have. When you are ready to make a decision, you may tell me if you want to participate or not. You do not have to participate if you do not want to. If you decide to participate, I will ask you to sign this statement and will give you a copy to keep.

Why am I being asked to take part in this research study?

You have been invited to participate in this study because of your position as faculty and responsible for teaching elementary statistics as a core curriculum subject.

Why is this research being done?

The purpose of this study is to uncover the reasons for and effects of math anxiety on female students and to help develop strategies to overcome this problem.

What will I be asked to do? Where will this take place and how much of my time will it take?

If you take part in this study, I will ask you to:

- Participate in an interview for approx. 45 minutes. You will receive the questions in advance of the interview and I will provide an offsite location if you prefer.

Will there be any risk or discomfort to me.

I have minimized any risk by providing confidentiality through assignment of pseudonyms for identity purposes. Interviews will be recorded into Rev.com and uploaded into a MAXQDA12 software program on my inhome office computer. All recorded interviews will be destroyed after uploading to the computer. The computer is password protected and can only be accessed by myself as the researcher. If the interviewee is uncomfortable with the college setting as an interview site, I have secured an offsite location near the college where the interview can be conducted.

Will I benefit by being in this research?

Northeastern University, Department: College of Professional Studies
Name of Investigator(s): Principal Investigator: Dr. Sara Ewell Student Researcher: Luanne Amato
Title of Project: Math Anxiety: The Impact On Traditionally Underserved And Marginalized Adult Female Undergraduate Students In Elementary Statistics
There will be no direct benefit to you for taking part in the study. However, the information learned in this study will be used to improve learning in elementary statistics by creating strategies to enhance understanding thus removing this barrier to successful degree attainment for adult females.

**Who will see the information about me?**

Your part in this study will be confidential. As the researcher I will be the only person to know identities. No reports or publications will use information that can identify you in any way or any individual as being part of this project.

To safeguard your confidentiality upon consent, a pseudonym will be assigned and utilized for all transcription and coding processes. Interviews will be recorded and once this data has been uploaded into coding software on a home computer, the interviews will be destroyed. All data will be stored on my password protected home computer.

**Can I stop my participation in this study?**

Your participation in this study is completely voluntary. You can refuse to participate in any or all portions of the study, and you can refuse to answer any questions. Even if you begin the study you can quit at any time. If you decide to quit the study all of your contributions will be eliminated and destroyed and your information will not be used for analysis and results.

**Who can I contact if I have questions or problems?**

If you have any questions about this study, please feel free to contact

- Luanne Amato, Researcher at amato.l@husky.neu.edu
- Dr. Sara Ewell, Principal Investigator s.ewell@neu.edu

**Who can I contact about my rights as a participant?**

If you have any questions about your rights in this research, you may contact Nan C. Regina, Director, Human subject Research Protection, 490 Renaissance Park, Northeastern University, Boston, MA 02115. Tel: 617-373-4588, Email: n.regina@neu.edu. You may call anonymously if you wish.

**Will I be paid for my participation?**

You will be given a $20.00 gift card to Dunkin Donuts or WaWa for participation. The gift card will be presented after the interview has been completed.

**Is there anything else I need to know?**

**I agree to take part in this research.**

_________________________   _____________ _____________
Signature of person agreeing to take part   Date
Consent Form/Students

Northeastern University, Department: College of Professional Studies
Name of Investigator(s): Principal Investigator: Dr. Sara Ewell  Student Researcher: Luanne Amato
Title of Project: Math Anxiety: The Impact On Traditionally Underserved And Marginalized Adult Female Undergraduate Students In Elementary Statistics

Informed Consent to Participate in a Research Study

We are inviting you to take part in a research study. This form will tell you about the study, but I, the student researcher, will explain it to you first. You may ask me any questions that you have. When you are ready to make a decision, you may tell me if you want to participate or not. You do not have to participate if you do not want to. If you decide to participate, I will ask you to sign this statement and will give you a copy to keep.

