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Contextual Factors Related To Stereotype Threat And Student Success In Science Technology Engineering Mathematics Education: A Mixed Methods Study

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CONTEXTUAL FACTORS RELATED TO STEREOTYPE THREAT AND STUDENT SUCCESS IN SCIENCE TECHNOLOGY ENGINEERING MATHEMATICS EDUCATION: A MIXED METHODS STUDY

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This dissertation, submitted by Lindsey Beth Leker in partial fulfillment of the requirements for the Degree of Doctor of Philosophy from the University Of North Dakota, has been read by the Faculty Advisory Committee under whom the work has been done and is hereby approved.

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Title	Contextual Factors Related to Stereotype Threat and Student Success in Science Technology Engineering Mathematics Education: A Mixed Methods Study
Department	Educational Foundations of Research
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Lindsey B Leker
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ABSTRACT

Stereotype threat is a widely researched phenomenon shown to impact performance in testing and evaluation situations (Katz, Roberts, & Robinson, 1965; Steele & Aronson, 1995). When related to gender, stereotype threat can lead women to score lower than men on standardized math exams (Spencer, Steele, & Quinn, 1999). Stereotype threat may be one reason women have lower enrollment in most science, technology, engineering, and mathematics (STEM) majors, hold a smaller number of STEM careers than men, and have a higher attrition rate in STEM professions (Hill, Corbet, & Rose, 2010; Picho & Brown 2011; Sorby & Baartmans, 2000). Most research has investigated stereotype threat using experiments yielding mixed results (Stoet & Geary, 2012). Thus, there is a need to explore stereotype threat using quantitative surveys and qualitative methods to examine other contextual factors that contribute to gender difference in STEM fields. This dissertation outlined a mixed methods study designed to, first, qualitatively explore stereotype threat and contextual factors related to high achieving women in STEM fields, as well as women who have failed and/or avoided STEM fields. Then, the quantitative portion of the study used the themes from the qualitative phase to create a survey that measured stereotype threat and other contextual variables related to STEM success and failure/avoidance. Fifteen participants were interviewed for the qualitative phase of the study and six themes emerged. The quantitative survey was completed 242 undergraduate participants. T-tests, correlations, regressions, and mediation analyses were used to analyze the data. There were significant relationships between stereotype threat and STEM confidence, STEM anxiety, giving up in STEM, and STEM achievement. Overall, this mixed methods study advanced qualitative research on stereotype threat, developed a much-needed scale for the measurement of stereotype threat, and tested the developed scale.

CHAPTER I

INTRODUCTION

Women today are underrepresented in the stereotypical male dominated fields of science, technology, engineering, and mathematics (STEM; Stoet & Geary, 2012). According to Fryer and Levitt (2010) there is a noticeable gender difference in math performance by the third grade, which continues throughout the school years and can be seen in SAT scores. This very early difference may cause women to dis-identify with mathematics, making them less likely to pursue a STEM major or career (Wai, Cacchio, Putallaz, & Makel, 2010). This effect continues to be evident in undergraduate and graduate studies, with women representing only 22% of bachelor's degrees in the math and physical sciences, and 13% of PhDs (Ceci, Williams, & Barnett, 2009). The effect strongest among minority women, with black women earning less than 2% of PhDs in math and science fields (Picho & Brown, 2011). This serves as a reinforcement that women are less skilled (or at least less "interested") in the math and science fields than men. Additionally, Issa and Stokes (2010) found that employers had a preference for men for in "masculine" fields, and presented fewer advancement opportunities for women in masculine fields. The researchers also found that women in masculine fields were more likely to feel disengaged because they felt a lack of control in the workplace (Eisenhart & Finkel, 1998) These factors have led to a large amount of experimental and survey studies investigating reasons for male and female differences in STEM fields.

The quantitative research on stereotype threat aims to induce stereotype threat in a testing situation. The awareness of the stereotype causes one to feel threatened in a testing or evaluation situation, which lowers performance. Stereotype threat can occur with any out-group as long as the individual has been exposed to the stereotype (Steele & Aronson, 1995; Spencer, Steele, & Quinn, 1999). For example, a black female may feel threatened in a math-testing situation because she perceives that women and black individuals have poor performance in math in comparison to white individuals.

Katz, Roberts, and Robinson conducted the first experiment on stereotype threat in 1965. The researchers had black and white undergraduate students complete a task they described as either measuring intelligence or measuring hand-eye coordination. The experimental condition manipulated whether a black or white experimenter administered the task. The researchers found that black students performed poorly when the task measured intelligence and was administered by a white experimenter. In 1995, Steele and Aronson coined the term “stereotype threat” when they did similar research on performance differences between white and black undergraduate students. Steele and Aronson primed participants with a passage explaining that a test they were about to take was a measure of intellectual ability. Steele and Aronson’s research has led to many more experiments about different groups impacted by stereotype threat and other contextual factors. For the current study, the focus will be on the literature related to gender stereotype threat. The current and past research on gender stereotype threat has been mostly experimental and has yielded mixed results (Stoet & Geary, 2012). The only survey that has been developed and validated to measure stereotype threat is the Social Identities and Attitudes Scale (SIAS; Picho & Brown, 2011).

The purposes of this mixed methods study were to (a) explore contextual factors, including stereotype threat, that are related to womens success and failure/avoidance in STEM fields and (b) create a survey based on the qualitative results, that can be used to measure stereotype threat. For the purposes of this study, contextual factors were defined as environmental factors that influence motivation and achievement in STEM. Stereotype threat is considered a contextual factor, but is of most importance to this study and is often mentioned separately. The remainder of chapter one will review the stereotype threat research pertaining to gender differences, review contextual factors related to stereotype threat, and conclude with the purpose and significance of the current study.

Gender Stereotype Threat

Spencer, Steele, and Quinn (1999) were the first researchers to investigate the effect stereotype threat has on women and math performance. The researchers conducted three separate experiments. In experiment one, high math identified male and female undergraduate students completed an easy and difficult math test. The researchers found that there were no performance differences between men and women on the easy math test, but that men performed better than women on the difficult math test. In the second experiment the researchers used the difficult math test from experiment one and told undergraduate participants that men performed at a higher level than women (threat condition) or that there were no male and female differences in performance (no threat condition). The women in the threat condition performed worse than men and women in all other conditions. The third experiment was similar to the second experiment except that in the "no threat" condition participants were told that there were no gender differences, and in the "threat" condition, they were told nothing. The women in the threat condition performed worse than men and women in all other conditions (see Figure 1). This was the first experiment that suggested the mere presence of men in a testing situation could lower female performance on math tasks (Spencer, Steele, & Quinn, 1999).

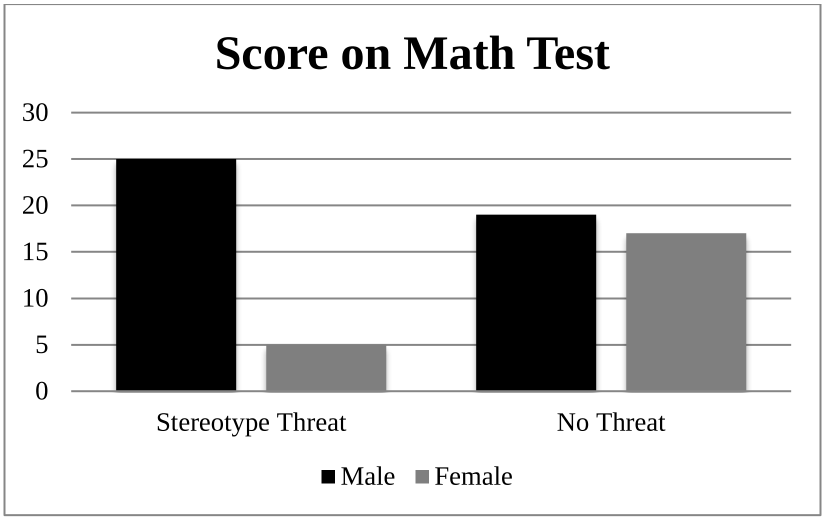


Figure 1. Male and Female Scores on a Math Test in a Stereotype Threat and No Threat Condition
Source: Spencer, S. J., Steele, C. M., & Quinn, D. M. (1999). Stereotype threat and women's math performance. *Journal of Experimental Social Psychology, 35*, 4-28.

Since the Spencer, Steele, and Quinn (1999) experiment there have been many experiments measuring stereotype threat effects in women. Most of the experiments use scenarios similar to that used in the Spencer, Steele, and Quinn (1999) experiment and investigate undergraduate male and female performance in testing situations while manipulating different experimental conditions. Typically, the experimental condition has men and women read a passage or watch something that suggests gender performance differences (threat condition). In the control (no threat condition) men and women either read nothing or a passage about male and female performance being equal. The participants then take a math or science related test and the researchers compare the results for men and women. Typically, researchers find that when women are placed in the stereotype threat condition they perform at a lower level than their male counterparts (Cadinu, Maass, Rosabianca, & Kiersner, 2005; Dar-Nimrod &

Heine, 2006; Keller, 2007; Spencer, Steele, & Quinn, 1999). As reviewed above, stereotype threat can affect female performance, which then influences the success and motivation of women in STEM fields. The impact stereotype threat has on women throughout their school years is reviewed below.

The Impact of Stereotype Threat

One of the most important topics in stereotype threat research is determining when the threat starts to impact performance, at which point interventions can be administered before performance deficits are evident. Devine (1989) reports that by the age of six, children are constantly exposed to cultural stereotypes and are aware of the stereotypes. Statistics suggest that male and female math grades are similar with a slight female advantage up until the 3rd grade (Stoet & Geary, 2012). Starting in the 3rd grade, boys have been found to have a slight math advantage over girls that grows with age and academic level (Keller, 2007). Some researchers suggest that children below the 3rd grade are not aware of the math stereotype and are not able to process it until the 3rd grade (Ganley et al., 2013; Muzzati & Agnoli, 2007). Muzzatti and Agnoli (2007) found that boys and girls showed equal self-confidence in math ability before the third grade, but this seemed to change for many after third grade. In the fourth and fifth grade boys typically rated boys as being better at math, and girls also typically rated boys as being better at math. This suggests that the awareness of the stereotype develops in grade school and that the mere knowledge of the stereotype is enough to lower performance. Indeed, Keller (2007) reported clear differences in math and science performance on standardized tests by late grade school.

Gangley et al. (2015) found that ability differences between men and women continue into middle school and that this growth continues into high school. The researchers found that this was especially true for women that valued math, and that women in stereotype threat conditions had much poorer performance on difficult items. One of the only qualitative studies that has investigated gender stereotype threat perceptions at the middle school level found that girls were more likely to have negative attitudes about STEM subjects and doubt the likelihood of their success (Shoffner et al., 2015). It was unclear if the negative attitudes were due to stereotype threat, conforming to the stereotype, or other contextual factors (Shoffer et al., 2015).

The good news is that the male-female gap in math performance is getting smaller. A meta-analysis based on 30 years (1950s-1980s) of SAT and ACT scores found a very large gap between the most gifted male and female students (13:1), which has since decreased and held steady at a 4:1 gap (Wai, Cacchio, Putallaz, & Makel, 2010).

Most research indicates that there is no known biological difference between men and women that would account for the difference in scores (Aronson, Fried, & Good, 2002; Ceci & Williams, 2009). Instead, there are certain contextual factors that cause women to be more susceptible to stereotype threat. Researchers suggest that the difference in scores is due to the fact that women believe and are consistently presented with information that men are better at math and science. In addition, if teacher expectations are affected by stereotype threat the teacher may unintentionally influence the performance of his or her students, thus supporting the stereotype (Rosenthal, 2002; Ceci & Williams, 2009). In education, stereotype threat can also cause students to not pursue the subject that the stereotype is associated with, thus limiting the choice of occupations they can choose. Contextual factors that are commonly found in the stereotype threat literature are reviewed below.

Contextual Factors Related to Stereotype Threat

Certain situations are more likely to lead to stereotype threat. The conditions that produce stereotype threat are ones that highlight the individual as belonging to a social category (Marx, Stapel, & Muller, 2005). When a woman views herself as being salient within that social category (e.g., "I am a woman, women are not expected to be good at math, and this is a difficult math test"), performance can decrease because of concerns about confirming the negative stereotype. Additionally, if a woman is highly identified with STEM subjects, or values the subject, the fear of confirming the stereotype causes heightened anxiety and other negative emotions. Domain identification and consequences of domain identification are reviewed below.

Domain identification refers to a subject or activity that an individual deems important for their future and/or self-esteem. The research that has been conducted on stereotype threat proposes that major performance deficits are more likely to occur in women of all ages that highly identify with math and/or science (Keller, 2007). Negative stereotypes tend not to be as important to women that place low value on math or science, thus low identification women are less likely to experience performance deficits in stereotype threat conditions. Keller (2007) found that women in secondary school that highly identified in math outperformed women who were low in math identification in a control condition (no-stereotype threat condition). When women were put in a stereotype threat condition, however, the highly identified women performed lower than the low identification women. Ben-Zeev, Fein, and Inzlicht (2005) induced stereotype threat in high math identified undergraduate women and found that the women performed poorly on the difficult test and also had higher arousal. Test difficulty and anxiety are also factors that influence stereotype threat effects, especially for women that are highly identified in STEM subject matter.

The research that has been conducted on stereotype threat suggests that the individuals within the stereotyped group are most likely to experience threat and perform poorly when the evaluation task is difficult. A difficult task increases the amount of cognitive load the individual must use to complete the task and will be more cognitively difficult than a task that is not as challenging (Ganley et al., 2013). In order to assess the effect of task difficulty and stereotype threat, researchers use varying levels of tests (easy-moderate-difficult). Research has suggested that as test difficulty rises, so does anxiety. Osborne and Walker (2006) suggest that anxiety is to blame for poor performance in highly identified women taking a difficult test.

Much of the research on anxiety effects on women's test performance suggests that anxiety increases intrusive thoughts. Spencer et al. (1999) found that anxiety and evaluation apprehension were negatively related to female undergraduate students' performance on a math test. Cadinu et al. (2005) focused on intrusive thoughts that are common in an anxiety-provoking situations. The researchers found that when female undergraduates were in a stereotype threat setting they reported significantly more negative math related thoughts than women in the control condition (Schmader & Johns, 2003).

Some researchers have focused on physiological measures to investigate the relationship between anxiety and performance. Croizet et al. (2004) measured arousal with low heart rate viability (HRV), which is an indication of mental load. The researchers found that when female undergraduates with a decrease in HRV were put in a stereotype threat condition they had lower performance. The researchers concluded that HRV served as a mediator between stereotype threat and performance. Osborne (2006; 2003) conducted studies on physiological measures of anxiety and stereotype threat and found that female undergraduates under stereotype threat had higher skin conductance, skin temperature, and blood pressure than those in a control condition.

Intrusive thoughts put together with physiological arousal can influence the function of working memory. As anxiety increases, working memory function dramatically decreases (Steele & Aronson, 1995). Working memory, otherwise known as short-term memory, is used to process information that is being attended to so that the information can go into long-term memory. Typically, high anxiety in a testing situation causes poor attention, racing thoughts, and worry, making it impossible for the test information to be processed efficiently and effectively (Tine & Gotlieb, 2013). The next section will introduce the purpose and need for the study based on the literature presented in chapter one.

Purpose of and Need for Study

The purpose of this mixed methods study is to qualitatively explore stereotype threat and develop a quantitative survey measuring stereotype threat and other contextual factors based on the qualitative findings. The current and past research on gender stereotype threat has been mostly experimental and has yielded mixed results (Stoet & Geary, 2012). The definition of stereotype threat suggests that it has to be conscious in order to affect performance (Steele & Aronson, 1995); however, recent research suggests that implicit awareness of stereotypes is enough to affect performance (Hill, Corbett, & St. Rose, 2010). In addition, the experimental nature of stereotype threat research has put little focus on individual experiences of success and failure in STEM fields. There is very little qualitative, nonexperimental quantitative (i.e., survey), or mixed methods research on gender stereotype threat; thus, support for the ecological validity of many current findings on stereotype threat is needed. Qualitative, nonexperimental research will allow for the triangulation of qualitative and quantitative data.

The only survey that has been developed and validated to measure stereotype threat is the Social Identities and Attitudes Scale (SIAS; Picho & Brown, 2011). The very limited research with the SIAS has been to validate the scale constructs. A literature search revealed that no published research articles have used the SIAS scale to study stereotype threat. There are other surveys that investigate STEM success and failure through moderators like self-efficacy, but none that measure stereotype threat directly (Brown & Josephs, 1999).

The SIAS scale was used in a pilot study (described below), but did not reliably measure stereotype threat. A future direction for research in gender stereotype threat is an increase in survey research and the development of a new or revised survey instrument that directly measures stereotype threat. In the proposed study, qualitative research will guide the development of a new stereotype threat survey and to contribute to the investigation of the contextual mechanisms mediating stereotype threat and performance deficits. Lastly, qualitative interviews will help to explore whether women report being consciously aware of stereotype threat and whether women perceive stereotype threat to be a factor in failure and avoidance.

The current mixed methods study will employ an exploratory sequential design, QUAL → quant (see Figure 2 for procedural diagram). The Qualitative part of the study will be emphasized as being most important because of the little qualitative research that has been done on stereotype threat, and because the qualitative phase will guide the quantitative portion of the study. The purposes of this mixed methods study are to (a) explore contextual factors, including stereotype threat, that are related to women's success and failure/avoidance in STEM fields and (b) create a survey based on the qualitative results, that can be used to measure stereotype threat.

Most importantly, the current study will allow the exploration of the development and implicit nature of stereotype threat. The author believes that stereotype threat is something that develops over time, starting very early in life, due to environmental influences. Individuals may not be aware of stereotype threat and how it affects decision-making. The qualitative phase of the study will be a way to explore factors that may influence internal stereotypes and how the stereotypes develop. The quantitative phase of the study will investigate whether participants explicitly report stereotype threat or if the participants are more likely to report the contextual factors.