Why am I being asked to take part in this research study?

You have been invited to participate in this study because you are a female adult student over the age of 25 and enrolled in elementary statistics.

Why is this research being done?

The purpose of this study is to uncover the reasons for and effects of math anxiety on female students and to help develop strategies to overcome this problem.

What will I be asked to do? Where will this take place and how much of my time will it take?

If you take part in this study, I will ask you to:

- Answer questions in a pre-course survey
- Participate in an interview for approx. 45 minutes. You will receive the questions in advance of the interview and I will provide an offsite location if you prefer.
- Participate in a focus group for approx. 1.5 hours at an offsite location.
- Answer questions in a post-course survey.

You can choose to participate in one, some, or all of these options.

Will there be any risk or discomfort to me.

I have minimized any risk by providing confidentiality through assignment of pseudonyms for identity purposes. Interviews will be recorded into Rev.com and uploaded into a MAXQDA12 software program on my in-home office computer. All recorded interviews will be destroyed after uploading to the computer. The computer is password protected and can only be accessed by myself as the researcher. If the interviewee is uncomfortable with the college setting as an
interview site, I have secured an off site location near the college where the interview can be conducted.

**Will I benefit by being in this research?**

There will be no direct benefit to you for taking part in the study. However, the information learned in this study will be used to improve learning in elementary statistics by creating strategies to enhance understanding thus removing this barrier to successful degree attainment for adult females.

**Who will see the information about me?**

Your part in this study will be confidential. As the researcher I will be the only person to know identities. No reports or publications will use information that can identify you in any way or any individual as being part of this project.

To safeguard your confidentiality upon consent, a pseudonym will be assigned and utilized for all transcription and coding processes. Completed surveys will be uploaded into the coding software on a home computer and the originals destroyed. Interviews will be recorded and once this data has been uploaded into coding software on a home computer, the interviews will be destroyed. All data will be stored on my password protected home computer.

**Can I stop my participation in this study?**

Your participation in this study is completely voluntary. You can refuse to participate in any or all portions of the study, and you can refuse to answer any questions. Even if you begin the study you can quit at any time. If you decide to quit the study all of your contributions will be eliminated and destroyed and your information will not be used for analysis and results.

**Who can I contact if I have questions or problems?**

If you have any questions about this study, please feel free to contact

- Luanne Amato, Researcher at amato.l@husky.neu.edu
- Dr. Sara Ewell, Principal Investigator s.ewell@neu.edu

**Who can I contact about my rights as a participant?**

If you have any questions about your rights in this research, you may contact Nan C. Regina, Director, Human Subject Research Protection, 490 Renaissance Park, Northeastern University, Boston, MA 02115. Tel: 617-373-4588, Email: n.regina@neu.edu. You may call anonymously if you wish.

**Will I be paid for my participation?**

You will be given a $20.00 gift card to Dunkin Donuts or WaWa for participation. The gift card will be presented after you complete any portion of the study options. Only one gift card will be provided, regardless of how many options you participate in.
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<th><strong>Is there anything else I need to know?</strong></th>
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<th><strong>I agree to take part in this research.</strong></th>
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<th>Signature of person agreeing to take part</th>
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<th>Signature of person who explained the study to the participant above and obtained consent</th>
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IRB# CPS16-08-12
Approved: 10/3/16
Expiration Date: 10/2/17
Appendix C: Interview Protocols

Interview Protocol – Administrator

Time of Interview:

Date:

Interviewer: Luanne Amato

Interviewees: College Administrators

The purpose of this study is to uncover the reasons for and effects of math anxiety on female students and to help develop strategies to overcome this problem. Data collection from administrators will include a 45 minute interview and access to a summary report of grading for elementary statistics over a prior three year period.

Part 1: Introductory Question Objective (10-15 minutes). Build rapport, describe the study, answer any questions, and obtain consent.