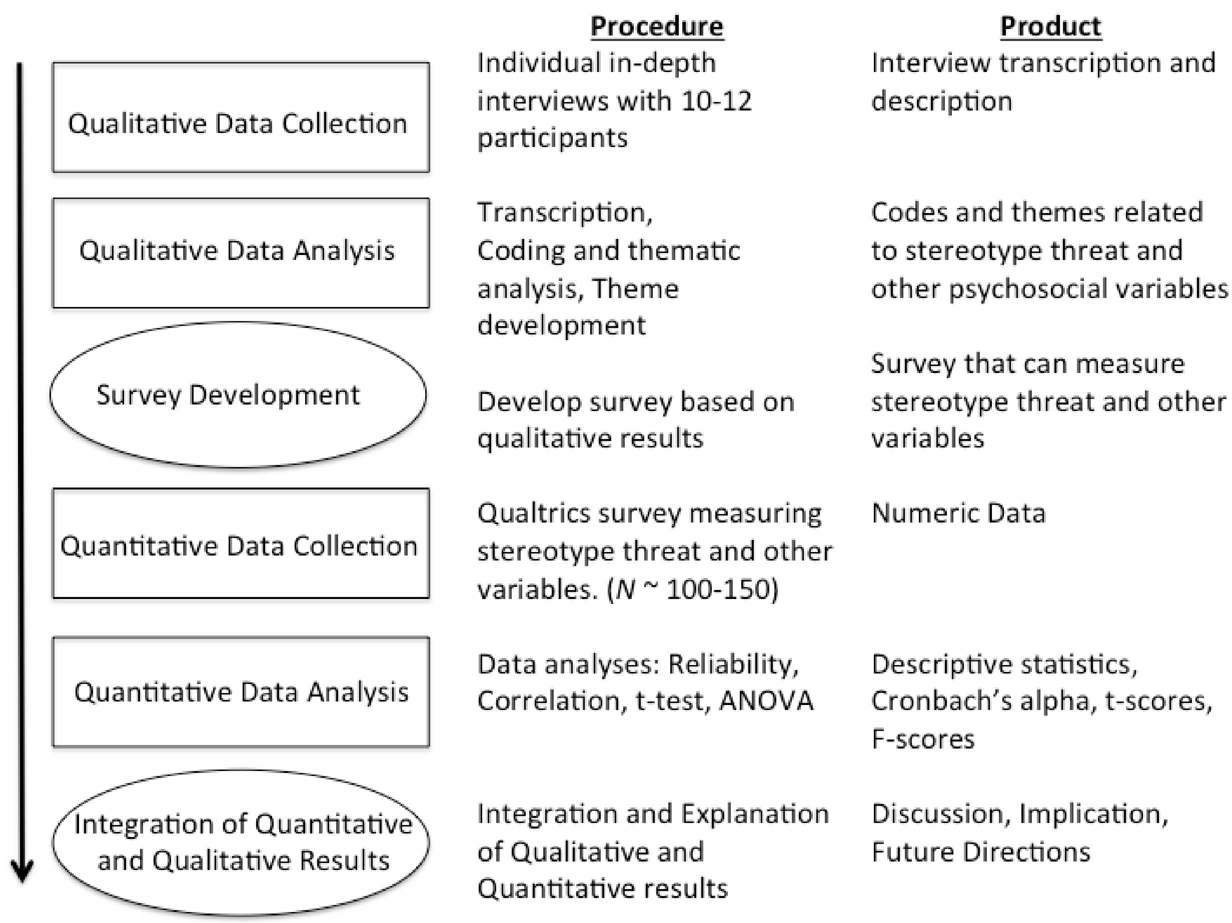


Figure 2. Procedural Diagram of Mixed Methods Study.

Research Questions

The following qualitative, quantitative, and mixed research questions will guide the study methods and analyses.

Qualitative Questions

Question 1. Is stereotype threat reported as a factor that influences performance and motivation to enter into a STEM major and career? Is stereotype threat reported as impacting performance and motivation in STEM majors and careers?

Question 2. What are the experiences of women that are consciously aware of stereotype threat and report stereotype threat as affecting their performance and motivation? What are the experiences of women that do not report stereotype threat as a factor affecting their performance and motivation?

Question 3. What are the reported contextual factors associated with (1) performance and (2) motivation to enter and succeed into STEM majors and careers?

Mixed Questions

Question 1. What findings emerge from the qualitative interviews that can be used to develop a multi-item survey scale measuring stereotype threat?

Question 2. What contextual factors emerge from the qualitative interviews that can be used to develop a multi-item survey measuring stereotype threat?

Quantitative Questions

Question 1. Do the developed scales have good construct validity and reliability?

Question 2. What level of stereotype threat do students experience?

Question 3. Are there gender differences in stereotype threat? Do the contextual factors relate to and predict stereotype threat?

Question 4. Does stereotype threat predict performance and motivation in STEM?

Significance of the Study

As previously stated, this mixed methods study aims to qualitatively explore how stereotype threat is related to STEM performance and motivation. The qualitative part of the study will also allow for the exploration of other contextual factors that may play a role in STEM performance and motivation. There is very little qualitative research exploring stereotype threat and gender related STEM success and failure. The results of this mixed methods study will fill in some of the research gaps on how stereotype threat plays a role in success and failure and whether stereotype threat is consciously reported. This mixed methods study is important for three reasons. First, the interviews will provide information on stereotype threat and other contextual factors that could be measured in a survey. Second, the survey will help to identify individuals that may be affected by stereotype threat and other contextual factors so that interventions can be used to reduce the effects of stereotype threat. Lastly, the study will be one of the only qualitative studies on factors related to high success in STEM fields and failure or avoidance in STEM fields.

Assumptions and Limitations

The researcher makes the assumption that interviewees are accurately reporting their current and past experiences in STEM fields. Research has shown that memories are not highly accurate, which may cause some individuals to report false information (Loftus, 2002). Interviewees may also be tempted to answer in pleasing manner or in a way that they think the interviewer would like them to answer.

Although this study is significant because it will be one of the only qualitative studies investigating STEM success and failure qualitatively, this also presents some challenges. The theoretical framework for the current study is based on experimental research, and there is little research to guide the qualitative methods of the current study. In addition, due to the exploratory nature of the study, it is unknown which contextual factors will be reported in the qualitative portion of the study.

Another challenge of the study will be recruitment of participants. Based on the low number of women in STEM majors and careers, it may be hard to find successful women in STEM majors and careers that have time and are willing to participate in an interview. Additionally, women may not want to report having low performance or motivation in STEM subjects, making it hard to find unsuccessful female participants to participate in the interview. The participants in the quantitative portion of the study will be undergraduate students with a limited age range, making generalizability a limitation of the quantitative portion of the study.

Definitions

The following definitions are provided to help readers understand terms used throughout this study:

STEM: The acronym STEM is used to describe Science, Technology, Engineering and Mathematics. STEM has recently become a popular topic because the United States is falling behind in science, technology, engineering, and mathematics industries. STEM was started to increase interest in science, technology, engineering and mathematics but to also specifically increase women's interest in STEM subjects because of the gender gap in STEM fields. (Bybee, 2010).

Stereotype Threat: Stereotype threat refers to being at risk of confirming, a negative stereotype about one's group (Steele & Aronson, 1995). Stereotype threat was coined by Steele and Aronson in 1995, when their experimental research showed that Black students performed more poorly on standardized tests than White students when their race was made evident. When race was not made evident, Black students performed better and equivalently with White students. The results showed that performance in academic contexts could be harmed by the awareness that one's behavior might be judged by racial stereotypes

Domain Identification: Another factor that increases an individual's vulnerability to stereotype threat is "domain identification," the degree to which an individual identifies with a given domain. The higher the domain identification, the more an individual is bothered by poor performance in that domain. There is evidence that minority students that value STEM subjects are the ones that are most likely to drop out of the valued subject (Osborne & Walker, 2006).

Stigma Consciousness: Stigma consciousness refers to the degree that individuals are aware and conscious of their stigmatized status. Individuals low in stigma consciousness typically report that they are unaware of their stereotyped status when interacting with other people and assume that stereotypes will not affect them personally, individuals high in stigma consciousness expect others to interpret their behavior and to judge them based on the stereotype associated with their group (Brown & Pinel, 2003). Picho and Brown (2011) measured a gender stigma consciousness variable that we interpret as a stereotype threat in the pilot study presented in Chapter III.

Math Identity: Similar to domain identification, individuals that highly identify with math subjects value math subjects more than others that do not identify with math. Math identity is included as a separate definition because much of the research on domain identification is associated with math subjects (Deemer, Thoman, Chase, & Smith, 2014). Research has shown that women that highly identify with math are more likely to dis-identify with math subjects after continued failure in math subjects (Steel, Reisz, Williams, & Kawakami, 2007). The pilot study in Chapter III also specifically measures math identity.

Implicit Associations Test (IAT): The implicit Association Test (IAT) measures underlying attitudes and beliefs that individuals may have difficult reporting because they are not consciously aware of the attitude or belief. The IAT measures the strength of associations between groups of individuals (e.g., women) and evaluations and/or stereotypes (e.g., bad, dumb). The IAT has shown that it is easier to make associations between groups and stereotypes based on our underlying attitudes and stereotypes (Greenwald, McGhee, & Schwartz, 1998).

Chapter I Summary

Stereotype threat is a widely researched factor that influences individual performance (Steele & Aronsons, 1995). Of most interest for the current study is gender-based stereotype threat, which has been found to influence women's performance and perseverance in STEM fields. Research has shown that gender stereotype threat effects become evident after the grade school years and continue to influence female performance and interest in STEM fields throughout middle school, high school and in college (Keller, 2007; Shoffner et al., 2015). The proposed study will also explore other contextual factors that may influence women's STEM performance and motivation in addition to stereotype threat.

Surprisingly, most research on stereotype threat is experimental in nature and there is very little qualitative or mixed methods research. In addition, there is currently only one survey that measures stereotype threat and related variables (Picho & Brown, 2011). The proposed study has been designed to explore stereotype threat and other contextual factors using mixed methods. The themes that emerge from the qualitative data can then be used to construct a survey to measures stereotype threat effects and other related contextual factors.

Chapter I provided a background on stereotype threat, gender stereotype threat, and the progression of stereotype threat. It also identified the research questions, significance, limitations, and definitions for the proposed study. A review of the literature relevant to this study is presented in Chapter II. Chapter III contains the results of a pilot study, as well as an explanation of the methodology for the proposed study.

CHAPTER II

LITERATURE REVIEW

Chapter II starts with a review of the most current research on stereotype threat and how this research relates to STEM success and failure. Next, there is a review of the qualitative research and themes that are associated with stereotype threat and STEM success; however, there is little qualitative research related to stereotype threat and STEM so the qualitative review is brief. The qualitative literature is followed by a review of possible interventions to reduce stereotype threat effects. Finally, chapter II concludes with criticisms of the current research reiterating the need for the current study.

How is Stereotype Threat Related to STEM?

In the past, male high school students scored higher in STEM subjects than female high school students; however, in the past twenty years this difference has been reduced to a small mean difference favoring men in science in math (Hyde et al., 2008; Stoet & Geary, 2012; Wai et al., 2010). In high school girls and boys have similar math grades, and in some cases girls outperform boys (Cherney & Campbell, 2011). As stated earlier in the review, men still out perform women on standardized tests but the difference has been reduced recently. This trend continues into college today with approximately equal numbers of men and women pursuing math and science bachelor's degrees (Wai et al., 2010). However, women drop out of STEM majors at a higher rate (Hill, Corbet, & Rose, 2010; Rask, 2010). For example, when considering engineering specifically, women represent 31% of introductory courses but earn only 20% of bachelor's degrees (Hill et al., 2010; Rask, 2010). When considering advanced degrees, the difference is even greater, with the exception of biological sciences. Women earned about half of PhDs in biological science, one third of PhDs in chemistry and math and one fifth of PhDs in computer science, engineering and mathematics (Hill et al., 2010). Current initiatives on gender stereotype threat and STEM focus on encouraging women to enter STEM majors, keeping women in the major, and the struggles of women pursuing STEM majors and careers.

Attrition of Women in STEM Majors

Why do women leave STEM majors in greater numbers than men? Some argue that men and women have biological differences in ability, specifically spatial ability where the difference in performance between men and women is large (Benbow et al., 2000; Geary, 1996). Sorby and Baartmans (2000) administered the Purdue Spatial Visualization Test: Rotations (PSVT:R) to 535 first-year engineering students and found that about 40% of women failed the test compared to 12% of men. After discovering the failure rate of women on the PSVT:R, Sorby decided to offer a spatial-visualization course for those that failed the task. Sorby found that spatial test scores increased by 30% after students completed the spatial-visualization course, but Sorby also suggested that spatial skills are just a small part of the skills needed for STEM subjects (Sorby & Baartmans, 2000). In addition, Ceci et al. (2009) reviewed hundreds of gender stereotype threat articles paying close attention to the suggestion of biological brain differences between men and women. The researchers concluded that there was no a clear biological difference between men and women that would account for gender difference in STEM fields.

Innate, biological differences between men and women also does not explain why men and women enter some STEM majors in equal amounts but do not graduate in equal amounts, suggesting that contextual factors influence higher female dropout rates. A plausible explanation is that when women enter STEM majors they are identified with math and science and have the self-efficacy necessary to succeed in STEM subjects. As previously stated, women that identify with math or science are more likely to feel anxious when faced with a stereotype threat situation

(Beasley & Fischer, 2012). The women that major in STEM subjects may not believe in the stereotype, but the awareness that the stereotype exists can affect performance (Johns, Schmader, & Martens, 2005). In addition, the awareness of stereotype threat may cause women to sense discriminatory behavior among opposite sex students and professors (Beasley & Fischer, 2012). If a female in a STEM major continues to experience anxiety, poor performance, and a sense of not belonging, then dis-identification can occur.

Dis-identification. Dis-identification is when students distance themselves from a specific subject because of past failures (Steel, Reisz, Williams, & Kawakami, 2007). Researchers have found that negative feedback about a performance related outcome in math leads women to dis-identify with math, lowering their perceived control and value in math courses (Deemer, Thoman, Chase, & Smith, 2014). In addition, when the dis-identified student is faced with the subject, they experience negative emotions like anxiety and boredom, which reinforces their avoidance behavior (Marx & Stapel, 2006). Dis-identification not only causes the student to avoid the subject, but also reduces the chance that they will be motivated to put forth future effort in the subject. (Appel & Kronberger, 2012). Dis-identification may be a factor related to the attrition of women in STEM majors, and also accounts for the large difference in men and women entering computer science and engineering majors where men greatly outnumber women (Fryer & Levitt, 2010; Wai et al., 2010). The implications of attrition and dis-identification of women in STEM careers is outlined below.

Implications for Women in STEM Careers

If a woman graduates with a higher education STEM degree, one would think that the stereotype threat struggle would be over, however, this is not the case. There is still a higher attrition rate for female faculty members in male dominated departments. Although the proportions of women in STEM occupations have increased since 1970 (see Figure 3), men still outnumber women in most STEM occupations except the social sciences. Holleran et al. (2011) specifically investigated job disengagement among STEM faculty by observing behavior and conversations in a STEM department. Holleran et al. (2011) found that conversations between men and women within the department tended to focus on personal and social matters and that, if research was a topic of conversation, the women' talk of research was deemed less competent. Interactions between men within the department tended to focus on research and grants.

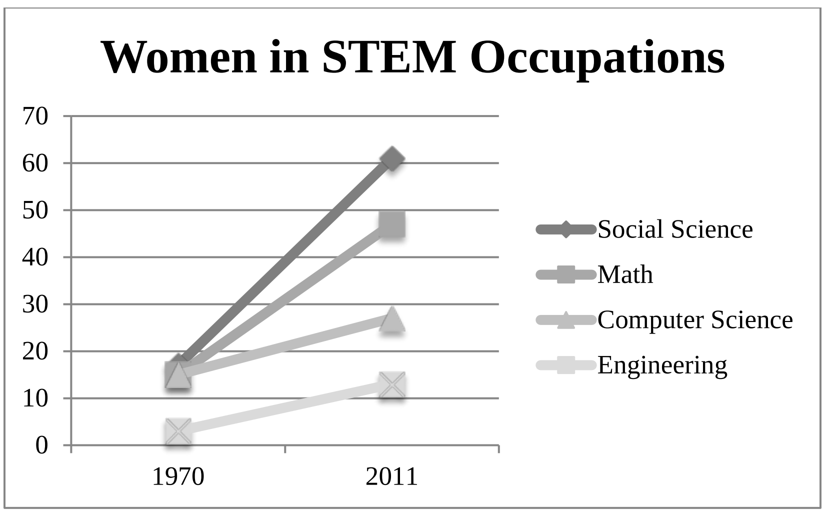


Figure 3. Percentages of Women in STEM Occupations in 1970 and 2011.
Source: Landivar, L. C. (2013). Disparities in STEM employment by sex, race, and Hispanic origin. *American Community Survey Reports*, ACS-24, US Census Bureau.

Westerwick, Glynn, and Huge (2013) investigated perceived quality of scientific publications based on author gender. The researchers presented subjects with the abstract of the publication along with author name. Male authors' publications were associated with greater scientific quality, especially if the publication was a stereotypical male topic such as politics or computer science. The results of the Holleran et al. (2011) study and the Westerwick, Glynn, and Huge (2013) study suggests that female faculty members and researchers are perceived as less competent and that it is hard to be woman in so called male-dominated occupations. This influences attrition of women in male-dominated occupations, leading to fewer women in the occupation and thus supporting the stereotype.

An especially powerful stereotype-activating cue is the underrepresentation of one's group (Inzlicht and Ben-Zeev, 2000). Being one of the only women in a STEM career can increase the salience of threat, which can then lead women to be less motivated, and abandon the profession (Kronberger and Horwarth, 2013). Schuster and Martiny (2017) suggest that anticipated positive and negative affect can predict women's career aspirations, and that a lack of women in a field can contribute to expected experiences in a male-dominated career. It has been argued that these expectancies can diminish performance, impose a sense of competence threat, suggest that women have to work harder than men to achieve the same standing, and reduce the sense of belonging the woman has in the workplace (Cadinu et al., 2005).

Qualitative Research on Stereotype Threat

There is very little qualitative research on stereotype threat. Most qualitative research related to stereotype threat does not explicitly mention stereotype threat and instead investigates women's success, perseverance, and self-esteem in STEM majors and jobs because it is easier to single out cases of female success in STEM. Charleston et al. (2014) conducted a qualitative study on African American women in computer science majors and found three major themes. It was a challenge to be a black woman in computer science, isolation and subordination are common, and the women had to make additional sacrifices as a woman to succeed in the field. Many simply stated that they spent long hours alone with little to no social interaction (Charleston et al., 2004).

Milner and Hoy (2003) qualitatively investigated self-efficacy and stereotype threat in a female, African American schoolteacher. They chose the schoolteacher because she was black, a woman, had a PhD and was a one of three African American teachers in her school. The researchers found similar results to the Charleston et al. (2014) study; that the teacher reported feeling socially isolated, feeling threatened by what she perceived the students thought about her abilities, and feeling a burden of having to enlighten others about what African American teachers were capable of accomplishing.

Of the few qualitative studies on stereotype threat, isolation and low support are common themes (Charleston et al., 2014; Milnor & Hoy, 2003). Factors that lead to success in a PhD program include close friends in the field, mentors, and family members within the field. It is unlikely that a woman, especially a woman belonging to a minority group, is going to have these supports because of the few women and minorities specifically in the engineering and technology fields of STEM (Chareston et al., 2012). Many of the factors that were reported to increase success in the qualitative literature are being researched as possible interventions and are reviewed below.

Stereotype Threat Interventions

One very important topic that is being increasingly valued in STEM research is how to raise girls' interest in STEM subjects in middle school and high school, and how to keep women in STEM majors in college. The next section will focus on current suggestions of single-sex schools, mentoring, and modified testing conditions.

Single-Sex Schools

Cherney and Campbell (2011) investigated if single-sex schools could increase women's confidence in STEM disciplines making women more likely to enter STEM majors in college. The researchers gave a survey measuring STEM subject preference and self-esteem to 548 male and female students in single-sex school and mixed-sex schools. The researchers also tested the participants' math performance on a difficult math test in a threat vs. no threat conditions. The researchers found that self-confidence and self-efficacy in STEM subjects was higher among women in single-sex schools but that the women were no more likely to enter STEM majors than those women in mixed-sex settings. Interestingly, when women in single-sex schools were given a stereotype threat scenario they had higher performance than a control condition suggesting that the increase in self-esteem buffered the effects of stereotype threat (Cherney & Campbell, 2011). Single-sex schools are a drastic solution for combating stereotype threat and since single-sex schools do not seem to increase interest in STEM subjects, a more practical solution that can be used in a coeducational setting is mentoring.

Mentoring

Gunderson et al. (2011) suggested that parents and teachers expose women to negative stereotypes associated with gender, even if they are not consciously aware of it. Gunderson et al. (2011) suggested that teachers and parents can reduce stereotype threat in young women by being math confident, or at least acting math confident, and being an advocate for women's participation in STEM. Mentoring in high school and college can significantly increase confidence in women interested in STEM (Young et al., 2013). Studies have shown that confident female professors and female role models in STEM fields can influence a female student's decision to choose a STEM major or career (Lockwood, 2006; Young et al., 2013).

Marx and Roman (2002) found that if a confident female experimenter administered a math test, gender differences in test score were not significant. This finding suggests that the female role model served as a buffer against stereotype threat (Marx & Roman, 2002). Another simple method that can be used in a coeducational setting is to simply modify testing conditions.

Modified Testing Conditions

Osborne (2006) suggests that relatively simple changes to testing situations can reduce stereotype threat. Osborne (2006) questions whether high stakes testing should be administered at all, but suggests that one way to minimize stereotype threat effects is to ask about gender at the end of test. In addition, simply notifying women about stereotype threat can act as a buffer to the effects of gender stereotype threat. Johns, Schmader, and Martens (2005) found that when they administered a difficult math test, women performed worse than men. However, when the researchers notified the women of stereotype threat and the anxiety that may result women performed better than they had without the notification. Although research on stereotype threat will help to buffer the influence of stereotype threat, many researchers suggest that the research on stereotype threat is misleading or that stereotype threat effects are influenced by other more important factors. This research is reviewed below.

Criticisms of Gender Stereotype Threat Research

While most research on stereotype threat suggests that stereotype threat is a major factor in achievement differences in STEM fields between men and women, there are a few researchers that suggest that achievement gaps are small and that stereotype threat is overemphasized (Stoet & Geary, 2012). Lindberg et al. (2010) conducted a meta-analysis in which they averaged effect sizes and found no difference in performance between men and women. Another meta-analysis reports that there was a large gender difference in SAT and ACT scored in the 1980s (13 men scoring above 700 for every women), but that this difference declined to 4:1 in the 1990s and has held steady since (Wai et al., 2010).

In addition, some studies fail to find stereotype threat effects. Cromley et al. (2013) measured stereotype threat susceptibility in 1358 participants using a survey. All 1358 participants were STEM majors. Cromley et al. (2015) failed to find any significant correlations among stereotype threat and course grades. The researchers concluded that stereotype threat may affect only a small sub group of individuals, and that others factors in addition to stereotype threat may affect performance. Additionally, Stoet and Geary (2012) reviewed replication attempts of the Spencer, Steele, and Quinn (1999) study and found that only 30% of the experiments actually replicated the results.

One possible explanation for these inconsistent findings is that individuals may not always be conscious of stereotype threat; however, most research suggests that stereotype threat has to be conscious in order to affect performance (Pinel, 1999; Steele & Aronson, 1995; Steele & Aronson, 2002). Pinel (1999) suggests that an awareness that one is a member of a stigmatized group can cause one to perform poorly or, conversely, enhance a person's performance if their group stereotype is positive. Steele and Aronson (1995) describe stereotype threat as individual having anxiety about confirming a negative stereotype about one's group, suggesting that stereotype threat has to be conscious. For example, Cadinu et al. (2005) found that when women were told that there were clear score differences between men and women, they performed more poorly on a math task in comparison to a control condition. However, Kiefer and Sekaquaptewa (2007) suggested stereotype threat may not be conscious, and that implicit (i.e. unconscious attitudes) can affect performance.

One way to test implicit attitudes is with the Implicit Attitudes Test (IAT; Nosek, Banaji, & Greenwald, 2002), which has subjects make male and woman associations with different stereotyped subjects. Kiefer and Sekaquaptewa (2007) found that performance differences between men and women were larger when women scored high on an implicit attitude task associating men with higher math performance. Cundiff, et al. (2012) found that women that had strong gender-science stereotypes had dis-identified with science and were less likely to pursue a science career. These results suggest that a conscious appraisal of stereotype threat may not be needed in order to affect STEM performance.

Many of the criticisms mentioned above could be investigated further with qualitative and mixed method studies. As mentioned previously, one limitation of the current research is the experimental nature of the research. Mixed methods research could fill in some of the missing links of the current research and guide future experimental research on stereotype threat and STEM achievement.

Chapter II Summary

Chapter II provided a detailed literature review of the major themes associated with gender stereotype threat and gender stereotype threat as it relates to STEM. Based on the literature, it is evident that there are clear gender differences in enrollment and attrition in STEM fields (Hill, Corbet, & Rose, 2010; Beasley & Fischer, 2012). The role that stereotype threat plays in this difference is controversial and results of experimental stereotype threat research have been mixed (Stoet & Geary, 2012). A brief review of qualitative stereotype threat research is also reviewed in Chapter II, although there is very little qualitative research associated with stereotype threat and gender performance differences. The review of the literature presented in

Chapter II again emphasizes the importance of future qualitative research on stereotype threat and gender differences in STEM fields.

The current mixed methods study will employ an exploratory sequential design, Qual → quant, with emphasis given to the qualitative strand of the study (see Figure 2 for procedural diagram). The purposes of this mixed methods study are to (a) explore contextual factors, including stereotype threat, that are related to women's success and failure/avoidance in STEM fields and (b) create a survey based on the qualitative results, that can be used to measure stereotype threat.

Chapter III describes a pilot study and presents an overview of the methodology for the proposed study mixed-methods study.

CHAPTER III

METHODOLOGY

The purposes of this mixed methods study are twofold (a) explore contextual factors, including stereotype threat, that are related to women success and failure/avoidance in STEM fields and (b) create a survey based on the qualitative results, that can be used to measure stereotype threat.

This study follows a pilot study carried out by the author, which allowed for refinement of the protocols and measurement tools. This chapter provides an overview of the pilot study, and describes the participants, procedures, and measures utilized in the current study. Additionally, it provides an explanation of statistical analyses performed on the data.

Pilot Study

In the fall of 2014, an explanatory sequential mixed methods pilot study (Quant → Qual) was conducted. The purpose of the pilot study was to quantitatively investigate if stereotype threat could be identified with a survey, and then to interview women who reported high stereotype threat, low success, and dislike for math. The quantitative goal of the study was to use the SIAS scale to measure stereotype threat in an undergraduate population. There were two reasons for using the SIAS: (1) to test if there is a gender difference in self-report stereotype threat, and (2) to test if participants would consciously report stereotype threat. The goal of the qualitative study was to interview women that reported high stereotype threat in the quantitative portion of the study, and to explore their perceptions of stereotype threat and contextual factors related to stereotype threat. The mixed goal was to compare the quantitative and qualitative findings and explore similarities in differences in the findings for a better understanding of stereotype threat and the relationship of other contextual factors.

Methods

Undergraduate students from a small, Midwestern university were invited to participate in an online survey. The principal investigator visited several introductory level STEM courses to explain the study and invite students to participate outside of class. An email containing a link to the survey was sent to all students. The survey took an average of 21 minutes to complete.

A total of 102 students (61 women, 41 men) with an average age of 22.95 years (SD= 6.88) completed the survey. The majority of the participants were Caucasian (79.4%), followed by Hispanic (5.9%), African American (5.9%), and Native American (4.9%). Eleven items from Picho and Brown's (2011) SIAS measured gender stigma consciousness ("My gender contributes to my self-confidence") and math identity ("Math is important to me") on a seven-point Likert type scale (1= *Strongly disagree*, 7= *Strongly agree*). Twenty items from Pekrun et al.'s (2002) math class related emotions scale measured negative math emotions (boredom and anxiety). Gender stigma consciousness (α=.74), math identity (α=.96), math boredom (α=.74), and math anxiety (α=.78) all had good internal reliability and were normally distributed.

The researchers asked women who reported low math identity and high negative math emotions to participate in an interview about their math experiences. Eight woman college students were interviewed for the qualitative portion of the study. Four of the women were white, two were African American, one was Hispanic, and one was Native American. The average age of the participants was 21 years. The interviews took between 30-45 minutes each and were recorded for transcription purposes. Each interview was transcribed verbatim.

Findings

For the quantitative portion of the study the gender stigma variable, indicating the presence of stereotype threat, was of most interest. The gender stigma consciousness variable was not correlated with any of the emotions, math identity, or math success (see Table 1).

Table 1. *Pilot Study Correlations on Stereotype Threat Using the SIAS Scale (Picho & Brown, 2011), and Pekrun's (2002) Math Class Related Emotions Scale*

	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**
1. GPA	-							
2. Stigma	.07	-						
3. Math Value	.21*	-.10	-					
4. Success	.42*	-.16	.49**	-				
5. Control	.30**	-.08	.45**	.51**	-			
6. Enjoyment	.29**	-.18	.70**	.59**	.52**	-		
7. Boredom	.25*	.19	-.55**	-.50**	-.36**	-.68**	-	
8. Anxiety	.27**	.18	-.46**	-.66**	-.66**	-.61**	.50**	-

*$p \leq .05$, **$p \leq .01$ (two-tailed)

Regarding stereotype threat, the results suggest that the SIAS scale may not be a good scale to use in relation to STEM fields because the lack of significant correlations suggest low criterion related validity.

For the qualitative portion of the study, six main themes emerged from the data: male and woman math differences, hedonic bias or attributing success internally and failure externally, math success decreases with schooling, math not important, in-class emotions, and after class emotions (see Table 2 for a description of themes and codes). To summarize, all of the woman subjects reported their ability to be low in the STEM subjects, yet they did not perceive that there was an overall male/woman performance difference in STEM subjects suggesting that stereotype threat may not be conscious. In addition, the qualitative findings also supported past research that woman performance deficits start in elementary school (Keller, 2007). Many of the women interviewed for the study suggested that they experienced a performance drop in math after the elementary school years; however, they had difficulty thinking of a reason for this performance drop. The women also reported that they were not interested in math and avoided taking math in high school and college.

These results suggest that stereotype threat and related contextual mechanisms may be more complicated than originally thought. If stereotype threat is not conscious or if women are denying that they are falling victim to the threat, more research is needed to identify exactly what contextual mechanisms should be targeted. It may be that there are numerous environmental factors that women are exposed to throughout their lives that implicitly influence their interest, attitudes, and performance in math.

Table 2. *Pilot Study Qualitative Themes*

Theme	Definitions	Codes
male and female math differences	Men are better at math because they are better with numbers and are more likely to go into a math related field.	Men better at math, men better with numbers, male occupations, male spatial skills
Hedonic bias	Female participants attribute their success to putting forth effort and trying harder. Teachers are the cause for math related failure due to poor teaching or the teacher not helping the student.	Success= effort, more effort than normal, tried harder, studied longer, got a tutor Disliked teacher, teacher disliked student, poor teaching, teacher would not help, teacher was gone, teacher was boring
Math success decreases with schooling	Participants reported having math success in elementary school, which decreased as they got older and continued in school.	Success with math in elementary school, special help in middle school, poor performance in high school, lack of understanding middle school, interested in math in elementary school, did not pass in high school, poor grades in middle school/ high school
Math not important	Math was seen as less important in comparison with other school subjects.	Math not interesting, math not important for future, math not as important as other classes, math not important for occupation, do not care about math
In-class emotions	Boredom and frustration were emotions reported during class.	Bored with class, bored- do not pay attention, frustrated- don't understand, frustrated- others doing better, frustrated about going to class, cannot pay attention- bored
After-class emotions	Relief and happiness were reported emotions after math class.	Relief- class over, glad after class, happiness after class

Limitations

The SIAS scale had good reliability and validity; however, many of the items on the SIAS scale were not domain specific. Further research could involve the SIAS scale with gender related questions, questions that are more specific to the STEM fields, and collected from a more diverse sample of participants. The qualitative portion of the pilot study interviewed only eight women that all reported a dislike and low success for math and science. In order to get a more representative sample, more participants with varied interests, performance, and motivation need to be interviewed.

The current study aims to rectify these limitations by exploring stereotype threat in a qualitative setting, by interviewing women that are successful and unsuccessful in STEM fields, and interviewing a larger number of women. The themes from the qualitative phase of the mixed methods study were used to develop a scale that can distinguish those who experience stereotype threat and other contextual factors related to stereotype threat.

The Qualitative Phase

Research Design

This mixed methods study aimed at exploring stereotype threat and other contextual factors that contribute to female success and failure/avoidance in STEM fields. For the purpose of this study, STEM success was defined as any woman with a completed M.S. or PhD in a STEM major. STEM failure and avoidance was defined as women that report having low math identity and high negative math class emotions. I expected that I would find contextual factors, other than stereotype threat, that are related to STEM success and failure. These contextual factors would be better explored using qualitative methods (Strauss & Corbin, 1998).

Participants. Participants were 15 women ages 18-53. None of the participants were students of mine in the past or present, and thus did not depend on grades from me. Twelve of the participants were White and three of the participants were Black. I knew the participants or was notified of possible participants through snowball sampling and personally asked each participant to be part of the study. I believed that knowing most of the participants would not only make the participants feel more comfortable talking with me, but also would also enhance the honesty and expression of their answers. I wanted to get a mix of women that were successful in STEM and liked STEM, some that had neutral feelings about STEM, and some that were unsuccessful and had negative emotions related to STEM. In addition, Stenius et al., (2008) suggest that a qualitative researcher should be certain to cover the variation of a phenomenon. Six of the women were successful and reported liking STEM subjects, three had neutral feelings and neutral experiences with STEM subjects, and six were unsuccessful and had negative emotions related to STEM subjects. I explained the informed consent to all participants before the interview, and asked each participant to sign the informed consent if they felt comfortable with the study. In addition, I made sure that participants were comfortable with their interview being audio recorded. A copy of the qualitative informed consent is including in Appendix A. Each participants name was put into a drawing for a $25 gift card to a restaurant of the participant's choosing.

Methodology. Strauss and Corbin (1998) suggest that qualitative research is a continuous process of data analysis that guides future data collection. I used the results of my pilot mixed methods study as a guide for data analysis and data collection. The individual interviews were semi-structured based on the following topics: history of academic performance in math from elementary school through college; reasons for specific successes and failures in math; emotions before, during, and after math class; family influence on preferred subjects; and perceptions of female and male success in math courses and occupations. Appendix B lists the interview questions that were used for the qualitative portion of the study. I interviewed each participant in my office or in a place in which the participant felt comfortable. Only two women suggested a place other than my office, so their interviews took place in a dining area on campus. Each interview took approximately 30 minutes to one hour. After each interview was transcribed, each participant was emailed her transcript to verify transcript content and meaning.