Introductory Protocol

You have been selected to speak with me today because you have been identified as someone who has a great deal to share about the placement of the elementary statistics course in the core curriculum and establishing resources to assist students in successfully completing the course. My research project focuses on the prevalence of math anxiety in females and how it is a barrier to successful degree completion since Elementary Statistics must be successfully completed to earn a degree. I also hope to gain more insight into how math anxiety affects performance for adult females.

Because your responses are important and I want to make sure I capture everything you say, I would like to audio tape our conversation today. Do I have your permission to record this interview? [If yes, thank the participant and turn on the recording equipment]. I will also be taking written notes during the interview. I can assure you that all responses will be confidential and only a pseudonym will be used when quoting from the transcripts. The tapes will be transcribed using Rev.com, and pseudonyms will be used to identify the participants. I will be the only one privy to transcripts and information and the tapes will be destroyed after they are uploaded into the coding software system.

To meet our human subjects requirements at the university, you must sign the form I have with me [see Appendix C]. Essentially, this document states that: (1) all information will be held confidential (2) your participation is voluntary and you can stop at any time if you feel uncomfortable, and (3) I do not intend to inflict any harm.

Do you have any questions about the interview process?
I have planned this interview to last about 45 minutes. During this time, I have several questions that I would like to cover. If time begins to run short, it may be necessary to interrupt you in order to push ahead and complete this line of questioning. Do you have any questions at this time?

**Part II: Objectives (30 minutes).** Obtain the participants insights, in his/her own words, into the challenges of and resources available for the core curriculum elementary statistics course. I would also like to discuss the American Statistical Association’s (ASA) reform recommendations for improvements in elementary statistics teaching.

**Prefatory statement:** I would like to hear about your experiences in your own words. To do this, I am going to ask you questions about the key experiences or observations that you have encountered in the discipline placement, execution, and creation of resources for elementary statistics. I am also interested in any ideas you may have related to the ASA’s reform suggestions. Your responses may include both academic and non-academic elements as appropriate.

**Questions:**

1. As an Administrator, what do you understand to be the challenges for students to earn a passing grade in elementary statistics? Can you give me some examples?

2. This college is known for its exceptional resources that help students. Can you tell me what some of the strategies and resources the college provides to assist students in undertaking elementary statistics? Do you think they are helping – especially since there is such a high failure rate? Do you have any new ideas that may decrease the failure rate? Can you give me some examples?

3. Elementary Statistics is currently placed in the mathematics discipline as a core curriculum subject. What do you think about that? Do you think this affects the way the course is taught? How so?

4. What do you think students should ultimately learn in an elementary statistics course? Can you give me some examples? Do you think this is happening?

   a) There have been reforms put forth by the American Statistical Association in 2005 and then updated in 2016 that seek to improve statistics course delivery methodology. The report also details growing dissatisfaction amongst administrators with traditional teaching methodologies. The report suggests a shift to more active learning strategies that include peer collaboration and real world experience in place of timed testing and the single ability to compute a numeric answer. Can you comment?
Interview Protocol – Faculty

Time of Interview:

Date:

Interviewer: Luanne Amato

Interviewees: Faculty for Elementary Statistics as a core curriculum subject

The purpose of this study is to uncover the reasons for and effects of math anxiety on female students and to help develop strategies to overcome this problem. Data collection from faculty will include a 45 minute interview.

**Part 1:** Introductory Question Objective (10-15 minutes). Build rapport, describe the study, answer any questions, and obtain consent.

**Introductory Protocol**

You have been selected to speak with me today because you have been identified as someone who has a great deal to share about the teaching and learning of the elementary statistics course in the core curriculum and how students experience and resolve math anxiety. My research project focuses on the prevalence of math anxiety in females and how it is a barrier to successful degree completion since Elementary Statistics must be successfully completed to earn a degree. I also hope to gain more insight into how math anxiety affects performance for adult females.