After the interviews were conducted, participants were asked to complete the Gender-Science IAT (Implicit Attitude Test; Greenwald et al., 1998). The IAT was used as an exploratory test to see if participants had an unconscious bias to associate male words with science and math words, and female words with liberal art words. The principal investigator was interested to see if women that were successful in STEM subjects and fields would still have a difficult time associating female words with STEM words, and if women that were unsuccessful in STEM would be more unconsciously biased than women that were successful.

Data Analysis. Creswell (2014) identified six steps for qualitative analysis. I will describe the analysis according to Creswell's steps.

Step 1: Organize and prepare for the data analysis. During this step, I listened to the audio recordings of the interviews and transcribed the interviews into a word document. While I was transcribing I made note of anything that I thought was interesting and also listened to the tone of the participant's voice and other inflections I thought were related to the participants' expressions of their answers.

Step 2: Read through the data. After each interview was transcribed, I reviewed the data in detail and reflected on the overall meaning of the transcripts. I also took the notes that I prepared while interviewing the participant and combined my notes with the transcripts. As I was reading through the responses I started to make a list of specific words or ideas that kept coming up in the interviews.

Step 3: Begin a detailed analysis with the coding process. Once I identified words/phrases that were used frequently, taken together with notes from the interview and notes on participant expression, I organized the material into smaller chunks. I followed Creswell's (2014) procedure of organizing the material into segments by taking significant statements and organizing the significant statements into groups of statements that were similar. Each group of statements had a different color so that I could group similar ideas within the different interviews. After I went through each interview, I copied the different colored statements into an Excel document according to color. I looked through all the colored statements and organized the statements further into overarching categories. I labeled the categories with common language or expression used by the participants.

Step 4: Use the coding process to generate a description of the participants as well as categories for the analysis. I used this process to generate codes for the descriptions, which then led to combining categories into themes. Each theme had a separate Excel sheet and I listed the categories under each theme. I then analyzed the themes and gathered the various categories into a general description for the corresponding theme.

Step 5: Advance how the description of the themes will be represented in the qualitative narrative. For this step, I chose significant statements from each of the themes to use as narrative passages. I chose statements that were mentioned often and that I felt represented the theme best. I also chose statements that were not necessarily mentioned the most, but had good expression and emotion to portray the theme.

Step 6: Interpret the meaning of the data. Creswell (2009) recognizes that a researcher's own background plays a role in the analysis process just as much as the researcher's theoretical lens. During my own interpretation process, my own experiences of success and failure in STEM helped me interpret the participants' perceptions. In order to remain objective in my interpretations, I focused specifically on what the participants were saying and the conclusions they drew from their successes and failures. I also provided my participants with my notes during member checks to make sure that my perceptions were accurate.

Trustworthiness

Qualitative research allows the researcher to take an active role in the collection and interpretation of what participants report during interviews. Stake (1995) cautioned qualitative researchers that their own assumptions and views may cause narrow thinking, and suggested researchers learn to understand their participants' views.

To increase the trustworthiness of this study's findings, I employed strategies recommended by qualitative researchers (Stenius et al., 2008). To decrease threats of credibility, I used triangulation by employing multiple sources of data to confirm emerging findings (Stake, 1995). I performed member checks by sending participants a copy of their interview transcript (Stenius et al., 2008). Lastly, I requested that one of my colleagues with experience in qualitative research review my analysis.

To increase the dependability of my study findings, I provided an audit trail, or a detailed explanation of the data collection and analysis methods. I also provided thick description so that other researchers could interpret and potentially replicate my findings. Furthermore, I provided maximum variation by purposefully recruiting participants that were successful, neutral and unsuccessful in STEM.

Anticipated Results

The purpose of the qualitative portion of the study was for participants to report their success and failure in STEM majors and careers, and perceptions of stereotype threat, thus allowing qualitative themes to emerge. The qualitative questions are re-stated below in chapter 4. The researcher withheld hypotheses for the qualitative portion of the mixed methods study to avoid bias during data analysis.

The Integration Phase

Research Design

The study had two points in which data were mixed. First, the qualitative data was used to guide the creation of the quantitative survey. Second, the interpretation of the qualitative and quantitative results together took place when the qualitative and quantitative portions of the study were complete. Similar to the qualitative research questions, I did not explicitly anticipate results for the mixed questions to allow findings to emerge from qualitative interviews.

In the integration phase, I took the themes that emerged from the qualitative phase to create questions that were used on a quantitative survey. The measures created from the qualitative findings are as follows: stereotype threat, STEM confidence, STEM achievement, STEM support, STEM motivation, STEM anxiety, giving up in STEM, and STEM challenge. A final interpretation of the quantitative and qualitative results taken together is explained in the discussion to represent the final integration phase. Each measure is described in more detail in the quantitative phase below.

The Quantitative Phase

Research Design

The goal of the quantitative phase was to create and test the validity of a survey based on the qualitative results. The qualitative themes were used to create survey questions that could measure stereotype threat and other variables that were related to STEM success and failure. The survey was then given to participants to investigate the reliability and validity of the scale, and also investigate male and female differences in stereotype threat and other contextual variables.

Participants. Participants were 242 male and female undergraduate students (18 years or older) from introductory STEM courses at a 4-year, medium sized, Midwestern university. The principal investigator visited four different classrooms and asked undergraduate students to participate by filling out a paper survey during class time or the same survey on Qualtrics outside of class (based on the instructor preference). The students were offered three points of extra credit for their participation, but were also told by their instructor that they would have other opportunities for extra credit later in the course. The principal investigator handed out an informed consent to everyone, and asked those that would be participating in the study to turn in their signed informed consent to their instructor. A copy of the quantitative informed consent is in Appendix C, and demographic information for participants is listed in Table 3. The instructors of the courses took the informed consents from the students and entered their extra credit based on the informed consent. The instructors then gave the principal investigator the informed consents for proper storage.

Table 3. *Participants Demographics in Quantitative Phase*

Variable	Subcategory	Intro STEM courses N = 242 Valid *n*	%
Gender	Female	134	55.3
	Male	108	44.6
Age in Years	18	28	13.3
	19	33	15.5
	20	21	9.8
	21	25	11.7
	22	26	12.2
	23	20	9.3
	24- 52	60	28.2
Ethnicity	African- American (non-Hispanic)	13	6.4
	Asian Pacific Islander	15	7.4
	Caucasian (non- Hispanic)	151	74.4
	Latino or Hispanic	11	5.4
	Native American	5	2.5
	Other	8	3.9
GPA	3.5 or above	86	43.2
	3.0 to 3.49	66	33.2
	2.5 to 2.99	39	19.6
	2.0 to 2.49	6	3.0
	Below 2.0	2	1.0

Note. Totals of percentages are not 100% for every characteristic because of rounding.

Measures. As mentioned above, the survey was created from the qualitative findings of phase one and contained measures of stereotype threat and other contextual factors related to STEM success and failure. Participants responded to the items on a 6-point Likert type scale from 1 (strongly disagree) to 6 (strongly agree). Items were grouped on a theoretical basis to create sub-scales within each dimension and tested by the calculation of Cronbach's alpha as a measure of internal consistency among the items. Example items from each scale are as follows:

- Stereotype threat (e.g., "When I reflect on my experiences in science and math courses, I feel that my gender affects how people treat me in science courses."),
- STEM confidence (e.g., "When I reflect on my experiences in science and math courses, I feel that my success in math courses influences how I feel about myself."),
- STEM achievement (e.g., "When I reflect on my experiences in science and math courses, I feel that I am unable to do well in science courses."),
- STEM support (e.g., "I am successful when my friends help me with my math homework."),
- STEM motivation (e.g., "I am motivated to do well in my science courses so that I am prepared for a high paying career."),
- Giving up in STEM (e.g. "I feel like giving up in math class when my teacher doesn't like me."),
- STEM anxiety (e.g., "I feel anxious in science class when I have to take a science exam."), and
- STEM challenge (e.g., "I am successful when I am challenged in my science courses.").

The codebook for stereotype threat questions and other contextual factor questions is detailed in Appendix D.

Demographic variables included gender (Male, Female, Other, Rather not say), Age (open ended), GPA (3.5 or above, 3.0 to 3.49, 2.5 to 2.99, 2.0 to 2.49, Below 2.0), major (open ended), and ethnicity (African-American (non-Hispanic), Asian/ Pacific Islanders, Caucasian (non-Hispanic), Latino or Hispanic, Native American, Other, Rather not say). The codebook for demographic variables can be found in Appendix E. It took participants approximately 15 minutes to complete the survey.

Rationale for Data Analysis

Data entry. Forty participants entered their survey answers into Qualtrics, and two hundred students completed their survey on paper. If the participants completed the survey on paper, the principle investigator entered their answers into Qualtrics. The data from Qualtrics was then downloaded into a .csv file and uploaded into SPSS for further analyses. All negatively worded items were reverse coded in SPSS. The principal investigator created a codebook based on the variables and data in SPSS.

Variable descriptive analysis. Quantitative data analysis was initially descriptive with measures including means, variances, standard deviations, skewness and kurtosis. The descriptive analysis allowed the principal investigator to develop an initial understanding of the data normality and variance collected during the quantitative phase.

Reliability and validity. An exploratory factor analysis was performed on all items of the survey. An initial extraction was performed to identify any irregularities in the data. Factors were dropped if less than three items loaded onto the factor. A promax oblique rotation factor analysis was performed to examine factor loading. All items were combined into factors (summed scales) after the factor analysis was complete.

Reliability analysis using Cronbach's alpha was conducted on all factors. Creswell (2014) states that internal consistency is a way to test reliability, especially in a cross-sectional survey, and a calculated Cronbach's alpha should be larger than .70 for most studies (Warner, 2013).

Mean difference analyses. *T*-tests were used to investigate gender differences between men and women in all variables. One-way ANOVAs investigate mean differences between independent and dependent variables when the independent variable has more than two levels. Age, Ethnicity, and GPA were independent variables with multiple levels.

Correlation and regression analysis. Pearson correlations were used to identify the magnitude and direction of bivariate relationships among the study variables. Warner (2013) states that Pearson r values around .10 indicate a small effect, around .3 indicate a medium effect, around .4 indicate a large effect, and anything greater than .60 indicates an extremely large effect. A linear regression analysis examined which independent variables were significant predictors of the dependent variables. Significant correlations were used to guide regression analysis.

Mediation analysis. Mediation analysis was used as an exploratory analysis to investigate the relationship between the independent variables, contextual variables, and stereotype threat. Although mediation was not addressed in the research questions, it was conducted to further investigate significant correlations, regressions and for future research. A mediation model was developed based on the findings of regression analyses and is explained in chapter IV.

Bootstrapping was used to test the indirect effects. Bootstrapping is a non-parametric method that resamples and replaces the data many times (in this case 5,000 times). The indirect effect is computed and a sampling distribution is created from each resample. With the distribution, a confidence interval, and a p value can be determined. If zero is not included in the confidence interval, the researcher can conclude that there is a mediation effect (Preacher & Hayes, 2004).

Chapter III Summary

A pilot study was conducted in the spring of 2014, which aimed at examining Picho and Brown's (2011) SIAS scale in a research setting and interviewing women to explore individual factors related to failure and avoidance in math. Several significant correlations were noted but none of the correlations included the stereotype threat variable of gender stigma consciousness. In addition, women reported many factors that influenced their failure and avoidance in math; however, none of the women reported that they perceived their failure and avoidance to be due to stereotype threat. There were pilot study limitations (low number of qualitative participants, SIAS questions were not domain specific), which guided the design of the proposed study.

The proposed study was made up of two individual phases. Phase I was a qualitative study aimed at exploring stereotype threat and other contextual factors related to STEM success and failure/avoidance in STEM. Phase II was based on the results from phase I and explored the themes from phase I to construct a survey measuring stereotype threat and other contextual factors. It is important to note that stereotype threat is a contextual factor but is mentioned separately from other contextual factors because it is of most interest in this study. The methodologies along with research questions were fully described in Chapter III.

CHAPTER IV

RESULTS

The purpose of this mixed methods study was to (a) explore contextual factors, including stereotype threat, that are related to women success and failure/avoidance in STEM fields and (b) create a survey based on the qualitative results that can be used to measure stereotype threat. In this study, contextual factors are defined as environmental factors that influence motivation and achievement in STEM. The qualitative study had 15 female participants that were interviewed to explore stereotype threat and contextual factors related to stereotype threat. Qualitative data was transcribed, reduced to significant statements during open coding, significant statements were then further reduced to codes, and all codes were compiled in an Excel spreadsheet for categorization. After all codes were put into categories, themes emerged from the categories and codes to address the following qualitative questions:

1. Is stereotype threat mentioned as a factor that influences performance and motivation to enter into a STEM major and career? Is stereotype threat reported as impacting performance and motivation in STEM majors and careers?
2. What are the differences between women that are consciously aware of stereotype threat and report stereotype threat as affecting their performance and motivation, and women that do not report stereotype threat as a factor affecting their performance and motivation?

After themes emerged from the qualitative study, the integration questions were addressed and are listed below:

1. What findings emerge from the qualitative interviews that can be used to develop a multi-item survey scale measuring stereotype threat?

2. What contextual factors emerge from the qualitative interviews that can be used to develop a more specific and detailed multi-item survey scale measuring stereotype threat?

A survey was created from the qualitative results specifically addressing the mixed questions. The survey consisted of 62 questions and measured nine factors that were related to the dialogue of the qualitative interviews. The quantitative study had 242 participants, who identified as being male or female that completed the survey. Quantitative data analysis consisted of *t*-tests and one-way ANOVA to investigate mean differences between independent variables (gender, age, and ethnicity) and the contextual variables, correlations and regressions to determine relationships between all variables, and mediation to further address the significant predictive relationships between independent and dependent variables. All quantitative analyses were planned based on the questions below:

1. Are there male and female differences in the stereotype threat and related contextual factors?
2. Is stereotype threat related to performance and motivation in STEM?
3. What are the contextual factors that are related to performance, and motivation in STEM?

This chapter reports the results of the qualitative and quantitative tests noted above. An interpretation of the results in relation to the research questions follows in Chapter V.

Qualitative Results

The interview transcriptions for each participant were examined and reduced to significant statements. The significant statements were reduced to codes and categorized in an Excel spreadsheet. Data reduction methodology revealed six major themes from the interviews. The six themes derived from transcripts are as follows:

1. Achievement Experiences (positive or negative)
2. Gender Stereotypes in STEM
3. Motivation Influencers
4. Emotion/Affect
5. Support Experiences (Family and Peer)
6. School Experiences

Table 4 describes each theme with definitions, codes and categories below. Each theme is described in more detail following the table.

Table 4. Qualitative Themes.

Theme	Definitions	Codes
Achievement Experiences	• Unsuccessful women reported avoiding STEM courses after one or more failure events in middle school or beyond. • Unsuccessful women enrolled in the minimum requirement for STEM courses in high school and beyond. • Successful women were more likely to continue taking STEM electives because of other successes in STEM.	• Failure in STEM leads to avoidance • Unsuccessful women took minimum STEM classes • STEM success leads to more STEM classes
Gender Stereotypes in STEM	• Unsuccessful women reported that they felt men were more successful in STEM and had a STEM "brain". • Unsuccessful women said that there were very few women in physics or chemistry. • Unsuccessful women reported that their home life growing up displayed many gender stereotypes.	• Unsuccessful women= men more successful in STEM • Successful women= heard men are better, don't believe • Men have math/science brain • No women in physics or chemistry • Home life displayed gender stereotypes
Motivational Influencers	• Unsuccessful and neutral women said that they took STEM courses because they had to for their major, because they wanted to get a certain grade, and because they wanted a high paying career. • Successful women said they took STEM classes because they felt an internal desire to succeed in STEM. • Both successful and unsuccessful women reported that over time their STEM motivation changed from intrinsic to extrinsic.	• Unsuccessful women= extrinsic motivation • Successful women= intrinsic motivation • Motivation changes over time
Emotion/Affect	• Unsuccessful women reported feeling frustration, sadness, anger, and anxiety that were associated with STEM classes. • Neutral women reported feelings of boredom and anxiety associated with STEM classes.	• Unsuccessful women= frustration, sadness, anger, anxiety • Neutral women= boredom, anxiety

	• Successful women reported being engaged during STEM classes and enjoying STEM classes.	• Successful women= enjoyment, engagement
Support Experiences	• If both parents were supportive about STEM activities, STEM success was much more likely. • If one or both parents encouraged non-STEM activities, STEM success was less likely. • If one or both parents were successful in STEM, STEM success was much more likely. • If parents were blue collar, STEM success was much less likely. • Women had friendships with other women that had similar interests.	• Both parents supportive, • Parents encouraged non-STEM activities • Peer group support- STEM • Peer group nonsupport-STEM • Peer group similar interests • One or both parents successful in STEM • Parents blue collar= lower STEM success
School Experiences	• Most STEM success memories were from high school and college. • Unsuccessful women were more likely to report having a male coach as a STEM teacher and that the teacher favored boys. • Successful women recalled one or more teachers that encouraged them to succeed in STEM. • Failure experiences for both successful and unsuccessful women were blamed on the teacher.	• Success memory=high school, college • Coaches favored boys • Teacher encouragement changed STEM behavior • Teacher was to blame for failure,

Theme 1: Achievement Experiences

When the women were asked interview questions related to successes and failures in their STEM classes, their answers varied according to whether the women were successful or unsuccessful in STEM. The women that were successful in STEM described mostly successful events in their STEM courses and had a difficult time coming up with any failure experiences. The unsuccessful women described mostly failure events in their STEM courses and had a difficult time coming up with any success experiences. Both of these findings were expected because I recruited successful and unsuccessful women. The difference in achievement experiences between successful and unsuccessful women was evident in the way that unsuccessful women avoided future STEM experiences, and successful women approached STEM experiences.