Because your responses are important and I want to make sure I capture everything you say, I would like to audio tape our conversation today. Do I have your permission to record this interview? [If yes, thank the participant and turn on the recording equipment]. I will also be taking written notes during the interview. I can assure you that all responses will be confidential and only a pseudonym will be used when quoting from the transcripts. The tapes will be transcribed using Rev.com, and pseudonyms will be used to identify the participants. I will be the only one privy to transcripts ad information and the tapes will be destroyed after they are uploaded into the coding software system.

To meet our human subjects requirements at the university, you must sign the form I have with me [see Appendix C]. Essentially, this document states that: (1) all information will be held confidential (2) your participation is voluntary and you can stop at any time if you feel uncomfortable, and (3) I do not intend to inflict any harm.

Do you have any questions about the interview process?

I have planned this interview to last about 45 minutes. During this time, I have several questions that I would like to cover. If time begins to run short, it may be necessary to interrupt you in order to push ahead and complete this line of questioning. Do you have any questions at this time?
**Part II:** Objectives (30 minutes). Obtain the participants insights, in his/her own words, into students’ emotional experience when taking elementary statistics course, an evaluation of the resources available to help with the challenges, and any ideas related to the American Statistical Association’s (ASA) suggestions for reform.

*Prefatory statement:* I would like to hear about your experiences in your own words. To do this, I am going to ask you questions about the key experiences or observations that you have encountered in the teaching and learning of elementary statistics and how students experience and resolve math anxiety. I am also interested in any ideas you may have related to the ASA’s reform suggestions. Your responses may include both academic and non-academic elements as appropriate.

**Questions:**
1. How would you describe the approach you use to teach elementary statistics? What has been most effective, and which things have not worked well? Can you give me examples?

2. How do you understand math anxiety? How do you know if your students have math anxiety? Can you give me examples of how you become aware of this problem? Do you think math anxiety is different for women and men?

3. Do you think your students feel comfortable to approach you when they have a problem in statistics? What strategies do you use to assist a student who are experiencing problems or who have math anxiety? Can you give me some examples?

4. Can you describe your early childhood experiences with mathematics at home and in school.

5. Can you tell me what experiences led you to choose your career as a math teacher?

6. There have been reforms put forth by the American Statistical Association in 2005 and then updated in 2016 that seek to improve statistics course delivery methodology. The report also details growing dissatisfaction amongst faculty with traditional teaching methodologies. The report suggests a shift to more active learning strategies that include peer collaboration and real world experience in place of timed testing and the single ability to compute a numeric answer. Can you comment?
Interview Protocol – Students

Time of Interview:

Date:

Interviewer: Luanne Amato

Interviewees: Students taking Elementary Statistics as a core curriculum subject

The purpose of this study is to uncover the reasons for and effects of math anxiety on female students and to help develop strategies to overcome this problem. Data collection from students will include a pre course survey, a 45 minute interview and/or focus group, and a post course survey.

**Part 1: Introductory Question Objective (10-15 minutes). Build rapport, describe the study, answer any questions, and obtain consent.**

**Introductory Protocol**

*You have been selected to speak with me today because you have been identified as someone who has a great deal to share about the experience of taking elementary statistics as an adult female. My research project focuses on the prevalence of math anxiety in females and how it is a barrier to successful degree completion since Elementary Statistics must be successfully completed to earn a degree. I also hope to gain more insight into how math anxiety affects performance for adult females.*

*Because your responses are important and I want to make sure I capture everything you say, I would like to audio tape our conversation today. Do I have your permission to record this interview? [if yes, thank the participant and turn on the recording equipment]. I will also be taking written notes during the interview. I can assure you that all responses will be confidential and only a pseudonym will be used when quoting from the transcripts. The tapes will be transcribed using Rev.com, and pseudonyms will be used to identify the participants. I will be the only one privy to transcripts ad information and the tapes will be destroyed after they are uploaded into the coding software system.*

*To meet our human subjects requirements at the university, you must sign the form I have with me [see Appendix C]. Essentially, this document states that: (1) all information will be held confidential (2) your participation is voluntary and you can stop at any time if you feel uncomfortable, and (3) I do not intend to inflict any harm.*

*Do you have any questions about the interview process?*

*I have planned this interview to last about 45 minutes. During this time, I have several questions that I would like to cover. If time begins to run short, it may be necessary to interrupt you in*
order to push ahead and complete this line of questioning. Do you have any questions at this time?