The unsuccessful women engaged in strategies in order to not have to take certain STEM courses. Many of the unsuccessful women reported that they picked their major based on how many math and science courses they would have to take, and the difficulty of those courses. Katrina thinks back to an experience in high school, "High school was easy except mathematics I was put in the classes for the dumb kids. I was like this is boring I already know this. So I stopped paying attention". Leah also remembered failure events in middle school and high school,

> "There's some people that are just naturally good at it I think and then there's some people who can be really good at it but they work really hard at it. People like myself can work my tail off at it and I'm just hoping to get a C".

In addition, the achievement experiences had an influence on the perceptions of those experiences depending on whether the female reported being successful or unsuccessful. Katrina talks about how she believed early on that she did not have the ability to do well in math,

> "I think because I just felt like I had an issue with being able to understand the language of mathematics. I just felt like I was always more artistic, I just kind of felt like I was only built to be right brained. I didn't have whatever it took to be as smart as someone who could do mathematics so I avoided science and math, but specifically math".

The successful women mentioned that being successful in STEM courses, motivated them to continue on in STEM courses, for example, Jackie remembers back to middle school, “I remember getting really into geometry even though it was hard for me, I did really well because I worked so hard and it made me want to just keep going”.

Theme 2: Gender Stereotypes in STEM

Gauthier et al., (2017) suggest that when one thinks of a scientist, their mental image is a male. Many textbooks reinforce the male scientist schema with masculine textbook examples (Buck et al., 2002). All women interviewed reported being conscious of or “hearing about” men having higher ability in STEM subjects. The women that were successful in STEM suggested that they did not agree with this thinking.

One woman explained that, “I don’t think guys are better at math or science, but I know some people do. It actually makes me work harder because I want to show everyone that it isn’t true.” For this woman, the stereotype actually motivated her to try harder in her STEM courses to prove that the stereotype was not accurate. This phenomenon is called stereotype uplift and is more common in men when faced with negative stereotypes (Walton & Cohen, 2003). Jackie explains her experience with stereotype uplift, “I remember my 6th grade teacher, he was a male and really into science… he only paid attention to the boys during science class. This made me mad so I just tried to work even harder to prove to him that girls could do it too.”

The unsuccessful women and neutral women explained that men have an easier time understanding math and science. Jessica, a neutral female, explained, “It's like men are smart mathematics and science type people. They (men) are more gifted in that area, it's more their thought process.” Jodi, another neutral female, voiced the same feelings, “Most of the smart math people I know are guys. I don’t think I know one girl that is majoring in physics or chemistry.” Michelle agreed that she had heard from teachers and peers that she should not try in math or science because men got better grades in those subjects,

Theme 3: Motivation Influencers of Success in STEM

Motivational influencers of STEM fields were addressed when interviewees were asked about what it meant to be successful in STEM. The unsuccessful and neutral women tended to explain STEM success in STEM as an increase in stature or in monetary income. One of the neutral women, Tammy, explained that the only reason she would go into a STEM field was to “make more money”. Many unsuccessful and neutral women reported that they were motivated to do well in a college level math or science course because the course was needed for their major or needed to graduate.

The successful women were more likely to report being motivated in STEM courses because of personal interest factors. Michelle explains her success and motivation in her high school math class, “I like math because it is challenging. You have to really work to find the answer, and then when you figure everything out it feels good”. Michelle mentioned that she was curious about science from an early age, “I remember loving dinosaurs as a kid and being really drawn to science experiments. I have always wanted to do well in science just because I really love science.”

Theme 4: Emotion/ Affect

I asked many questions related to emotions surrounding STEM courses. The women were asked about their emotions before, during, and after STEM classes, as well as what emotions they experienced during successes or failures in STEM. The unsuccessful women reported the most intense feelings associated with STEM. Leah explains, "I remember just sitting at the kitchen table and crying just being so frustrated because I didn't understand it". Many of the other unsuccessful women reported crying about failures in STEM courses or frustration about not being able to understand the content. The neutral women had more of an, "indifferent", attitude towards their success and failures in STEM. Tammy explains, "I mean I was happy if I did well in one of my courses, but I guess just on to the next". Tammy also explains her feelings about failure, "If I would fail in one of my courses, even in college, I would just think- oh well better luck next time". Boredom was a common emotion mentioned among the neutral women, Whitney explains, "It wasn't that I disliked math or science but I just had a really hard time staying engaged so I got really bored".

The successful women reported much different emotions in relation to their successes and failures in STEM. Michelle thinks back on her emotions in her high school biology class, "I usually was the nerd in class with wide eyes watching and listening to the teacher because I loved my biology class so much. I felt energized and excited in that class". Jackie explains that she was always excited to go to physics class, "I had physics every day after lunch in high school, I just thought it was so cool. I would eat really fast because I was so excited to go to class because I just enjoyed it so much".

Theme 5: Support experiences (Family and Peer)

Keller (2007) suggests that stereotypes form unconsciously over time, and are one reason that women disengage from STEM subjects starting in late elementary school. Like the emotions theme above, the unsuccessful women had extreme responses to the family and peer questions. Jennifer recounts an experience she had with her Dad while he was trying to help her with her math homework in high school, "I remember my Dad punching the wall because I couldn't understand my math homework". Jennifer also explains that her Mom was not good at science, and the feelings she experienced after a conversation with her Mom in high school, "My Mom would even say “You're good at English, go into something that emphasizes English. Science isn't your strong point, you're good with words’. Jennifer also mentions how her Mom’s failure in science made her feel better about herself, “My Mom wasn't good in mathematics either, she failed intro to algebra in college five times. Knowing that actually made me feel better because I felt like less stupid. I blamed my stupidity in science on my genes”.

One interesting finding was that the successful women that were interviewed all had parents that were successful in STEM related careers. It did not matter if the successful parent was Mom or Dad, but just that they were successful and valued the hard sciences. Jackie explains, “My Mom was an accountant and my Dad was an engineer, they both started working with my sister and I at a very young age, so we learned to really love both math and science”. The successful women were also less likely to report gender stereotypes and often referenced that their parents’ jobs in STEM fields.

Theme 6: School Experiences

All women, except the neutral women, emphasized school experiences in their success and failure in STEM courses. Most of these experiences took place in high school or college. Jackie, a successful female, explains an experience in college,

> “I worked with the same three people throughout college (for group work) there were three of us, two girls and a guy who would work in a group and do our homework together. We were all in mechanical engineering. We had the same exact answers but I feel like the guy would always get a higher grade than we did. I always thought that the professor had a thing against women, but maybe that was just me”.

Jackie also explains another college experience in her college program, “I was the only woman out of 80 graduates in engineering. There was one woman professor in engineering and she was always pressuring me to go into the types of engineering that are more woman orientated." Many of the successful women reported positive high school experiences with teachers and peers, Michelle thinks back to her high school math teacher, "I feel that I succeeded in my math courses in high school because my teacher was a really good teacher and dedicated to his students.

Most of the unsuccessful women blamed their failure in math and science on specific teachers that they remembered from middle school and high school. In some cases the teachers favored men. Michelle recalls her high school math teacher, "The math teachers at my high school were all males and also coaches. They favored the male athletes". However, many of the unsuccessful women mentioned that their math and science teachers did not do anything specific to them personally but that they were just a really bad teacher and hard to understand. Leah explains this, "I had a really bad pre-algebra teacher. I didn't understand anything and got like a "C" in the class. When I entered algebra I was totally lost because my pre-algebra teacher was so bad".

IAT

The female participants took the Gender-Science IAT test on the principal investigator's laptop after their interview was complete (Greenwald et al., 1998). The IAT presents participant results as little to no automatic preference, a slight automatic preference, moderate automatic preference, or a strong automatic preference. All six unsuccessful women had a strong automatic preference for male-science and female-liberal arts. Of the three neutral women, two had a strong automatic preference for male-science and female-liberal arts and one had a moderate automatic preference for male-science and female-liberal arts. The six successful women had variable results. Two of the successful women had a strong automatic preference for male-science and female-liberal arts, two had a moderate automatic preference for male-science and female-liberal arts, one had a slight automatic preference for male-science and female-liberal arts, and one had a slight automatic preference for female-science and male-liberal arts. These results indicate that in most cases we are unaware of biases that develop over time and affect our decision-making and preferences. This gives further evidence that stereotype threat may not be conscious.

Qualitative Question 1

The first qualitative question explored if women reported stereotype threat influenced their performance and motivation to enter into a STEM major and career. The STEM achievement and stereotype threat themes suggested that stereotype threat plays a role in female performance and motivation, but that women do not say that stereotype threat is affecting their performance. The women interviewed mentioned an awareness of stereotype threat in math and science, but did not state that this awareness influenced their STEM performance.

Qualitative Question 2

The second qualitative question sought to identify the differences between women that are consciously aware of stereotype threat and report stereotype threat as affecting their performance and motivation, and women that did not report stereotype threat as a factor affecting their performance and motivation. There was no evidence that the women participating in this study were aware of stereotype threat; thus, I was not able to identify differences between women that were consciously aware or not consciously aware of stereotype threat. It was observed that women who reported being exposed to more stereotype threat, compared to those who were not, were much more likely to be unsuccessful in STEM subjects.

Integration Point 1 Results

The study had two points in which qualitative and quantitative data were mixed. First, the qualitative data guided the creation of the quantitative survey. In addition, the quantitative survey results were compared to the qualitative findings for the second integration point. The second integration point will be discussed in Chapter V.

Integration Question 1

The first integration question concerned if findings would emerge from the qualitative interviews to develop a valid and reliable survey scale specific to stereotype threat. The corresponding qualitative questions focused on stereotype threat in the common environments stereotype threat occurs (Gunderson et al., 2012; Nosek et al., 2002b). Specifically, Gender Stereotypes in STEM subjects, School Experiences, and Support Experiences. As an example, Maria remembered her school and home experiences early in life and being told, “girls can’t do well in STEM or science, those are boy subjects”. It is important to note that the stereotype threat themes that emerged were many times part of other contextual factors that participants mentioned. These contextual factors seem to play an important role in how stereotype threat forms unconsciously over time and that the contextual factors are not exclusive of stereotype threat. The second integration question addresses this below.

Integration Question 2

The second integration question focused on the contextual factors influencing stereotype threat that emerged from the qualitative interviews. The contextual factors were used to develop a more specific, detailed survey scale measuring stereotype threat, and the contextual factors that contribute to stereotype threat. The specific contextual factor themes that emerged are as follows: achievement experiences, motivational influencers, and emotion/affect. For example, Leah remembered her high school math class and said, "I just wanted to avoid the class because I would be so bored, I didn't care if I did well in the class. The only thing that motivated me was that I had to have a certain GPA to play volleyball". The themes mentioned in questions 1 and 2 were used as a guide to create questions for the quantitative survey. When creating the questions for the survey, I explored the common comments the female participants made that were part of the coding and categorization process.

Quantitative Results

The quantitative phase of the study consisted of 242 men and women undergraduate students (18 years or older) from introductory STEM courses at a 4-year, medium sized, Midwestern university. The principal investigator visited four different classrooms and asked undergraduate students to participate by filling out a paper survey during class time or the same survey on Qualtrics outside of class (based on the instructor preference).

Reliability and Validity of Scales

Reliability analyses using Cronbach's alpha was conducted on each factor and are shown in table 5. All scales were found to be reliable, however, the Cronbach's alpha for the motivation scales were slightly lower than an acceptable alpha of .70 (Tavakol & Dennick, 2011). All items were assessed on a 6-point scale (1 = *Strongly Disagree,* 6 = *Strongly Agree*).

Descriptive Statistics

Descriptive statistics were computed on scales and sub-scales of the survey. Descriptive statistics included mean, standard deviation, skewness, kurtosis, minimum and maximum. Table 5 summarizes the descriptive statistics. The descriptive statistics demonstrate normal distributions and normal skewness and kurtosis. The descriptive statistic results indicated that analysis could continue with comparison of means, correlation, regression, and mediation.

Comparison of Means

T-tests and one-way ANOVAs (for variables with more than one group) were computed to investigate differences between the demographic variables when compared to stereotype threat and the other contextual factors.

The *t*-tests did not reveal any significant difference between men and women with any of the contextual variables including the stereotype threat variable. However, there was a difference between men (M= 33.6, SD= 9.5) and women (M= 37.0, SD= 10.1) on STEM anxiety that approached significance (p= .09). Table 6 displays gender differences in relation to the contextual factors. A one-way ANOVA tested group differences among the contextual factors with the independent variables of age and ethnicity because of the multiple levels within each of the independent variables. The one-way ANOVA results for age can be seen in Table 7, and the results for ethnicity can be seen in Table 8. There was no significant mean difference between age, ethnicity and the contextual variables.

Table 5. *Descriptive Statistics for Contextual Scales*

Dimension	Sub-scale	Items	Contextual Factors *N* = ~242						
			M	*SD*	Skew	Kurt	α	min	max
Stereotype Threat		StereoThreat_1, 2, 3, 4, 5, 6	13.6	4.5	.03	- .11	.95	7	22
Stem challenge		STEMchal_1, 2	7.9	2.1	- .24	.53	.75	5	12
STEM support		STEMsup_1, 2, 3, 4, 5, 6	8.0	2.0	- .35	.80	.82	6	24
STEM motivation		Smot_1, 2, 3, 4 Mmot_1, 2, 3, 4	36.4	6.4	-.36	.66	.81	15	42
	Science motivation	Smot_1, 2, 3, 4	18.3	3.4	-.29	.31	.65	10	24
	Math motivation	Mmot_1, 2, 3, 4	18.0	3.4	- .39	.51	.63	9	25
STEM give up		SGiveUp_1, 2, 3, 4, 5 MGiveUp_1, 2, 3, 4, 5	32.9	10.0	-.33	.15	.90	20	58
	Science give up	SGiveUp_1, 2, 3, 4, 5	16.0	5.2	-.17	.13	.83	10	26
	Math give up	MGiveUp_1, 2, 3, 4, 5	17.0	5.3	-.32	.02	.83	12	28
STEM anxiety		AnxSci_1, 2, 3, 4, 5 AnxMath_1, 2, 3, 4, 5	35.9	10.0	-.05	.30	.89	24	54
	Science anxiety	AnxSci_1, 2, 3, 4, 5	17.7	5.1	.05	.15	.83	12	23
	Math anxiety	AnxMath_1, 2, 3, 4, 5	18.2	5.6	- .23	.06	.83	13	24

Note. Descriptive statistics were calculated using the averaged vales of each individual scale; Skewness (Skew); Kurtosis (Kurt).
Range for all subscales was 1 (strongly disagree) to 6 (strongly agree).
Total participants that reported on each scale varied from 236-245.

Table 6. *Male and female Mean Differences among the Dependent Variables*

Dependent Variable	Male *N*	Male *M*	Male *SD*	Female *N*	Female *M*	Female *SD*	Mean Difference	*t*	*df*	*p*
Stereotype Threat	64	12.9	5.6	129	14.8	6.8	-1.8	-1.9	191	.13
STEM confidence	65	13.5	4.7	131	13.8	4.5	-.29	-.42	194	.39
STEM challenge	63	7.8	1.9	131	8.0	2.2	-.30	- .42	194	.40
STEM teacher	63	9.5	2.1	131	9.4	2.0	.07	.21	192	.92
STEM anxiety	61	33.6	9.5	127	37.0	10.1	- 3.5	- 2.3	186	.09
STEM achievement	62	38.9	11.3	129	35.5	11.1	.05	1.9	189	.90
STEM motivation	61	36.6	6.1	128	36.3	6.6	.27	.28	192	.75
STEM support	63	9.5	2.1	131	9.4	1.9	.10	.19	191	.80

Note. p > .05 for Levene's test for homogeneity of variances for all dependent variables.

Table 7. *Age One Way ANOVA with Contextual Factors*

Dependent Variable	Sum of Squares *Between*	*Within*	*Total*	*df* Total	Mean Square Between	Mean Square Within	*F*	Sig.
Gender Bias	609.3	15996.6	16605.9	212	152.3	99.9	1.5	.20
STEM confidence	40.9	3758.1	3799.1	211	10.2	22.5	.46	.78
STEM challenge	23.2	692.3	715.6	212	5.8	4.2	1.4	.24
STEM teacher	103.9	602.3	706.2	213	4.5	4.1	1.1	.37
STEM anxiety	609.4	15996.6	16605.9	213	152.4	99.3	1.5	.20
STEM achievement	1086.4	19489.9	20576.3	214	271.6	121.1	2.2	.07
STEM motivation	190.7	6665.9	6856.7	212	47.7	41.7	1.1	.35
STEM give up	477.2	16732.9	17210.1	214	119.3	105.9	1.1	.35
STEM support	31.3	662.7	694.0	211	7.8	4.3	1.9	.10

Note: Age was grouped into five categories: (1) 18-21, (2), 22-25, (3) 26-29, (4) 30-33, (5) 34- 37.
* $p < .05$ ** $p < .01$

Table 8. *Ethnicity One-Way ANOVA with Contextual Factors*

Dependent Variable	Sum of Squares *Between*	*Within*	*Total*	*df* Total	Mean Square Between	Mean Square Within	*F*	Sig.
Gender Bias	125.7	7907.4	8033.1	230	25.1	42.1	.60	.70
STEM confidence	117.7	3995.1	4112.8	229	23.5	20.9	1.1	.35
STEM challenge	15.1	832.5	847.7	229	3.0	4.4	.69	.63
STEM teacher	24.5	793.9	818.4	230	4.9	4.2	1.2	.33
STEM anxiety	733.0	18034.4	18767.5	230	146.6	98.5	1.5	.20
STEM achievement	208.7	23816.7	24025.4	228	41.7	128.0	.36	.90
STEM motivation	305.0	7542.4	7847.4	229	61.1	41.0	1.5	.20
STEM give up	640.9	17985.7	18626.6	228	128.2	99.4	1.2	.27
STEM support	10.7	760.2	771.0	230	19.2	2.2	4.0	.75

Note: Ethnicity consisted of: (1) white and (2) non-white.

* $p < .05$ ** $p < .01$

Correlations

Table 9 presents several significant, positive correlations among the stereotype threat variable and other contextual factors. Stereotype threat had significant positive correlations with STEM confidence, STEM anxiety, and giving up in STEM. Stereotype threat also had a significant negative correlation with STEM achievement. The significant correlations guided the regression analysis detailed below.

Regression

Linear regressions investigated the predictive relationships expressed in quantitative research question 2. Specifically, do the contextual factors predict stereotype threat? Does stereotype threat predict performance and motivation in STEM? In addition, GPA was used as an outcome variable with the contextual variables as predictors. Several of the relationships were significant and are shown in Table 10. Of most interest for the current study were the significant predictive relationships between the contextual factors and stereotype threat.

Table 9. *Correlations*

Scales	1	2	3	4	5	6	7	8	9	10	11	12	13
1. Stereotype Threat	—												
2. STEM confidence	.25**	—											
3. STEM challenge	.06	.09	—										
4. STEM support	-.02	.10	.29**	—									
5. STEM teacher	-.14	.10	.20**	.40**	—								
6. SEM motivation	-.03	.31**	.18*	.12	.26**	—							
7. STEM anxiety	.26**	-.00	-.03	-.09	-.20**	.03	—						
8. STEM give up	.27**	-.01	-.16*	.01	-.14	-.08	.50**	—					
9. STEM achievement	-.28**	.19**	.05	.12	.37**	.30**	-.42**	-.43**	—				
10. Gender	.14	.03	.04	.10	-.02	-.02	.16*	.11	-.14	—			
11. Age	.10	-.00	.05	-.02	-.03	-.08	-.07	-.05	.00	-.07	—		
12. GPA	-.13	.01	-.06	-.14*	-.14	-.14	.01	.00	-.11	-.30**	.08	—	
13. Ethnicity	.03	.12	-.06	.04	.12	.15*	.05	.05	.05	.03	.04	-.14*	—

* $p < .05$ (2-tailed), ** $p < .01$ (2-tailed)

Table 10. *Simple Linear Regression analyses among contextual variables.*

Independent	Dependent	Overall Model R^2	Individual β	p
STEM confidence	Stereotype Threat	.06	.35	.00**
STEM anxiety		.07	.17	.00**
Giving up in STEM		.07	.17	.00**
STEM achievement		.08	-.16	.00**
STEM confidence	STEM motivation	.10	.43	.00**
STEM challenge		.03	.55	.01*
STEM achievement		.01	.17	.00**
Stereotype threat		.00	-.03	.64
STEM challenge	Giving up in STEM	.03	-.80	.03*
STEM anxiety		.25	.50	.00**
STEM achievement		.19	-.40	.00**
Stereotype threat		.07	.41	.00**
STEM confidence	STEM achievement	.19	.46	.00**
STEM anxiety		.42	-.47	.00**
STEM motivation		.30	.52	.00**
STEM support		.01	.69	.09
Stereotype threat		.08	-.28	.00**
STEM confidence	GPA	.00	-.00	.86
STEM motivation		.02	-.02	.05*
STEM support		.02	-.06	.05*
STEM challenge		.00	-.02	.40
Stereotype threat		.02	-.02	.08

Note. A series of simple linear regressions were run between the independent and dependent variables. This analysis served as a confirmation step for the mediation analyses and also investigated the relationships between variables in addition to correlation.
* $p < .05$, ** $p < .01$

Mediation

Mediation analysis further explained the predictive relationships between the contextual variables and the outcome variables. The quantitative research questions did not mention mediation analysis; however, mediation was conducted as an exploratory analysis. The correlation and regression results guided the development of the mediation model. One model was developed for mediation analysis, shown in Figure 4. In the model, (1) stereotype threat is the predictor variable, (2) motivation, STEM confidence, STEM anxiety, and STEM support are the mediator variables, and (3) achievement, giving up in STEM, and GPA are the outcome variables. According to this model, a direct relationship suggests that the predictor variable has a predictive effect on STEM achievement, giving up in STEM and GPA. A meditational relationship suggests that the mediator variables mediate the significant relationship between the predictor and outcome (Preacher & Hayes, 2004). Additionally, 95% bootstrap confidence intervals assessed the significance of mediational effects and indirect effects (Preacher & Hayes, 2004).

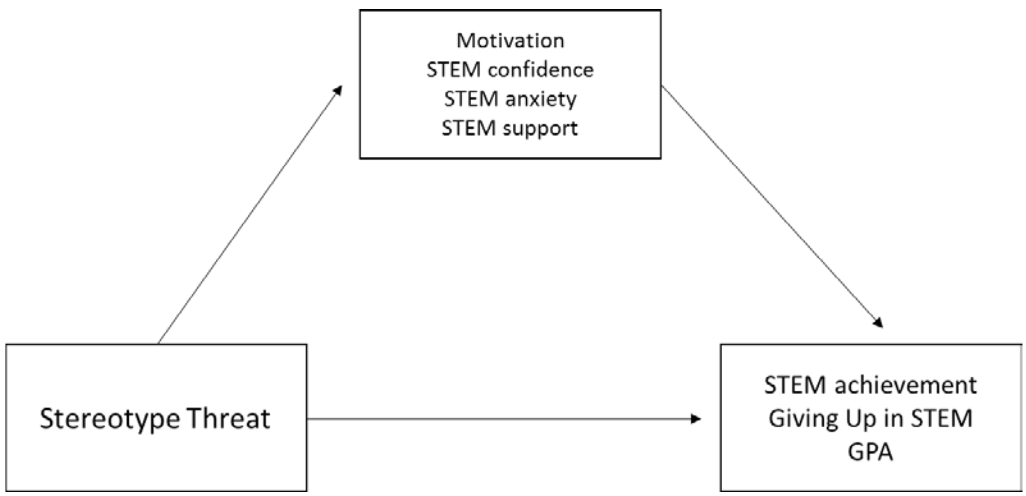
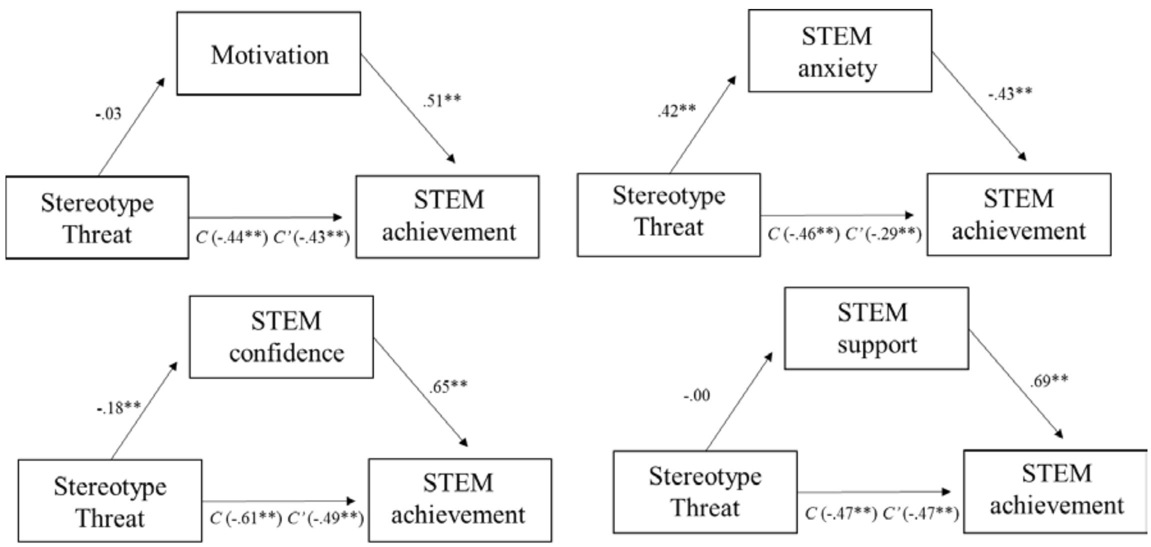
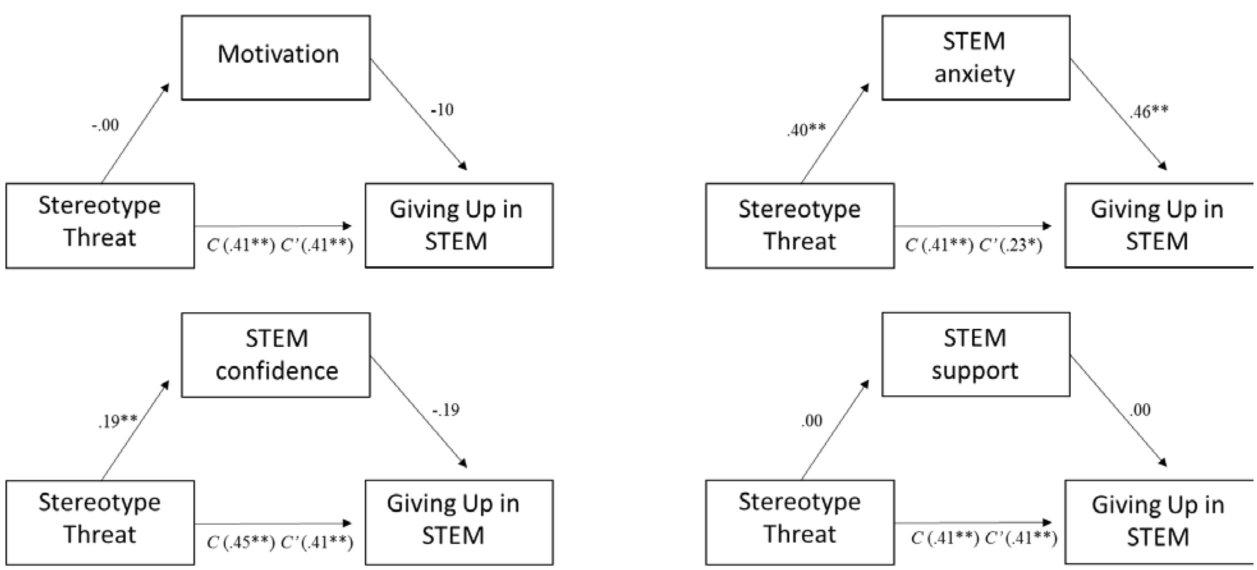


Figure 4. Mediation Model. A direct relationship suggests that the predictor (independent) variable has a predictive effect on the outcome (dependent) variable. A meditational relationship suggests that contextual factors mediate the significant relationship between the predictors and outcome.

Figure 5 shows all mediational relationship with stereotype threat as the predictor variable, motivation, STEM anxiety, STEM confidence, and STEM support as the mediator variables, and STEM achievement, give up in STEM, and GPA as the outcome variables. All models had significant relationships between the predictor and outcome variable (stereotype threat- achievement variables), but adding the mediator did not reduce the direct effect to "0" so the mediator variables did not play a role in the significant relationship. However, the mediator did reduce the direct effect in many cases and further bootstrap analysis revealed a few significant indirect effects.





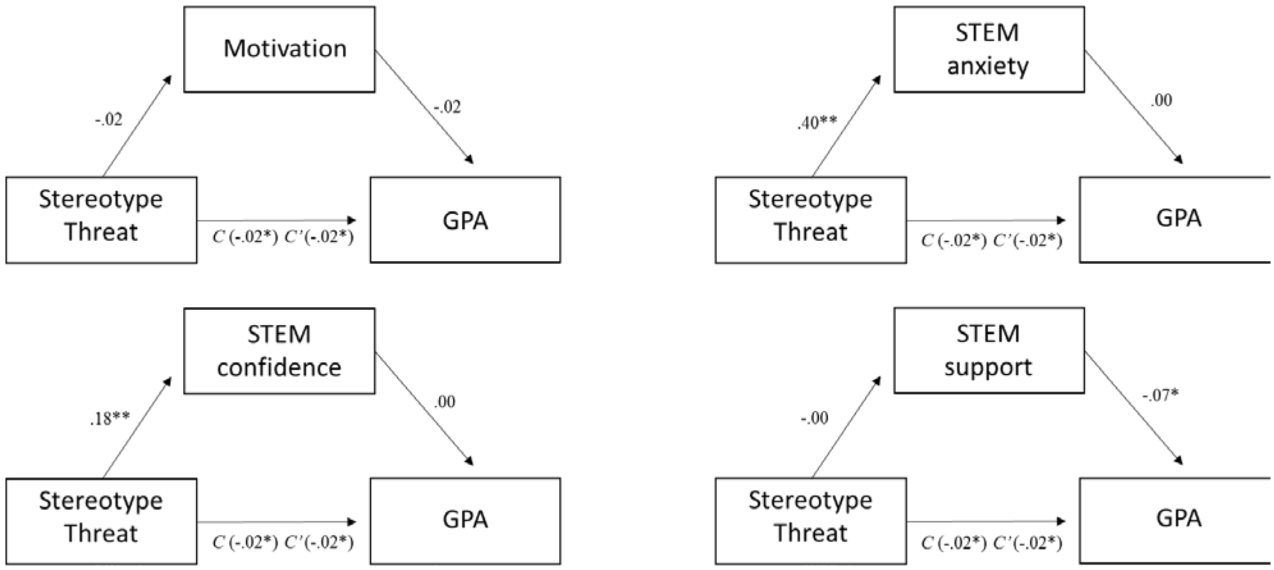


Figure 5. Standardized Beta (β) regression coefficients presented for each path. Path *a*, *b*, *c*, and *c'*.
* $p < .05$, ** $p < .01$

The PROCESS macro was used for bootstrap analysis (Hayes, 2013). The process output provides confidence intervals for the indirect effect, which indicates if there is a mediation effect. If zero does not fall between the upper and lower limits of the confidence intervals, there is an indirect effect of the mediator (Preacher & Hayes, 2004). Table 12 shows the confidence intervals and indirect effects of the mediators. Based on the bootstrap analysis results, STEM confidence indirectly effected STEM achievement, STEM anxiety indirectly effected STEM achievement and give up in STEM.

Table 11. *Bootstrap confidence intervals for indirect effects*

Stereotype Threat (x)	95% Bootstrap CI [a]		
	STEM achieve (y)	Give Up (y)	GPA (y)
STEM confidence (m)	.04, .24*	-.13,.63	-.00, .00
STEM anxiety (m)	-.33, -.07*	.06,.33*	-.00,.00
STEM motivation (m)	-.09, .07	-.03, .00	-.00, .00
STEM support (m)	-.06, .03	-.02-.02	-.00, .00

*Mediational effect present if range between lower and upper bound of confidence interval does not include zero.

Quantitative Questions

Contextual factors included STEM confidence, STEM anxiety, STEM challenge, STEM support and most importantly stereotype threat. Each of the quantitative questions are repeated below and are summarized in relation to the quantitative results.

Question 1. Are there male and female differences in the stereotype threat and related contextual factors? An independent samples *t*-test examined differences between men and women in the contextual factors. The *t*-tests did not reveal any significant difference between men and women with any of the contextual variables including the stereotype threat variable. There was a noticeable difference in STEM anxiety between men and women; however, this difference was not significant. Table 6 displays gender differences in relation to the contextual factors.

Question 2. Is stereotype threat related to performance and motivation in STEM? Table 9 presents several significant, positive correlations among the stereotype threat variable. Stereotype threat had significant positive correlations with STEM confidence, STEM anxiety, and giving up in STEM. Stereotype threat also had a significant negative correlation with STEM achievement. Overall, the correlational analysis identified that positive bivariate relationships existed among the stereotype threat variable with performance and motivation. The significant correlations were further examined through regression analysis to investigate the relationship between stereotype threat and performance and motivation. Table 10 shows several significant predictive relationships between stereotype threat and STEM confidence, STEM anxiety, giving up in STEM, and STEM achievement. The significant relationships guided an exploratory mediational analysis to further investigate the relationships between variables.

Question 3: What are the contextual factors that are related to performance, and motivation in STEM? The most interesting significant correlations between the contextual factors (not including stereotype threat) includes a strong positive correlation between giving up in STEM with STEM anxiety, and a significant negative correlation between giving up in STEM with STEM achievement. These results suggest that the contextual factors are related to performance and motivation in STEM. The significant correlations were further examined through regression analysis to investigate the relationship between the contextual factors and performance and motivation. Table 10 shows several significant predictive relationships between the contextual factors and STEM motivation, giving up in STEM, and STEM achievement. The significant relationships guided an exploratory mediational analysis to further investigate the relationship between variables. Mediation analyses did not reveal any significant direct effects, but there were significant indirect effects between STEM confidence/STEM achievement, and STEM anxiety/STEM achievement and give up in STEM. Most importantly, the correlation, regression, and mediation analyses suggest that STEM confidence and anxiety play a role in STEM achievement.

Chapter IV Summary

This chapter reported the qualitative results, the integration results, and the quantitative results of this mixed methods study. The qualitative phase was concerned with whether stereotype threat would be a mentioned as a factor that influenced performance and entrance into STEM courses, majors and careers. Another goal of the qualitative phase was to investigate any other contextual factors that were mentioned as having an effect on STEM performance. Participants did not specifically state that stereotype threat was a cause of their failure or avoidance of STEM, however, there was mention of being aware of and exposed to stereotype threat in STEM. The qualitative interviews also made evident a number of contextual factors that influence STEM achievement, avoidance and failure. The goal of the first integration point was to take the different themes that emerged from the qualitative study and create a survey that could be used for the quantitative phase of the study. One of the major goals of the quantitative phase was to make sure that the survey that was created was reliable and valid, which it was. In addition, the quantitative phase investigated gender differences among the dependent variables, correlations among the dependent variables, and predictive relationships. There were not any significant gender differences, but there were many interesting correlations and regressions among the contextual variables, specifically the stereotype threat variable. The final integration point will be discussed in Chapter V and will bring all parts of the study together for a final interpretation.

In addition, the next chapter further interprets the results, and provides insight to what the results mean in the light of previous published literature and implications for practice.

CHAPTER V

DISCUSSION

This dissertation outlined a mixed methods study designed to qualitatively explore stereotype threat and contextual factors related to high achieving women in STEM fields, as well as women who have failed and/or avoided STEM fields. The quantitative phase of the study used the themes from the qualitative phase to create a survey to measure stereotype threat and other contextual variables related to STEM performance and motivation. The goal of this mixed methods research was to advance qualitative research on stereotype threat and develop a scale for the measurement of stereotype threat.

This chapter opens with a summary of previous chapters, continues with an interpretation of the findings, relating them to existing literature, and provides implications based on the conclusions. Recommendations for future studies are identified along with limitations realized in the current study. The dissertation closes with the author's final thoughts on the influence of stereotype threat on STEM performance and motivation.

Dissertation Summary

Chapter I highlighted gender-based stereotype threat, which has been found to influence female performance and perseverance in STEM fields. Research has shown that gender stereotype threat effects become evident after the grade school years and continue to influence female performance and interest in STEM fields throughout middle school, high school and in college (Keller, 2007; Shoffner et al., 2015). Chapter I also mentioned the need for more research on gender stereotype threat that was not experimental in nature. The author suggested the development of more survey research and the need for more qualitative research to explore gender based stereotype threat. In addition, Chapter I identified the research questions, significance, limitations and definitions of the dissertation.

Chapter II provided a detailed literature review of the major themes associated with gender stereotype threat and gender stereotype threat as it relates to STEM. A brief review of qualitative stereotype threat research was also reviewed in Chapter II, although there is very little qualitative research associated with stereotype threat and gender performance differences. The review of the literature presented in Chapter II again emphasizes the importance of future qualitative research on stereotype threat and gender differences in STEM fields.

Chapter III described a pilot study that was conducted in the spring of 2014, which aimed at examining Picho and Brown's (2011) SIAS scale in a research setting and interview women to explore individual factors related to failure and avoidance in math. Chapter III also described the proposed mixed methods study goals. Phase one was a qualitative study aimed at exploring stereotype threat and other contextual factors related to STEM success and failure/avoidance in STEM. Phase two was based on the results from study one and took the themes from study one to construct a survey measuring stereotype threat and related contextual factors.

Chapter IV reported the qualitative results, the integration results, and the quantitative results of the mixed methods study. The qualitative phase explored whether stereotype threat would be mentioned as a factor that influenced performance and entrance into STEM courses, majors and careers. Another goal of the qualitative phase was to investigate any other contextual factors that were mentioned as having an effect on STEM performance. The goal of the first integration point was to take the different themes that emerged from the qualitative phase and create a survey that could be used for the quantitative phase of the study. In addition, the quantitative study investigated gender differences among the dependent variables, correlations among the dependent variables, and predictive relationships. There were not any significant gender differences, but there were many interesting correlations and regressions among the contextual variables, specifically the stereotype threat variable. There were also interesting indirect effects between contextual factors and STEM achievement.

This chapter provides an interpretation of the results presented in Chapter IV, and ties those results to the available literature. It also includes a discussion of the implications of the study, identifies limitations of the study, and offers recommendations for future research. The chapter ends with final remarks by the author based on the results of the mixed methods study.

Interpretation of Results

The interpretation of results are presented in a way that follows the progression of analyses discussed in Chapter IV. It begins with an overview of the qualitative interpretation, followed by a discussion of the first integration point. Next, the results from the quantitative portion of the study are discussed, and finally the second integration point.

Qualitative Phase

Question 1: Is stereotype threat mentioned as a factor that influences performance and motivation to enter into a STEM major and career? Is stereotype threat reported as impacting performance and motivation in STEM majors and careers? Stereotype threat was not specifically mentioned as a factor that influenced performance and motivation in STEM majors and careers. I did not expect that participants would explicitly mention stereotype threat as a cause of STEM failure/avoidance but I thought that participants would mention factors that suggest stereotype threat. For example, I expected participants to mention traditional male and female roles in the family influencing STEM interest. Some participants did mention such factors; however, many could not explain why they disliked STEM or did poorly in STEM. This result with consistent with the pilot study.

Many women recounted events in their life where they were either explicitly told that men were better at STEM than women or had the perception that men were better at STEM than women because of things that they were exposed to throughout their lives. Because of the lack of qualitative research, these are new findings. The qualitative research that has explored stereotype threat has mostly interviewed one or a few successful women in STEM and has found that support is a major factor in STEM success (Charleston et al., 2014; Milnor & Hoy, 2003). This is consistent with the current study, as support was a major theme found to influence STEM success and failure. In this study, support was considered a contextual variable and will be reviewed in detail in relation to the contextual factor question. The themes that mostly encompassed stereotype threat were gender bias in STEM and achievement experiences.

One qualitative finding that is worth noting is many mentions of a performance drops around middle school. Although this was not a theme in the current study, it is consistent with past qualitative research. Fryer and Levitt (2010) found that women start to experience poor performance in the elementary school years. As mentioned above, many of the women interviewed for this study suggested that they experienced a performance drop in math after the elementary school years; however, they had a hard time coming up for a reason for this performance drop.

Question 2: What are the differences between women that are consciously aware of stereotype threat and report stereotype threat as affecting their performance and motivation, and women that do not report stereotype threat as a factor affecting their performance and motivation? As I mentioned in qualitative question 1, there were not any women that explicitly stated that stereotype threat played a role in their failure and STEM avoidance. Although, all women mentioned that they had at least heard that men were better in STEM subjects than women. The women that had a dislike or had failed in STEM were much more likely to comment on gender barriers to their success than the women that were successful. This is consistent with a qualitative study that found successful women in STEM fields had additional barriers to success (parenting, isolation) compared to men (Charleston et al., 2004). However, some of the women that were successful mentioned that the additional barriers actually motivated them to work harder in their respective fields. This is known as stereotype uplift, and is much more common among men in a stereotype threat situation (Green, 2000).

One of the most interesting components of the qualitative study was the results of the IAT test (Greenwald et al., 1998). All 15 women completed the IAT test after their interview and almost all women had at least a slight preference to associate male words with science and female words with liberal arts. This suggests that even those women that have succeeded in STEM still have an unconscious gender bias from the exposure of gender stereotypes throughout their life (Keller, 2007). A take away from the qualitative research put together with the results of the IAT is that the successful women have somehow learned to override the unconscious bias when they are engaged in STEM activities. A couple themes/contextual factors that seems to play a role in overcoming threat are motivation and support.

Integration Point 1

Question 1: What findings emerge from the qualitative interviews that can be used to develop a multi-item survey scale measuring stereotype threat? There was a specific stereotype threat theme that emerged from the interviews. The stereotype threat questions were formed from looking back to common codes and categories that developed during the qualitative analysis. Interestingly, the questions that I created from the codes and categories were very similar to the gender stigma consciousness questions in the Picho and Brown (2012). The major difference between my questions and the questions of the SIAS was that I made the gender bias questions much more subject specific and then summed the questions into a STEM scale. This was one conclusion we had in our pilot study, and it seemed to work well for the current study survey.

Questions 2: What contextual factors emerge from the qualitative interviews that can be used to develop a more specific and detailed multi-item survey scale measuring stereotype threat? One of the major themes that emerged from the qualitative phase was the influence of support from teachers, peers, and family members on STEM success. Many women mentioned that they were motivated to do well in STEM courses by a teacher that believed in them, because they had a good support group, and/or a lack of stereotypes at home and support at home. This is very important because support seems to play a large role in other contextual themes that emerged and is consistent with past qualitative research (Charleston et al., 2004; Milnor & Hoy, 2003). For example, some women mentioned that they were motivated to do well in their STEM courses because they did not want to disappoint their parents or because their parents instilled a love of science and math into their lives. Because my results are consistent with the little published qualitative research, I will review some of the research below in support of my findings.

Research has shown that when supportive teacher-student relationships are established early in a child's academic career, that relationships not only improve the quality of daily classroom interactions, but also reduce the risk of low achievement and avoidance (Hamre & Pianta 2005). Teacher support has been shown to be the strongest predictor of academic success and overall well-being (Hughes et al., 2008; Furrer & Skinner, 2003). The mention of emotional support in the literature supports other contextual factors that were found in this dissertation, specifically the theme of emotion and affect. The results indicate that support, teachers specifically, not only influence academic success but also the emotions children experience at school and in the classroom. Although teachers play a very important role in academic and STEM achievement in the classroom, parents are still very important outside of the classroom.

Estell and Perdue (2013) found that parent or caregiver support is very important for academic success but that academic success seems to be significantly associated with behavioral engagement at school. These researchers emphasize that engagement is a main mechanism through which children are motivated to learn. Other research points out the importance of parent or caregiver support as parental warmth, or emotional support (Bodovski & Youn, 2011). High parental warmth may help to promote academic success by reducing anxiety and increasing enjoyment in school. Conversely, parent-child relationships that are low in parental warmth are associated with poor academic achievement and behaviors (Bodovski & Youn, 2011). Many of the women that were interviewed in the current study mentioned emotional responses they had when their parents would get frustrated with their performance in STEM courses, thus influencing their motivation to excel in STEM courses and influencing the emotions they experienced while at school. The last support system that has been mentioned in the research and also mentioned in the current study is peer support.

Peer support is particularly associated with emotional responses in the school environment, which consists of children's feelings and perceptions about school and learning (Estell & Perdue, 2013; Furrer & Skinner, 2003). In addition, peer support also has a direct impact on academic achievement by influencing positive emotions about school, which then influences motivation and behavior at school (Cappella et al., 2013). Wentzel and Wigfield (1998) found that peer support contributed to the sense that the classroom was an emotionally safe space and that peer support encouraged children to take the risks necessary for learning (Duke et al., 2011; Smith et al., 2013). The women that were interviewed for this dissertation mentioned that they were more likely to succeed and be engaged when the peers were interested in the same topics as they were. Some women also mentioned that peers influenced their motivation and emotions in STEM courses because of a feeling of competition between friends. A couple women did mention that peers actually played a negative role in their STEM success because the peers actually reinforced a feeling of stupidity in STEM courses, or because the female would copy the friend's homework instead of trying to do the work herself.

I think the most important aspect of these findings goes back to some of the qualitative research that was reviewed in Chapter II. Mentorship is one of the biggest influences on STEM success and also can be used as an intervention to mediate the effects of all stereotypes, not specific to women in STEM (Gunderson et al., 2011). This gives more evidence to the importance of qualitative research in relation to student success. Mentorship could also be a factor that may be able to be researched quantitavely with a survey because it is more conscious than the influence of stereotypes (Young et al., 2013).

Quantitative Phase

Question 1: Are there male and female differences in the stereotype threat and related contextual factors? Is stereotype threat related to performance and motivation in STEM? A *t*-test did not reveal any significant difference between men and women in the stereotype threat variable or any of the summed contextual variables. There are many factors that might contribute to this result, but this result is consistent with the pilot study. The pilot study mentioned in Chapter

III did not find any significant stereotype threat sex differences using the Picho and Brown (2012) SIAS scale. As mentioned previously this scale has not been used extensively in stereotype threat research. The goal of this study was to create a survey that made questions from the SIAS scale more specific to STEM subjects and then use a summed scale to incorporate the different STEM subjects. The Picho and Brown (2012) scale is very general, and the principal investigator thought this may be one reason there were not male and female differences. Making the questions of the current survey more specific to STEM did not seem to have an effect on gender differences in stereotype threat. However, there was a close to significant gender difference in STEM anxiety (p=.09). Although there were no significant gender differences, this may be one of the most important results of this dissertation.

The principal investigator believes that stereotype threat has an influence on academic achievement; however, because of the unconscious nature of stereotype threat one would be unable to measure stereotype threat on a survey. This finding put together with the findings of the pilot study give evidence to the fact that the research on stereotype threat should move toward being qualitative in nature. The problem with experimental research is that it puts the participant in a threat condition to measure stereotype threat, but experimental research does not investigate what can be done to lessen the effects of stereotype threat. In addition, experimental research does not investigate the mechanisms behind stereotype threat, and how stereotype threat develops over time. Qualitative research would better investigate the development of stereotype threat, stereotype threat interventions and solutions.

It is worth noting that one-way ANOVAS were administered on the independent variables with multiple levels (GPA) and contextual dependent variables. There were no meaningful significant results for the stereotype threat variable or any of the other contextual variables. The quantitative scale, and even the stereotype threat variable, did provide some interesting correlations and regressions, which are discussed below.

Question 2: What are the contextual factors that are related to (1) performance, and (2) motivation to enter and succeed into STEM majors and careers? Several significant correlations were found between the stereotype threat variable and the contextual factors. There were some surprising correlational results with the stereotype threat variable. Stereotype threat was positively correlated (.25) with STEM confidence, STEM anxiety (.26), giving up in STEM (.27), and negatively correlated with STEM achievement (-.36). The significant correlations suggest that stereotype threat influences confidence and anxiety further influencing STEM performance. These results were surprising because the pilot study with the SIAS scale did not produce any significant correlations between the stereotype threat variable and other variables. The SIAS has not been used outside of the pilot study, and is the only survey that specifically addresses stereotype threat. Because of this, there is very little research to compare with the dissertation survey results. The dissertation correlations are new results and may give evidence to importance of making the stereotype threat variable more specific to STEM subjects.

There were also many positive and negative correlations between the contextual factors. Some of the most interesting correlations include the following: STEM achievement was positively correlation with having a supportive teacher (.40), STEM motivation was positively correlated with having a supportive teacher (.36), and giving up in STEM was positively correlated with STEM anxiety (.50). These results are consistent with the support themes in the qualitative phase of the study and are considered new because of the lack of comparable survey research.

Correlations were also used to investigate relationships between the independent variables (sex, age, GPA, ethnicity) and the contextual factors, however, there were no significantly large correlations. There some small positive correlations between gender and the following variables: STEM anxiety, ethnicity and STEM motivation.

Integration Point 2

The most interesting findings related to stereotype threat involved the comparison of qualitative and quantitative findings. One goal of this mixed methods study was to explore gender differences in performance (due to stereotype threat) both quantitatively and qualitatively. The women interviewed for the qualitative phase of the study reported male and female performance differences in math but could not explain why there was a difference. In the quantitative phase, neither women nor men reported that they were susceptible to stereotype threat. This may suggest that women do not need to be conscious of stereotype threat in order for it to affect performance, or that women are denying stereotype threat as the reason for their poor performance in math. The last finding specific to gender differences and stereotype threat is a difference in performance due to emotion. Many of the unsuccessful women in the qualitative phase of the study reported negative STEM emotions, which influenced the women' decision to give up or avoid STEM. The quantitative phase of the study had an almost significant gender difference in STEM anxiety, which suggests that negative emotions play a role in poor performance. In addition, the mediation results suggested that STEM anxiety indirectly mediates the relationship between stereotype threat and STEM performance. These findings are consistent with research suggesting that negative math class emotions can contribute to poor performance (Pekrun et al., 2002).

A second goal of the mixed methods study was to compare the contextual factor results for both the quantitative phase and the qualitative phase. The quantitative and qualitative results supported prior research on the contextual factors related to stereotype threat. There was a significant difference in math identification in the quantitative phase and the women interviewed in the qualitative phase reported that they were not interested in math and avoided taking math in high school and college. This supports past research on dis-identification and early female avoidance of math subject (Fryer & Levitt, 2010; Wai et al., 2010). The other contextual factor that was consistently mentioned in the qualitative phase of the study was support. The women interviewed mentioned that support influenced their emotions, confidence, and success in STEM. Correlation results in the quantitative phase supported this finding with many significant positive correlations between the support variables, stereotype threat and STEM confidence. Taken together these results reiterate the importance of support, and mentorship to overcome stereotype threat (Gunderson et al., 2012; Lockwood, 2006; Young et al., 2013).

Implications for Gender Stereotype Threat

Although the basic mechanisms have been identified in experimental stereotype threat research (Steele & Aronson, 1995), the experimental research has reached a saturation point. However, quantitative research could investigate stereotype threat interventions and use conditional reasoning measures to investigate levels of threat Past research has made mention of a few possible interventions (Aronson et al., 2002; Johns et al., 2005), which could be explored more extensively with qualitative research, and mixed methods research.

In addition, some researchers criticize many of the early stereotype threat experimental findings suggesting that this research may be flawed (Stoet & Geary, 2012). One of the most important findings from past research is that something seems to happen to women in late elementary school that influences their interest in STEM topics (Schoffner et al, 2015; Spencer et al., 1999). Qualitative research would be the next obvious step to guide stereotype threat research in a younger population. Many of the females in the current study reported being influence by their parents, peers and teachers at a very early age. It would be interested to ask a younger population of girls their perceptions of parental and peer influence in their STEM success.

A clear direction for intervention research and gender stereotype threat research is the role that support plays in STEM interest and involvement. The successful females that were interviewed in the qualitative phase of the study made many mentions of their parents being involved in STEM careers, which increased their own interest. Again, this could be studied through qualitative research at a young age. It is also important for support systems to be aware of their own biases and stereotype threat so that they can be more conscious of how they approach situations and decisions. The IAT is an obvious solution to this, as kids and adults can be given the test to show that they are not immune to unconscious biases (Greenwald et al., 1998).

If gender stereotype threat can be prevented or overcome at an early age, there would not be an emphasis on getting girls involved in STEM. This would also increase the numbers of women choosing STEM careers, which would then impact stereotype development of the younger generation

Limitations

This study made the assumption that interviewees were accurately reporting their current and past experiences in STEM fields. Research has shown that memories are not highly accurate, which may cause some individuals to report false information (Loftus, 2002). Interviewees may also be tempted to answer in pleasing manner or in a way that they think the interviewer would like them to answer. Many of the interviewees were individuals that I personally knew and have known for a long period of time, I hope that this may have enhanced the honesty of the participant. In addition, three of the interviewees were black females. This presents a higher level of threat because the participant belongs to two stereotyped groups (female/ African American). This threat may have been enhanced due to the fact the African American women were being interviewed by a white female.

Although this study was significant because it is one of the only mixed methods studies investigating STEM success and failure qualitatively, this also presented some challenges. The theoretical framework for the current study was based on experimental research, and there was little research to guide the qualitative methods of the current study. It was also hard to tie the qualitative results to current research because of the lack of qualitative research. In addition, due to the exploratory nature of the study, it was unknown which contextual factors would be reported in the qualitative portion of the study and almost impossible to come up with hypotheses and research questions.

Another challenge and limitation of the study was recruitment of participants. Based on the low number of women in STEM majors and careers, it was hard to find successful women in STEM majors and careers that had time and were willing to participate in the interview. Surprisingly, it was even harder to find women that were unsuccessful or avoided STEM and women that felt neutral about STEM. This may be because women did not want to report having low performance or motivation in STEM subjects. The participants in the quantitative portion of the study were undergraduate students with a limited age range, making generalizability a limitation of the quantitative portion of the study. In addition, some participants had trouble interpreting the questions on the quantitative survey. Specifically, the stereotype threat questions confused some participants.

One last limitation involves the IAT (Greenwald et al., 1998). Recent research has suggested that the IAT may not be an accurate way to test implicit bias. Some researchers have found that if one primes participants before completing the IAT their biases can change. In this study, the participants completed the IAT immediately after answering questions related to stereotype threat. This may have impacted the results of the IAT test, because participants in this study were unintentionally primed by the interview questions before completing the IAT (Azar, 2008).

Future Research

These results suggest that stereotype threat and related contextual variables may be more complicated than originally thought. If stereotype threat is not conscious or if women are denying that they are falling victim to the threat, more research is needed to pin point what contextual factors should be targeted. It may be that there are numerous environmental factors that women are exposed to throughout their lives that implicitly influence their interest, attitudes and performance in math. The current study did a good job of indicating that women have been exposed to stereotype threat over time, and that support plays a key role STEM success and failure. If stereotype threat can not be measured by a survey because it is unconscious, qualitative research will be the only way to explore possible interventions. The next step in gender stereotype threat research is to qualitatively explore possible interventions and to use the interventions to lessen the effects of stereotype threat. The interventions could potentially prevent the contextual factors from influencing stereotype threat and resulting performance deficits. Although the experimental research that has been done on stereotype threat is interesting, it does not give guidance on next steps for stereotype threat research.

Finally, each of the six themes discovered within the study should be examined individually explored using qualitative research. This would give more breadth to the research on contextual factors related to STEM success and failure but also provide support for the results in this study. The contextual factors seemed to be reported more explicitly than stereotype threat. If more qualitative research is done on each of the themes, this could lead to quantitative scales that could be given to identify women most at risk for failure in STEM.

Final Remarks by the Author

The findings of this study are some of the first that incorporate qualitative and quantitative research. I have always been interested in stereotype threat research because of my own successes and failures in science and math. Although I enjoyed math and science in elementary school, I believed that I could not be successful in STEM subjects starting in middle school. There was not a good reason for this thinking, but I do remember some factors that may have played a role. My peer group in middle school changed, my Mom never helped me with my homework, I was more focused on sports and boys than school, and I usually copied my friends' math and science work because I was not motivated to spend the time on STEM subjects. One specific instance I clearly remember was having a terrible teacher in high school geometry that happened to be female. I struggled in the class, and dreaded going to the class every day. I copied my best friend's work and got by with a "C". I never wanted to take another math class after that and I avoided math until college. In college, I took the minimum math necessary for my major.

This all changed when my college biopsychology teacher encouraged me to work in his rat lab. This male became my mentor and instilled the love of science in me very late in my college career. I wish I would have had someone like my mentor earlier in life. Years later, I was offered a large amount of money to teach psychology statistics as an adjunct because nobody else in the psychology department would teach the class. I needed the money so I agreed even though I had almost failed my undergraduate psychology statistics class. I loved teaching the course, mostly because I had to learn the material in order to teach it. I loved seeing my students succeed and actually see the application of statistics to life.

It is because of these personal reasons that this research is so near and dear to my heart. I have seen my own biases develop over time, but I know that anyone can overcome these biases and excel at anything they put their mind to.

APPENDICES

APPENDIX A

INFORMED CONSENT

TITLE:	*College Students' Attributions for Success and Failure in Math: A Mixed Methods Study on Stereotype Threat.*
PROJECT DIRECTOR:	*Lindsey Leker*
PHONE #	*701-866-9477*
DEPARTMENT:	*Educational Foundations and Research*

A person who is to participate in the research must give his or her informed consent to such participation. This consent must be based on an understanding of the nature and risks of the research. This document provides information that is important for this understanding. Research projects include only subjects who choose to take part. Please take your time in making your decision as to whether to participate. If you have questions at any time, please ask.

You are invited to be in a research study with the purpose of exploring your perceptions of your own success and failure in math. The researcher conducting this study is Lindsey Leker, a PhD graduate student in the educational foundations of research program at the University of North Dakota.

Approximately 12 people will take part in the interview part of the study. Your participation will last approximately 30-45 minutes. The principal investigator will ask you a series of questions about your past experiences with math success and failure. The interview will be informal and conversational in nature and will focus on your perceptions of what has contributed to your success and failure in math. You can decide how much detail you would like to provide for each question. The interview will be audiotaped.

Although there is minimal risk in this study, some participants may feel somewhat uncomfortable or embarrassed discussing their failures in math and any emotions they have related to math. Should you become upset at any point in the study, you may stop at any time or choose not to answer any questions.

You will not be paid for being in this study, nor will you incur any costs for being in this research study. Your name will be entered into a drawing for a $25 gift certificate to a local eating establishment for participating in the study. If you choose not to participate, there will not be any penalty.

A summary of the results can be made available to you if you request them below. By participating in this study you may benefit personally in terms of reflecting on the factors that affect your success and failure in math. Ultimately, we hope that the knowledge gained through your participation will assist us in understanding how students perceive their success and failure in math and how this may affect their behavior in math class and preference for the subject of math.

The University of North Dakota and the research team are receiving no payments from other agencies, organizations, or companies to conduct this research study. The records of this study will be kept private to the extent permitted by law. In any report about this study that might be published, you will not be identified. Your study record may be reviewed by Government agencies, the UND Research Development and Compliance office, and the University of North Dakota Institutional Review Board. Any information that is obtained in this study will remain confidential and will be disclosed only with your permission or as required by law. Your name will not be used in data analysis or any final reports. Only the researcher will have access to the data. After the data is analyzed, the remaining data and audio files will be kept by the principle investigator for at least 3 years, after which time it will be destroyed. All data files will be password protected and/or kept in a locked file cabinet.

Your participation is voluntary. You may choose not to participate or you may discontinue your participation at any time without penalty or loss of benefits to which you are otherwise entitled.

You may ask any questions that you have now. If you have any other questions, concerns, or complaints about the research after the interview please contact the principle investigator Lindsey Leker at (701) 866-9477 or Dr. Robert Stupnisky at (701)777-0744. If you have questions regarding your rights as a research subject, you may contact The University of North Dakota Institutional Review Board at **(701) 777-4279**.

- You may also call this number about any problems, complaints, or concerns you have about this research study.
- You may also call this number if you cannot reach research staff, or you wish to talk with someone who is independent of the research team.
- General information about being a research subject can be found by clicking “Information for Research Participants” on the web site: http://und.edu/research/resources/human-subjects/research-participants.cfm

If you would like the principal investigator to email you the results of the study, please provide your email address: ________________________.

Your signature indicates that this research study has been explained to you, that your questions have been answered, and that you agree to take part in this study. You will receive a copy of this form.

Subjects Name: ____

Signature of Subject Date

I have discussed the above points with the subject or, where appropriate, with the subject's legally authorized representative.

Signature of Person Who Obtained Consent Date

Appendix B

Possible Qualitative Questions for Study One

Questions Related to Success and Failure
What does it mean to be successful in STEM major/career?
What factors led to your success in STEM fields?
Did you have any experiences in college that made you feel like you wanted to quit the major/drop out?
Can you tell me about a time in which you failed in a STEM related course?
What goes through your mind when you succeed in STEM?
Are there any instances in which you have given up in STEM? Why did this occur?
Questions Related to Family
Growing up what stereotypes do you think you were exposed to at home?
How did you parents and family influence your choice of major in college and career aspirations?
Questions Related to School
Growing up what stereotypes do you think you were exposed to in school?
Did your grade school, middle school, and high school teachers treat men and women differently in STEM courses? How?
Think about a specific math or science class that you did not like. Tell me about the class. What were your emotions during that class? What about a class that you liked?
What emotions do you experience before and after STEM classes? Have you always felt this way?

APPENDIX C

INFORMED CONSENT

TITLE:	*Contextual Factors Related to Student Success in STEM Education: A Mixed Methods Study on Stereotype Threat*
PROJECT DIRECTOR:	*Lindsey Leker*
PHONE #	*701-866-9477*
DEPARTMENT:	*Educational Foundations and Research*

A person who is to participate in the research must give his or her informed consent to such participation. This consent must be based on an understanding of the nature and risks of the research. This document provides information that is important for this understanding. Research projects include only subjects who choose to take part. Please take your time in making your decision as to whether to participate. If you have questions at any time, please ask.

As a student at Mayville State University or Minnesota State University Moorhead, you are invited to be in a research study with the purpose of exploring your perceptions of your own success and failure in STEM. The researcher conducting this study is Lindsey Leker, a PhD graduate student in the educational foundations of research program at the University of North Dakota.

Approximately 300 people will take part in the online questionnaire part of the study at area colleges and universities. You will be asked a series of demographic questions, including age, sex, and ethnicity, followed by a series of survey questions. All information, including demographic information will be kept confidential. Your participation will last approximately 20 minutes.

Although there is minimal risk in this study, some participants may feel somewhat uncomfortable or embarrassed answering questions about their failures in STEM and emotions they have related to STEM. Should you become upset at any point in the study, you may stop at any time or choose not to answer any questions.

You will not be paid for being in this study, nor will you incur any costs for being in this research study. Your professor will give you three points of extra credit for participating in the study. If you choose not to participate, you may discuss other extra credit options with your professor.

A summary of the results can be made available to you if you request them below. By participating in this study you may benefit personally in terms of reflecting on the factors that affect your success and failure in STEM. Ultimately, we hope that the knowledge gained through your participation will assist us in understanding how students perceive their success and failure in STEM and how this may affect their behavior in STEM class, and majors and preference for STEM careers.

The University of North Dakota, Mayville State University, and Minnesota State University Moorhead and the research team are receiving no payments from other agencies, organizations, or companies to conduct this research study. The records of this study will be kept private to the extent permitted by law. In any report about this study that might be published, you will not be identified. Your study record may be reviewed by Government agencies, the UND Research Development and Compliance office, and the University of North Dakota Institutional Review Board. Any information that is obtained in this study and that can be identified with you will remain confidential and will be disclosed only with your permission or as required by law. Your name will not be used in data analysis or any final reports. Only the researchers will have access to the data. After the data is analyzed, the principal investigator will keep the data for at least 3 years, after which time it will be destroyed. All data will be password protected and/or kept in a locked file cabinet.

Your participation is voluntary. You may choose not to participate or you may discontinue your participation at any time without penalty or loss of benefits to which you are otherwise entitled. Your decision whether or not to participate will not affect your current or future relations with Minnesota State University Moorhead or your professors at Minnesota State University Moorhead.

If you have any other questions, concerns, or complaints about the research please contact the principle investigator Lindsey Leker at (701) 866-9477 or Dr. Robert Stupnisky at (701)777-0744. If you have questions regarding your rights as a research subject, you may contact The University of North Dakota Institutional Review Board at (701) 777-4279.

- You may also call this number about any problems, complaints, or concerns you have about this research study.
- You may also call this number if you cannot reach research staff, or you wish to talk with someone who is independent of the research team.
- General information about being a research subject can be found by clicking "Information for Research Participants" on the web site: http://und.edu/research/resources/human-subjects/research-participants.cfm

If you would like the principal investigator to email you the results of the study, please provide

your email address: ________________________

Your signature indicates that this research study has been explained to you, that your questions have been answered, and that you agree to take part in this study. You will receive a copy of this form.

Subjects Name: ____

________________________________ ____________________

Signature of Subject Date

Appendix D

Stereotype Threat and Contextual Factors Codebook

This survey codebook contains information on the stereotype threat and STEM achievement variables used in the current study. Participants were asked to rate each item based on their behaviors in the class in which the survey was provided. All items were measured on a 6 point scale where 1 (Strongly Disagree) to 6 (Strongly Agree).

When I reflect on my experiences in science and math courses, I feel:

Name	Item
STEMachieve_1	Doubt about my math abilities (REVERSE)
STEMachieve_2	Doubt about my science abilities (REVERSE)
STEMachieve_3	I am unable to do well in science courses (REVERSE)
STEMachieve_4	I am unable to do well in math courses (REVERSE)
StereotypeThreat_1	That members of the opposite sex interpret my behavior in science courses based on my gender
StereotypeThreat_2	That members of the opposite sex interpret my behavior in math courses based on my gender
StereotypeThreat_3	That my gender affects how people treat me in science courses
StereotypeThreat_4	That my gender affects how people treat me in math courses
StereotypeThreat_5	My gender influences how math teachers interpret my behavior
StereotypeThreat_6	My gender influences how science teachers interpret my behavior
STEMconf_1	That my success in science courses influences how I feel about myself
STEMconf_2	That my success in math courses influences how I feel about myself
STEMconf_3	My self-confidence is strongly tied to my success in math courses
STEMconf_4	My self-confidence is strongly tied to my success in science courses
STEMachieve_5	I have always done well in math

STEMachieve_6	I have always done well in science
STEMachieve_7	I learn things quickly in math
STEMachieve_8	I learn things quickly in science
STEMachieve_9	I have strong math skills
STEMachieve_10	I have strong science skills
STEMachieve_11	I am good at math
STEMachieve_12	I am good at science
STEMachieve_13	I can easily master advanced math concepts
STEMachieve_14	I can easily master advanced science concepts

I am successful when:

Name	Item
SuccSTEMchal_1	I am challenged in my math courses
SuccSTEMchal_2	I am challenged in my science courses
SuccSTEMsup_1	I have adequate support from other students in my math courses
SuccSTEMsup_2	I have adequate support from other students in my science courses
SuccSTEMteach_1	I have a knowledgeable science teacher
SuccSTEMteach_2	I have a knowledgeable math teacher
SuccSTEMteach_2	I have a supportive science teacher
SuccSTEMteach_3	I have a knowledgeable math teacher
SuccSTEMteach_4	I have a supportive math teacher
SuccSTEMsup_5	My parents encourage me to do well in my math courses

SuccSTE Msup_6	My parents encourage me to do well in my science courses

I am motivated to do well in my science courses:

Name	Item
Smot_1	To get above a “C” in the course
Smot_2	So that I am prepared for a high paying career
Smot_3	So I don’t disappoint my parents
Smot_4	Because I believe science will be important for my future

I am motivated to do well in my math courses:

Name	Item
Mmot_1	To get above a “C” in the course
Mmot_2	So that I am prepared for a high paying career
Mmot_3	So I don’t disappoint my parents
Mmot_4	Because I believe math will be important for my future

I feel anxious in math class when:

Name	Item
AnxMath_1	I have to answer a question in class
AnxMath_2	I have to take a math exam
AnxMath_3	I have to ask the math teacher a question
AnxMath_4	When I have to work in groups on class assignments
AnxMath_5	When I have to work with members of the opposite sex on class assignments

I feel anxious in science class when:

Name	Item

AnxSci_1	I have to answer a question in class
AnxSci_2	I have to take a science exam
AnxSci_3	I have to ask the science teacher a question
AnxSci_4	When I have to work in groups on class assignments
AnxSci_5	When I have to work with members of the opposite sex on class assignments

I feel like giving up in math class when:

Name	Item
MGiveUp_1	My teacher doesn't like me
MGiveUp_2	I don't have any friends in the class
MGiveUp_3	My parents don't care about my math success
MGiveUp_4	I am not interested in a math career
MGiveUp_5	I have difficulty grasping a math concept

I feel like giving up in science class when:

Name	Item
SGiveUp_1	My teacher doesn't like me
SGiveUp_2	I don't have any friends in the class
SGiveUp_3	My parents don't care about my science success
SGiveUp_4	I am not interested in a science career
SGiveUp_5	I have difficulty grasping a science concept

Appendix E

Demographics Codebook

This survey codebook contains information about the demographics variables used in the current study. Only students that were 18 or older were allowed to participate

Demographic Questions

Name	Item
Gender	**What is your gender?** (1) Male (2) Female (3) Other (4) Rather not say
Age	**What is your age in years?**
GPA	**What is your current grade point average (GPA)?** (1) 3.5 or above (2) 3.0 to 3.49 (3) 2.5 to 2.99 (4) 2.0 to 2.49 (5) Below 2.0
Major	**What is your college major?**
Ethnic	**To which racial or ethnic group(s) do you most identify?** (1) African-American (non-Hispanic) (2) Asian/ Pacific Islanders (3) Caucasian (non-Hispanic) (4) Latino or Hispanic (5) Native American (6) Other (7) Rather not say

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