**Part II:** Objectives (30 minutes). Obtain the participants insights, in her own words, the experience of taking elementary statistics, evaluation of assistance in the form of internal and external resources, and understanding of and experience with math anxiety.

_prefatory statement:_ *I would like to hear about your experiences in your own words. To do this, I am going to ask you questions about the key experiences or observations that you have encountered in elementary statistics and your experience with math anxiety. Your responses may include both academic and non-academic elements as appropriate._

**Questions:**

7. Can you describe your experiences when taking math in elementary or high school. Can you give me some examples that describe your in class experience or what you were faced with doing homework?

8. Did you ever need help with math assignments? If you did, who or what helped you?

9. Describe your feelings about taking elementary statistics before you started this class? Why do you think you felt this way? Did you hear comments about taking statistics or did you judge this class based on other experiences in taking math? Can you give me some examples?

10. How is it going now? Do you feel comfortable or are you anxious? Could you give me some examples of situations that contribute to how you are feeling right now – from in class or when you have to do your homework?

11. Tell me about the class. Do you like it? Do you understand it? Does the teacher help you with understanding? Can you give me some examples?

12. What do you think should be done differently? Can you give me examples?

13. Do you think your learning mathematics is more difficult for you because you are female? Can you explain?
Appendix D: Pre and Post Course Survey

Student Pre-Course Survey

I am: (Please check all that apply)

Age:

[ ] 21-30  [ ] 31-40  [ ] 41-50  [ ] 51-60  [ ] over 60

Marital Status:

[ ] Married  [ ] Single without dependents  [ ] Single with dependents  [ ] Domestic Partner

Race/Ethnicity

[ ] Asian or Pacific Islander  [ ] Black/African American  [ ] Hispanic/Latino

[ ] White/Caucasian  [ ] American Indian/Native American  [ ] Other: __________________

Student Financial Aid (please check all that apply)

[ ] Federal Grant  [ ] State Grant  [ ] School Grant  [ ] Student Loans

Before the course begins, please provide some insights:

1. What are the reasons that you have enrolled in higher education at this time of your life?

2. Describe your feelings about taking this course and explain why you feel this way. (excited, scared, unsure, worried, nervous, challenged, no identifiable feelings)

3. Define your understanding of math anxiety? Do you think you have math anxiety?
   a. If you think you have math anxiety, how do you think it began? What experiences did you have to cause it?
   b. If you think you have math anxiety explain how you think it will affect how well you do in the course

4. If you encounter a problem while taking this course what will you do? Where will you go to get help?

5. Other comments:

6. Please check the boxes if you are interested in participating
Please contact me to participate in an interview

Please contact me to participate in a focus group

https://www.surveymonkey.com/r/TXJ5WVG
Student Post-Course Survey

Now that the course is over, please provide some insights:

7. Please agree or disagree with the statement “Elementary Statistics is a math course” and explain why.

8. Please rate your teacher and explain your rating. (excellent, good, fair, poor)

9. Do you think you had “math anxiety” during this class?
   
   c. If you think you have math anxiety, how did it affect your learning?

   d. If you think you have math anxiety how did it affect your performance and grade?

10. If you encountered a problem while taking this course what did you do? Where did you go to get help? Was the resource(s) very helpful? (teacher, peers, resource center, text book)

11. Please provide a commentary about the textbook. Was it helpful, or not? Please explain.

12. Other comments: