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The Impact of the Impostor Phenomenon on the Math Self-Efficacy

Of Males and Females in STEM Majors

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The Impact of the Impostor Phenomenon on the Math Self-Efficacy Of Males and Females in STEM Majors

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Dedication

To Claire Moreaux Blondeau,

who taught me a love of learning.

And

To Dylan Jared Crow,

who shows me.

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The Impact of the Impostor Phenomenon on the Math Self-Efficacy

Of Males and Females in STEM Majors

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Abstract. In the undergraduate and working environments, some science, technology, engineering, and math (STEM) areas remain dominated by males. The purpose of this study was to understand the gendered experience of individuals in STEM majors by assessing students' math self-efficacy, impostorism (a feeling of intellectual phoniness), and future goals. Based on prior research, an overall conceptual model was proposed and analyzed. Several related precursors including gender role orientation, perceived parental influence, math identity, and theories of intelligence were included in the model. Three hundred six undergraduates (64.38% female) in the colleges of natural science, geosciences, and engineering responded to an online survey addressing these constructs. Based on prior research, hypotheses were created proposing that females would report higher impostorism, lower math self-efficacy, and more femininity than males. I expected that masculinity, perceived parental influence, an entity theory of intelligence, and high math identity would predict the impostor phenomenon. Moreover, I hypothesized that the relation of each of these predictors to impostorism would be moderated by sex. For the next two hypotheses, I proposed that the four sources of math self-efficacy would predict math self-efficacy, but this relation would be moderated by impostorism. Finally, I expected that impostorism would lead to reduced future expectations and aspirations, but that this association would be mediated by math self-efficacy. Results indicated partial support of the study hypotheses, and a revised model was created. Both sexes reported similar levels of impostorism, but females had lower math self-efficacy and greater femininity than males. Masculinity negatively predicted the impostor phenomenon, while math identity and an entity theory of intelligence positively related to the dependent variable. Sex moderated the effect of perceived parental influence such that males' impostorism was more affected by parental influence than females'. Emotional arousal was a strong contributor to math self-efficacy, but this relation was attenuated by impostorism. Coping with emotional arousal was positively associated with math self-efficacy; however, this association was significantly stronger for low impostors than high ones. Finally, impostors were less likely to expect to go to graduate school or work in a STEM-related field. Implications for schools and professors are discussed.

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Chapter 1: Introduction

Statement of the Problem

In both work and school environments, math is perceived as a male domain, one that does not fit with the social role so often ascribed to females (Crosnoe et al., 2008; Eccles et al., 1989; Lips, 2004). Within the US and abroad, this stereotype holds true: males dominate science, technology, engineering, and math (STEM) areas. Whereas females may leave high school with the intent to major in a STEM field, they more frequently pick non-STEM areas once they matriculate (Xie & Shauman, 2003). Approximately 33% of male and 14% of female undergraduates choose a STEM major in college (Chen, 2009). With the majority of STEM diplomas going to males, females lack the necessary credentials to work in most STEM jobs (Betz, 1992; O'Brien et al., 2000). The sex discrepancy is problematic as STEM professions typically garner greater salaries and prestige than the average US occupation (Hodge, Siegel, & Rossi, 1964; Nakao & Treas, 1994; U.S. Department of Labor, 2012). Moreover, STEM jobs continue to expand in the US, and more workers will be needed in the future to fill these positions (U.S. Department of Commerce, 2011). The current study attempts to understand some of the psychological variables associated with this sex discrepancy in order to enable more females to enter and persist in STEM areas.

Studies have used different terms to designate STEM. Research may refer to any of the individual subjects (e.g. math-based, science-related) or combine them into different groupings (e.g. science-engineering, science/math). Although the terms differ, the areas and meanings overlap greatly. Therefore, in the present study, I have included in my review any research that refers to these subjects individually or in combination.

However, for the current analysis, I considered participants enrolled in the academic colleges of engineering, geosciences, or natural sciences to be STEM majors.

Study Overview and Theoretical Framework

In spite of their aptitude, females, rather than males, often report lower self-beliefs about their abilities in math areas (Betz & Hackett, 1983; Pajares & Miller, 1994). These views may be the reason why females avoid STEM majors and jobs. Two relevant self-beliefs related to achievement are self-efficacy and the impostor phenomenon.

Bandura's (1986) Social Cognitive Theory explains learning as a product of environment, behavior, and personal factors all acting in tandem and influencing one another. The first factor consists of both the social and physical environment. The social environment affects learning via vicarious experiences, where the learner observes a model's behavior and the resulting consequences. If the learner perceives the consequences as being desirable and doable, then she will repeat the behavior. Additionally, individuals actively bring about their own learning through their cognitions, self-regulation, and self-beliefs.

One important self-belief posited by Social Cognitive Theory is self-efficacy, an individual's confidence in her ability to succeed on a given task or situation (Bandura, 1997). A student with high academic self-efficacy believes she has the ability to carry out the necessary behaviors to ensure a high grade, good presentation, or other positive outcome. Self-efficacy is correlated with choice, motivation, effort, and persistence in academic domains. As such, it is also highly related to achievement (Bandura, 1997).

Numerous studies (Cordero et al., 2010; Pajares, 1996) have found that females report lower math self-efficacy than males. This difference occurs even when both sexes have equal abilities. Since math self-efficacy relates to math achievement and choice of math major/career, this sex discrepancy is alarming (Betz & Hackett, 1981; 1983). Why are females less confident than males in their own ability to succeed in math? The sources of math self-efficacy may lend insight into this question.

Bandura (1986; 1997) identified four sources of self-efficacy beliefs. The strongest one is prior achievement, also known as mastery experiences; individuals who have been successful on similar tasks previously expect to succeed in the future. Next, students can develop self-efficacy through vicarious information. Here, they observe others and make referential judgments about their own chances for success. Vicarious experiences can be especially informative in novel situations. The third source of self-efficacy is verbal persuasion whereby teachers, parents, peers, and others encourage or discourage the student. Negative verbal feedback can be more influential than positive persuasion. Finally, emotional arousal affects the self-efficacy of individuals. Students experiencing anxiety, fear, or other emotions interpret their ability based on this physiology. These four sources act in tandem to increase or decrease the self-efficacy of the learner.

One group of people may be less affected by the positive influences of the sources of self-efficacy, individuals suffering from the impostor phenomenon (Clance & Imes, 1978). Research is mixed on whether or not females are more likely to experience the impostor phenomenon (Caselman, Self, & Self, 2006; Kumar & Jagacinski, 2006); however, in the male-dominated STEM areas, I expect that females will report greater levels of impostorism than males.

Impostors are outwardly successful individuals who discount their own abilities in their achievements (Clance & Imes, 1978; Clance & O'Toole, 1988). They believe they have earned successes due to luck, charm, or extreme effort. Since they feel like frauds who are hiding their own inabilities, they suffer from extreme anxiety and fear of being discovered. Repeated success and verbal encouragement do nothing to change the negative self-beliefs of impostors. However, any small setback or negative feedback results in a large decrease in their self-confidence (Thompson et al., 2000). Impostors overestimate the ability of others while underestimating their own, thereby miscalibrating the social comparison associated with vicarious learning (Clance & O'Toole, 1988). Research implies that impostors have a distorted, self-defeating view of the four sources of self-efficacy (Ives, 2011; Pajares, 2001; Want & Kleitman, 2006) as well as reduced goals for the future (Clance & O'Toole, 1988). This study will measure the relation among math self-efficacy and its sources, impostor phenomenon, perceived parental influence, sex, gender role orientation, and future aspirations/expectations.

Sex is a biological category of males or female, determined by genetics, genitalia, hormones, or other fixed characteristics. Gender, on the other hand, is a socially learned role that makes one a boy, man, masculine, or a girl, woman, feminine (Bussey & Bandura, 1999). Humans are agentic in their own gender role development which stems from experience and multiple social influences (Busey & Bandura, 1999). The level to which one adopts the attributes associated with a stereotypical man or woman has several names within the literature: gender role identity (Neuville & Croizet, 2007), sex role orientation (Bem, 1974), psychological gender (Brosnon, 1998), to name a few. For the purposes of this study, I use the term sex to describe the biological classification as male or female, and gender role orientation to describe the socially acquired categories of masculine or feminine. As an example, a male may report that he is an expressive and nurturing person, attributes normally descriptive of women. While his biological sex is male, his gender role orientation may be considered more feminine. Additionally, as a related gender variable, I consider the participants' views on the rights and roles of women in society, opinions termed traditional or egalitarian.

Purpose of the Study

The current study investigates the relation between the two self-beliefs, math self-efficacy and the impostor phenomenon, as well as sex, gender role orientation, and future expectations/aspirations. Students currently enrolled in a STEM major were invited to participate in the online survey. The purpose of the study was to better understand the motivational and personal self-beliefs that females experience in STEM environments that may limit their future goals. Mau's (2003) longitudinal research revealed that males were much more likely than females to choose and work in science and engineering careers. Recent studies, however, have shown that persistence in STEM majors does not differ by sex (Ohland et al., 2008; 2011). Engineering students with high math/science self-efficacy beliefs are more likely to persevere in their math and science classes (Lent et al., 2003). Through a greater understanding of math self-efficacy, the impostor phenomenon, sex, and gender role, I hope ultimately to contribute to the literature on retention and encourage more females to enroll in STEM majors in order to earn the necessary credentials to work in related occupations.

I proposed that females would have greater levels of impostorism and femininity, and lower levels of traditionality than males. Additionally, I theorized that males would report higher math self-efficacy. Masculinity, perceived parental influence, math identity, and theories of intelligence would significantly predict the impostor phenomenon according to my next hypothesis. For female participants, impostorism would depend on math identity and gender role orientation, whereas males would not display this pattern. I expected that prior achievement, vicarious information, verbal persuasion, and emotional arousal together would significantly predict math self-efficacy. Moreover, each of these sources' influence on math self-efficacy would depend on impostorism levels. Finally, I proposed that math self-efficacy would mediate the relation between impostor phenomenon and future aspirations and expectations. Whereas impostors would not expect or aspire to future success as highly as non-impostors do, this relation will be due to the impostors' reduced math self-efficacy. These hypotheses were consolidated in an overall model of students' STEM experiences (See Fig. 1, p. 34).

As a way to combat low achievement, some researchers have developed interventions to increase self-efficacy in participants (Luzzo et al., 1999). However, if impostors discount these interventions, then they will not be effective. This study attempts to determine if an association between self-efficacy and the impostor phenomenon exists in order to ultimately design better interventions to enable and encourage more females to pursue STEM occupations.

Chapter 2: Literature Review

In universities across the U.S., males greatly outnumber females in the majority of science, technology, engineering, and math (STEM) fields. In the 2008-2009 school year, females earned 17.84% of the bachelor's degrees in computer and information sciences, 16.50% of the degrees in engineering and engineering technology, and 44.49% of the degrees in mathematics (U.S. Department of Education, 2010). Since most STEM occupations require STEM-related degrees, many females leave college unqualified to work in these industries. Even with the necessary credentials, females, more than males, choose to work in non-STEM jobs or drop out of the employment field altogether (Xie & Shauman, 2003). In sum, in both academia and employment, males outnumber females in STEM areas. This situation disadvantages females in that STEM jobs garner greater salaries and status than most other U.S. occupations (Hodge, Siegel, & Rossi, 1964; Nakao & Treas, 1994; U.S. Department of Labor, 2012).

The sex discrepancy in STEM has been explained by several theories, including biological and sociocultural ones. Originally, researchers argued that females were innately inferior to males in quantitative reasoning (Benbow & Stanley, 1980). However, a wealth of studies have disproven this theory (Else-Quest et al., 2010; Lindberg et al., 2010) by showing that males and females have equal abilities in mathematics. If males were innately superior, then the sex gap in math would be pervasive across time and location. The rapid diminishment of the gap in the U.S. as well as the differential findings from cross-national data indicate that the sex differences are neither genetic nor inevitable (Bussey & Bandura, 1999; Lindberg et al., 2010).

Other researchers have argued that the mathematics gap is due to differing sociocultural experiences of males and females. Hackett and Betz (1981) proposed that males are exposed to more math-related activities as children. Young males are encouraged to explore the spatial environment while engaging in activities that develop their spatial skills (Bussey & Bandura, 1999; Levine et al., 1999). They spend more time playing with computer video games (Quaiser-Pohl et al., 2006) and geometric toys (e.g. Legos; Bornstein et al., 1999), two experiences which may develop visual-spatial and mathematic skills. In secondary school, males used to take more or harder STEM courses (Ernest, 1976; Hewitt & Goldman, 1975). However, this difference no longer exists. Both sexes take equal numbers and levels of STEM classes, and they earn similar grades as well (College Board, 2012; Hyde & Mertz, 2009; Lindberg et al., 2010; Wang, 2012). Moreover, differential course-taking in high school does not account for the pervasive sex gap in the physical sciences and engineering in college (Riegle-Crumb et al., 2012).Whereas males may still be exposed to more math-related activities, this contrast does not result in enrollment differences in higher level math classes in secondary school.

Aside from having dissimilar experiences in childhood, males and females receive different gendered academic socialization as well. Young females are taught not to expect or value success in math (Lindberg et al., 2008), and that any mathematical achievement will take a lot more effort for them than for males (Chen & Zimmerman, 2007). Children implicitly and explicitly learn from parents (Eccles et al., 1989; Frome & Eccles, 1998) and teachers (Betz & Fitzgerald, 1987; Li, 1999; Wang, 2012) that males are better than females in math. Mothers believe that daughters will have to work harder than sons to succeed in math (Frome & Eccles, 1998). Teachers support this stereotype and believe that males have higher mathematic abilities than females. Therefore, the instructors have more positive attitudes toward and higher expectations for their male students (Li, 1999). STEM classes may be filled with microaggressions that create a hostile environment for females (Seymour & Hewitt, 1997). Through this socialization, children learn that math is a male domain that requires more work for females.

These experiences and messages may cause males to have more favorable math attitudes than females (Gunderson et al., 2012). In elementary school, males listed greater math interest than females, although this gap decreases over time (Fredericks & Eccles, 2002). On a standardized assessment, high school males reported greater interest than females in learning math (Liu, 2009). This difference continues into college; Lent and colleagues (Lent et al., 1991) found that undergraduate males had higher interest in taking math classes, which also predicted science-based career choices. As adults, undergraduate males reported greater interest in STEM careers than females did (Cordero et al., 2010). The difference may be moderated by race. Riegle-Crumb and King (2010) found that White women reported significantly lower math-related affect than White men, but other races did not display this pattern.

Not only do males have greater interest in math, but they also tend to place higher importance on it than females do. Across nations, 15-year-old males reported valuing math slightly more ($d=.10$) than females did (Else-Quest et al., 2010). Other research found that adolescent females were less likely to enroll in advanced math classes than their male peers because the females did not think it was as important or useful (Parsons et al., 1984). However, the sex gap in mathematical interest may be disappearing. Fredricks and Eccles (2002) showed that male students began elementary school with greater interest than females; but, by the end of high school, the two sexes had similar mathematical interests (Wang, 2012).

A recent theory for the sex difference in STEM activities has involved choice. Wang and colleagues (Wang, Eccles, & Kenny, 2013) argue that females have high achievement in several areas, and thus have many options available to them. Females, more than males, may be constrained by their family roles, and thus elect to study or work in non-STEM fields due to the more flexible working conditions (Ceci & Williams, 2010). Ceci, Williams, and Barnett (2009) propose that STEM careers often have rigid structures with family-unfriendly work conditions. Females recognize these constraints and choose to work in other fields. Many reasons may contribute to females' choice to avoid STEM employment, including childhood experiences, gender socialization, or work-family conflict. Another possible cause for the different choice may be self-efficacy; males believe they have a greater chance of succeeding in STEM classes and careers than females do.

Self-Efficacy

Bandura (1986) first proposed the concept of self-efficacy as an important part of his Social Cognitive Theory. Self-efficacy is a judgment of one's own ability to complete the necessary behaviors to accomplish a given task. Individuals with high self-efficacy are confident they will succeed on the particular undertaking in the future. It differs from academic self-concept in that self-efficacy is much more context-specific (Pajares & Miller, 1995). Bandura (1986) theorized that self-efficacy, even more than ability, affects choice, effort, and perseverance. It is highly influential over behavior as it determines how one uses one's own skills and knowledge to accomplish a task.

Self-efficacy feeds back onto itself, with achievement affecting self-efficacy which then affects subsequent achievement (Schunk, 1987). For instance, a student who succeeds in her math class will experience an increase in her math self-efficacy and her positive expectations for future math tasks. Therefore, she will be more motivated in the math tasks and more likely to produce successful outcomes, thereby increasing her self-efficacy again. After a failure, the reverse situation will occur. If a student fails at a task, her self-efficacy decreases and she does not think she will be successful in future related endeavors. Therefore, she is not motivated to complete the task since she believes she will fail. Without motivation or effort, she fails, and her self-efficacy decreases even more. Thus, instructors and students must break the cycle by providing the pupil with smaller, easier tasks in order to build self-efficacy until she can complete the difficult activity (Craft & Hogan, 1985).

Researchers have often studied self-efficacy due to its high correlation with academic achievement and choice (Liu, 2009; Richardson, Abraham, & Bond, 2012). Individuals with high self-efficacy will have greater achievement than those with low self-efficacy, even when controlling for ability (Pajares, 1996). Moreover, students pick courses in domains where they think they will succeed. Betz and Hackett (1981; 1983) found that self-efficacy significantly correlated with choice of college major and career. Later research (Luzzo et al., 1999) replicated these findings within the science domain.

Students with high academic self-efficacy exhibit strong self-regulatory measures and are more effective and efficient learners (Richardson et al., 2012; Schunk & Pajares, 2005). They are more likely to adopt mastery goals (Usher & Pajares, 2009; Zeldin et al., 2008) and have more positive attitudes toward math (Akin & Kurbanoglu, 2011). Self-efficacy is highly correlated to interest (r = .59), as students who report high interest in an area are more likely to think they can be successful in it (Rottinghaus, Larson, & Borgen, 2003). Not surprisingly, these adaptive learning behaviors and interest also relate to achievement, as students with high self-efficacy also demonstrate greater motivation and academic successes (Schunk & Pajares, 2005).

Additionally, individuals with high self-efficacy are more likely to succeed because they display perseverance and resilience in the face of difficulty. During transition stages, self-efficacy buffers students from the negative outcomes often associated with change and adjustment. Bailey and Baines (2012) found that UK pupils with strong academic self-efficacy beliefs had a more positive adjustment to secondary school. Self-efficacy also enables individuals to persist in difficult situations (Sexton & Tuckman, 1991). For females working in STEM careers, strong self-efficacy helped them overcome the career obstacles they faced as non-traditional employees (Zeldin & Pajares, 2000). Lent and colleagues (2003) studied engineers and found that self-efficacy indirectly related to persistence through its association with goals and interest. Since self-efficacy predicts achievement and persistence, understanding its sources may lead to methods to promote academic successes.

Sources.

Prior achievement. According to Bandura (1986; 1997), four constructs contribute to self-efficacy: prior achievement (mastery experiences), vicarious information, verbal persuasion, and emotional arousal. Not surprisingly, how an individual perceives that she has done in the past highly influences how confident she is about related future activities. Thus, Bandura (1997; Bussey & Bandura, 1999) hypothesized that prior achievement would be the strongest source of self-efficacy. When a student completes a task, she interprets and evaluates her achievement. If she believes she has been successful, her self-efficacy in that domain increases and she is more likely to believe she can accomplish a similar task in the future. Several studies (e.g. Liu, 2009; Multon, Brown, & Lent, 1991) have shown the strong influence of prior achievement on self-efficacy in participants of a variety of ages, nationalities, and intelligences.

Researchers have studied the effects of prior achievement on self-efficacy in participants of all ages. Joet and colleagues (Joet, Usher, & Bressoux, 2011) found that in participants as young as third grade, mastery experiences were the strongest predictors of self-efficacy. For 11^{th} grade students, PSAT scores, a measure of prior experience, led to greater self-efficacy (O'Brien, Martinez-Pons, & Kopala, 1999). Hackett and colleagues (Hackett, Betz, O'Halloran, & Romac, 1990) manipulated the results of an experimental anagram task given to undergraduate students and found that participants in the successful condition increased their self-efficacy after completing the task. In the working adult population, mastery experiences provided the greatest self-efficacy to males in science-related careers (Zeldin, Britner & Pajares, 2008). For participants as young as third grade up to adults, mastery experiences strongly predict self-efficacy.

More specifically, Bandura (1997) proposed that individuals' *perception* of their past achievement contributes to self-efficacy, perhaps more than the outcome itself. Lent, Lopez, and Bieschke's (1991) study showed that college students' prior performances (ACT scores) coupled with their perception of their successes impacted their self-efficacy. However, Lopez, Lent, Brown, and Gore (1997) found that the actual experience did not affect self-efficacy, whereas the perception of it did. To account for these findings, participants in the current study will report their quantifiable achievements (SAT score and college GPA) as well as their perceptions of them.

Vicarious information. The second source of self-efficacy is vicarious information or modeling (Bandura, 1997). For this source, individuals observe another person complete a task and then compare themselves to the model. The student's self-efficacy changes depending on the success or failure of the model. Models that are most similar to the individual provide the greatest influence over the individual's self-efficacy (Schunk, 1987), a finding that may put females at a disadvantage in STEM areas where there are not many same-sex models (Sekaquaptewa & Thompson, 2003). Additionally, general social comparison falls under the vicarious learning variable. A student compares her grade or other measure of achievement to the rest of the class' to determine how to interpret the score. If she does better than her peers, her self-efficacy increases. Vicarious learning is most influential when individuals are unsure how their performance will be evaluated or have little experience with the assessment (Chen & Usher, 2013; Usher & Pajares, 2008).

Verbal persuasion. Verbal persuasion is the third source of self-efficacy (Bandura, 1997). Here, students receive verbal messages from teachers, parents, and peers about their abilities. If the individual is encouraged or praised in a given area, her related self-efficacy will increase. Bandura (1997) cautions that negative messages, especially ones received in childhood, may be more influential over self-efficacy than positive ones.

Emotional arousal. Finally, an individual's self-efficacy is affected by her emotional or physiological arousal (Bandura, 1997). This final source is often measured by anxiety, but is not necessarily limited to this variable. Students use their emotional levels as a way to interpret their abilities, thus affecting their self-efficacy. For example, an individual who experiences a lot of anxiety before taking a test may construe this emotion as evidence that she is not prepared for the exam. Thus, the anxiety leads her to reduce her self-efficacy.

Bandura (1997) argued that many personal and contextual factors affect how the sources impact self-efficacy. Their influence may be additive, relative, multiplicative, or configurative; and individuals become better at integrating the sources as they develop their cognitive abilities. Teasing out the individual effects of the sources can be difficult, as students often receive multiple indicators simultaneously (Bandura, 1997; Usher & Pajares, 2008). For instance, an undergraduate who excels on a presentation may receive a high grade (mastery experience), verbal encouragement from her professor and peers (verbal persuasion), as well as a reduction in anxiety (emotional arousal). The three sources act together to elevate the student's self-efficacy.

Additionally, individual differences impact which sources are most influential in a given situation. Some students' self-efficacy may be highly affected by their prior achievement, while others may discount the importance of those successes (Lent & Brown, 2006). Just as with self-efficacy, the sources should be measured at the level of specificity in the outcome variable (Bandura, 1997; Lent & Brown, 2006). Therefore, the current study uses a scale, the Academic Self-Efficacy in Math Classes Scale (Fast et al., 2010), which asks students about their experiences in college math courses specifically.

Moreover, the sources of self-efficacy may influence males and females differently. Zeldin and Pajares (2000) found that within the STEM field, females' self-efficacy was highly influenced by verbal persuasion and vicarious information. However, they may be unlikely to receive these sources since professors may be biased against females in STEM (Ancis & Phillips, 1996). Additionally, females lack same-sex mentors in their fields (Sekaquaptewa & Thompson, 2003; U.S. Department of Education, 2010), so they may have a harder time receiving the verbal encouragement or vicarious learning that males do. Whereas females may have similar achievement levels as males (Lindberg et al., 2010; Wang, 2012), their self-efficacy is less influenced by their successes.

Math self-efficacy. In the literature, math self-efficacy (MSE) is frequently operationalized as a measure of an individual's confidence in her ability to successfully complete math tasks, problems, and/or courses (Betz & Hackett, 1983; Lent, Lopez, & Bieschke, 1991). MSE has been studied extensively in a variety of participants of different ages, races, and nationalities. (Lee, 2009; Liu, 2009; Schunk & Lilly, 1984). The majority of studies have found that MSE correlates or even predicts achievement in math or choice of a math course (Moulton, Brown, & Lent, 1991; Betz & Hackett, 1983). Several researchers have investigated the mediating effects of math self-efficacy on achievement (Ferla, Valcke, & Cai, 2009; Lopez, Lent, Brown, & Gore, 1997; Pajares & Miller, 1994). MSE is an important component in understanding mathematical success.

Mathematical self-efficacy has been found to correlate with mathematical achievement in a variety of nationalities. In an analysis of an international math exam, Lee (2009) revealed that, across 41 countries, MSE strongly related to scores on the math assessment. Researchers have found similar results using different assessments in Nigeria (Ayotola & Adedeji, 2009; Tella, 2011), Greece (Metallidou & Vlachou, 2007), and The Netherlands (Vrugt, Oort, & Waardenburg, 2009). Multon and colleagues (1991) conducted a meta-analysis of math self-efficacy and found it to relate to performance (r = .38) across intelligences, ages, and measures.

Additionally, several studies have shown that math self-efficacy (MSE) accounts for some of the sex difference in math performance measures. Self-efficacy was a stronger predictor of math exam scores than either sex or anxiety in Nigerian high school students (Ayotola & Adedeji, 2009). In the U.S., MSE added 20% to the variance in math scores above sex, race, and homework variables on an international math assessment (Kitsantas, Cheema, & Ware, 2011). In college students, self-efficacy more strongly predicted problem solving than did sex, past experience, or self-concept (Pajares & Miller, 1994). In all of these studies, the males outscored the females, a finding that was partially or fully explained by their greater math self-efficacy.

Sex differences in math self-efficacy. One common finding in research is that males often report higher levels of math self-efficacy than females (Huang, 2013; Pajares & Miller, 1994). Studies with participants of varying ages and nationalities have found this sex discrepancy. Males had higher math self-efficacy in middle school (Liu, 2009), adolescence (Bandura et al., 2001), and in college (Betz & Hackett, 1983; Lent, Lopez, & Bieschke, 1991). This outcome occurs even when males and females have equal abilities (Cordero et al., 2010; Pajares, 1996). Internationally, males report higher math self-efficacy as well (Tella, 2011; Vrugt, Oort, & Waardenburg, 2009). The sex difference may begin during the middle school transition (Jacobs et al., 2002) or as students move into high school (Bussey & Bandura, 1999).

One possible reason for the sex discrepancy may be that males and females have differential exposure to the sources of math self-efficacy in childhood (Hackett & Betz, 1981; Lent, Lopez, & Bieschke, 1991). Males, more than females, are encouraged to explore the spatial environment and use computers, giving them greater mastery experiences with science and math (Bussey & Bandura, 1999). Females receive less encouragement to study math and have fewer role models (Sekaquaptewa & Thompson, 2003). Additionally, females report higher levels of math-related anxiety (Lent et al., 1996; Pajares & Kranzler, 1995). These differences in the sources may result in unequal levels of math self-efficacy later in life between males and females.

Since math self-efficacy often correlates with achievement or other positive math-related outcomes, the sex discrepancy is alarming. Females are receiving and internalizing the message that they should not expect to succeed in math. Are females who have accepted these gendered norms more susceptible to decreases in mathematical self-efficacy? The current study investigates this question.

Gender role orientation in math self-efficacy. Since the internalization of societal gender norms may account for some of the variation in math self-efficacy (MSE) levels, some researchers have investigated the relation between gender role orientation and MSE. Using the Bem Sex Role Inventory (Bem, 1974), Betz and Hackett (1983; Hackett & Betz, 1989) found a positive association between masculinity and math self-efficacy. Femininity, however, was unrelated to math self-efficacy. Hackett (1985) replicated these findings by using path analysis to demonstrate that gender role mediates the association between sex and math self-efficacy. Once gender role was included in the model, there was no direct link between sex and MSE.

Sex differences in math self-efficacy interventions. Due to its association with achievement, math self-efficacy (MSE) is a variable often targeted for intervention programs designed to increase it (e.g. Luzzo et al., 1999). Interestingly, some interventions have operated differently for males and females, lending support to the argument that the sources of math self-efficacy influence the sexes in different ways. Cordero and colleagues (2010) found that their interventions involving performance accomplishment and belief-perseverance techniques did not work as well or as immediately for females. The authors concluded that self-persuasion may not be as important a contributor to MSE for females as males. However, Zeldin and colleagues' (2008) study revealed that females, but not males, were influenced by the verbal persuasion of others. Thus, females may be more likely to believe encouragement from others rather than themselves. In the current study, both math self-efficacy and its sources will be measured to determine if sex or gender differences occur.

Future aspirations and expectations. Self-efficacy also strongly relates to future aspirations and expectations (Adedokun et al., 2013). As with Armstrong and Crombie (2000), the present study considers *aspirations* to refer to an individual's desire or preference, while *expectations* denote an individual's belief that she can actually accomplish the task. Here, participants report their level of aspiration/expectation in attending graduate school or working in STEM fields. Mau (2003) found that participants reporting high math/science self-efficacy also had greater math/science career aspirations. Furthermore, males in this study reported higher self-efficacy as well as higher occupational goals than females. However, a study of 8th grade participants did not produce sex differences (Navarro et al, 2007). Students with greater math self-efficacy also reported more aspirations to take math classes in high school and obtain a math-related job. Participants who think they can carry out the necessary behaviors to successfully complete math tasks also aspire to take more math courses and to work in more math-related occupations.

Bandura (1986; 1997) posited that both self-efficacy and outcome expectations influence behavior through their association with interest. As such, many studies of self-efficacy also include measures of participants' expectations of what will happen once they complete the task in question. In general, participants with higher math self-efficacy have higher expectations of the consequences of their behavior. Navarro and colleagues (2007) found that 8th grade students' math/science self-efficacy predicted their expectations for academic success at a later time. This association was replicated in undergraduate participants (Byars-Winston et al., 2010). Students who had high confidence in their math abilities were more likely to expect positive consequences of succeeding in math.

Some researchers have studied not only expectations, but also behavioral intent. In Gainor and Lent's (1998) undergraduate participants, math self-efficacy did indeed predict outcome expectations. Additionally, these two variables together predicted intent to enroll in math courses. Students with higher confidence in their math abilities and greater expectations for the consequences of taking math courses were more likely to claim they would take these classes. Lent and colleagues (2001) found similar results: math self-efficacy positively correlated with course intent. Overall, students with higher math self-efficacy have higher expectations for the future and greater resolve to engage in math activities. The current study will investigate the effect of math self-efficacy on future goals. One possible reason that individuals low in self-efficacy may have lower aspirations and expectations is that they suffer from the impostor phenomenon.

The Impostor Phenomenon

In the 1970s, Clance and Imes counseled or taught several academically successful women who reported feelings of "intellectual phoniness" (Clance & Imes, 1978, p. 241); these women believed that they were not smart enough to receive the achievements or positions they had earned. They attributed their successes to temporary variables such as luck, extreme hard work, or charm, rather than ability; however, when they failed, they blamed their own lack of intelligence. The women took no pleasure in their repeated achievements, nor did they believe they could replicate these successes in the future (Clance, 1985). They constantly feared evaluation and failure since they perceived that these events would expose them as frauds (Clance & O'Toole, 1988). The impostors believed they were fooling others into believing they were smart. Clance and Imes (1978) termed the internal experience the impostor phenomenon, as the women in their research felt like frauds in academic settings.

The women reported several common experiences related to their impostorism. They suffered from extreme anxiety due to their fear of failing or of exposing their supposed inabilities. Thus, they were more likely to settle for certain success, rather than take on a challenge and risk failure. Impostorism was not the same as false modesty or actual inability, as the impostors had the necessary expertise, yet truly believed they lacked the skills necessary to be successful (Clance, 1985). Due to their fear of being discovered as impostors, the women worked extra hard to create exceptional work. They tended to be perfectionists, as they believed that any mistake may reveal their inabilities. Or, they would procrastinate as a form of self-handicapping, so they could blame their failure on a lack of preparation. Even when their achievements were noticed and rewarded, the impostors felt their accolades were undeserved, and they went to extreme lengths to discount positive feedback or prior successes. Conversely, they overvalued negative feedback and were highly influenced by previous defeats. Success made them feel guilty, as they did not believe they deserved it. Moreover, the impostors underestimated their own abilities and overestimated those of others. (Clance & Imes, 1978; Clance & O'Toole, 1988).

Subsequent research has confirmed and expanded on the initial findings of Clance and Imes (1978). Researchers have found impostorism to relate to several negative outcomes. Impostors have little confidence in their own competence or abilities (Kumar & Jagacinski, 2006; September et al, 2001), and they experience extreme anxiety and fear of failure (Fischer & Holtz, 2007; Fried-Buchalter, 1997). The phenomenon correlates with both perfectionism (Henning et al., 1998) and self-handicapping strategies (Ross et al., 2001; Want & Kleitman, 2006), two methods for avoiding the negative affect associated with failure. Impostors are more likely than non-impostors to espouse an external locus of control (Sightler & Wilson, 2001) and suffer from depression (McGregor et al., 2008).

Researchers put impostor levels around 20% of the overall population (Cromwell et al., 1990), but certain groups are more susceptible to impostorism than others. Clance (1985) proposed that students may be especially vulnerable due to the emphasis on evaluation in school. The uncertainty of transition periods such as the start of a new school or career may lend itself toward impostorism (Topping & Kimmel, 1985). As in the initial research (Clance & Imes, 1978), several studies have found impostorism in high-achieving participants (e.g. Cromwell et al., 1990; Harvey, 1981; King & Cooley, 1995). Entrepreneurs, medical professionals, honors students, and marketing managers have all reported impostor tendencies (Cromwell et al., 1990; Fried-Buchalter, 1997; Henning et al., 1998; Sightler & Wilson, 2001). The impostor phenomenon has mostly been studied in high school, college, and adult populations; however, it has been identified in participants as young as elementary school (Chayer & Bouffard, 2010).

Some researchers have identified different cultural experiences with impostorism. Chae and colleagues (1995) found that Americans were more likely to report the impostor phenomenon than Korean participants. Within the U.S., Asian Americans experienced greater impostorism than both African Americans and Latino/a Americans, who did not differ in their levels of the phenomenon (Cokley et al., 2013). The impostor phenomenon has been studied in African American populations (Austin et al., 2009; Ewing et al., 1996) and was not found to correlate with racial identity.

Clance and Imes (1978) initially reported the impostor phenomenon in clinical settings, and much of the subsequent research has been conducted on well-being and other affective variables. The impostor phenomenon correlates with overall poor mental health (Sonnak & Towell, 2000) and psychological distress (Henning, Ey, & Shaw, 1998). Several articles have found that impostors' fear of evaluation or failure leads to extreme state or trait anxiety (Clance & Imes, 1978; Thompson, Foreman, & Martin, 2000). Women may be especially susceptible to test anxiety related to impostorism (Kumar & Jagacinski, 2006). Another emotion experienced by many impostors is depression due to the self-doubt associated with the phenomenon (McGregor, Gee, & Posey, 2008). Impostors have low self-acceptance (September et al., 2001) and high levels of shame (Cowman & Ferrari, 2002). The impostor phenomenon relates to negative well-being; understanding the construct may help alleviate some of the psychological distress experienced by impostors. Due to their fear of being discovered as phonies, impostors often work especially hard and are successful (Henning et al., 1998). However, as the previous research indicates, this achievement often comes at a psychological cost. These negative results may dissuade females from working in STEM careers.

Due to the miscalibration of their own abilities, many impostors set goals far below their potential (Hirschfield, 1982). They may aspire to careers beneath their abilities, or may not seek advancement in those careers (Clance & O'Toole, 1988). When they encounter obstacles, impostors often give up or perceive the setback as a sign of their lack of ability (September et al., 2001). Even when they do succeed, impostors do not feel elation at their achievements (Hirschfield, 1982). The current research investigates the relation between impostorism and future aspirations and expectations.

Sources.

Family dynamics. Clance and Imes (1978) proposed two sources for the impostor phenomenon in high achieving women: family and society. The authors described two family dynamics that could lead to impostorism. In the first type, the woman had an academically high-achieving sibling or close relative. No matter how successful the woman was, her family still considered her to be the "sensitive one" or the "socially-adept one," while her sibling was the "smart one." While the impostor worked hard to earn their approval, the family attributed her achievements to temporary causes rather than her intellectual abilities. The individual learned to do the same, never believing in her own intelligence.

In the second familial source of the impostor phenomenon, the impostor grew up with the constant message that she was academically gifted and superior at everything she did. Eventually, she encountered areas where she struggled or had to put forth effort to succeed. Since the girl believed that achievement came effortlessly for those students with high ability, she concluded that she must have lacked the intelligence that others believed she possessed. She began to doubt her own abilities as well as her parents' claims. The women in Clance and Imes' (1978) study often recounted childhood stories that fit into one of these two scenarios.

Subsequent research has investigated the relation between family upbringing and the impostor phenomenon. Langford and Clance (1993) stated that impostors came from families with conflict, but no outlet or support for the child to deal with it. Children in this environment want to impress others, but also protect themselves from disapproval. They must attempt to become an idealized child in order to earn others' affirmation so they can feel validated and develop a positive self-concept. For children in these families, any criticism can be especially damaging, resulting in humiliation, shame, and a loss of self-esteem. Thus, the child learns to depend on others' positive evaluation as a way to keep her own self-worth high.

Not surprisingly, the impostor phenomenon has been found to impact individuals whose families emphasized achievement and success (King and Cooley, 1995). Sonnak and Towell (2002) found that parental overprotection as well as low self-esteem related to the impostor phenomenon. The overprotective parent took over the child's tasks in order to prevent her from failing. Thus, the child failed to develop her own sense of self or knowledge of her own abilities. She felt guilty and undeserving of the praise received due to her parent's work; eventually this led to feelings of impostorism. Want and Kleitman (2006) investigated this further by asking participants questions about mothers and fathers separately. The researchers discovered that *paternal* overprotection or a lack of *paternal* warmth or caring could lead to impostorism, but maternal variables did not directly relate. The present study accounts for the family dynamic source with a measure of parental influence on math attitudes.

Gender-role stereotyping. The second source of the impostor phenomenon according to Clance and Imes (1978) is gender-role stereotyping. The researchers argue that this experience begins in preschool, when girls receive the message that society does not expect them to succeed academically. The girls learn that women who achieve have done so due to some mistake rather than their own abilities. According to social norms, women should be ashamed of personal ambition or achievement needs (Clance & O'Toole, 1988). Therefore, women must worry that if they are successful, they may be rejected by others or seen as unfeminine. Benjamin (1984) described the conflict as wanting to be feminine like mom, but still be agentic like dad. Following the initial study (Clance & Imes, 1978), nearly all research on the impostor phenomenon considered sex as an influential variable. However, few studies investigated the impact of gender role stereotyping on impostorism.

Sex and gender role research. Nearly all studies of the impostor phenomenon have studied the relation of sex to the construct. The first research on impostorism was conducted with an all-female participant group (Clance & Imes, 1978). However, the researchers concluded that future studies needed to investigate the variable in both females and males. A later review of research on impostorism reported no sex differences in the percentage of males and females reporting the impostor phenomenon (Langford & Clance, 1993). Subsequent studies have shown mixed results, with some showing no sex differences (*e.g*. Caselman, Self, & Self, 2006; Fried-Buchalter, 1997; Harvey, 1981), and others concluding that females report it more frequently (*e.g*., Kumar & Jagacinski, 2006; McGregor, Gee, & Posey, 2008).

There are several possible reasons for the inconsistent sex difference. Females and males may have different sources of impostorism (Caselman, Self, & Self, 2006), or the construct may affect the sexes differently (Kumar & Jagacinski, 2006). King and Cooley (1995) found that female impostors spent more time on academic tasks than non-impostors, but males did not display the same pattern. Males may be more likely to overcome the impostor phenomenon due to added social support (Kumar & Jagacinski, 2006) or verbal persuasion of influential others (Clance & O'Toole, 1988). Clance and O'Toole (1988) proposed that males were more likely than females to receive verbal encouragement from mentors and faculty members to enroll in honors classes. Therefore, although males and females experienced impostorism in equal numbers, the males were not as adversely affected by it.

While many studies have compared males and females on levels of reported impostorism (*e.g*., Caselman, Self, & Self, 2006; Kumar & Jagacinski, 2006; McGregor, Gee, & Posey, 2008), few have investigated gender-role stereotyping and gender-role orientation as related constructs. In the original research, Clance and Imes (1978) anecdotally reported that men experience impostorism much less frequently and intensely as women. However, "feminine" men seemed to be more vulnerable to the impostor phenomenon than non-feminine men. September and colleagues (2001) found that participants high on instrumental traits, that is, either masculine or androgynous individuals, reported lower impostor scores than expressive and undifferentiated participants. A lack of masculine/instrumental traits correlated with higher levels of impostorism. On the other hand, Cromwell and colleagues (1990) found that impostors did not differ from non-impostors on masculine and feminine attributes. Considering that the original research proposed that gender-role stereotyping was a major source of impostorism (Clance & Imes, 1978), it is surprising that more studies have not investigated the relation between gender identity and the impostor phenomenon. The current study attempts to fill this gap by determining if an association between impostorism and sex or gender role exists.

The impostor phenomenon and personality. The impostor phenomenon has been studied extensively in relation to personality variables. Several studies have shown an association between perfectionism and impostorism. Clance and O'Toole (1988) list perfectionism as one of the behaviors that helps identify a client suffering from impostorism. Impostors maintain exceptionally high standards for their own work, seeing any small mistake to live up to the unrealistic standards as a sign of incompetence and failure (Thompson, Davis, & Davidson, 1998; Thompson, Foreman, & Martin, 2000). Henning, Ey, and Shaw (1998) reported high levels of the impostor phenomenon in their sample of students in the medical field; this variable strongly related to both perfectionism and psychological distress. Thompson and colleagues (2000) found that impostors experienced greater anxiety, negative affect, and concern after making mistakes when compared to non-impostors. Those participants experiencing the impostor phenomenon set unrealistic expectations for themselves, and they were highly critical when they did not achieve them.

Several studies have compared impostorism to traits on the Five Factor Model of personality (Costa & McCrae, 1992). Impostors are often Introverts (Chae et al., 1995; Ross et al., 2001) who withdraw from social situations in order to prevent being discovered as frauds (Langford & Clance, 1993). Women impostors may be especially vulnerable to introversion as men tend to receive greater social support in the face of their impostorism (Clance & O'Toole, 1988), while women withdraw from social contact (Beard, 1990). Ross and colleagues (Ross et al., 2001) also found that the impostor phenomenon correlated with Introversion, but their study showed a much stronger relation with Neuroticism. Not surprisingly, the Anxiety facet of the Neuroticism scale had the largest association. These results were similar to ones found by Bernard and colleagues (2002), whose research showed a strong positive correlation between the impostor phenomenon and Neuroticism and a negative one with Conscientiousness. The Depression and Anxiety facets of Neuroticism had the strongest association with impostorism.

Maintenance of the impostor phenomenon. Impostorism is a pervasive phenomenon that can be resistant to interventions to reduce it. Clance and her colleagues (Clance & Imes, 1978; Clance & O'Toole, 1988) reported that impostors often engage in a cyclical set of behaviors known as the impostor cycle that reinforces impostorism while perpetuating negative outcomes. First, the individual experiences extreme fear and anxiety over not succeeding and being discovered as a phony. Therefore, she puts forth a lot of effort to ensure she will not fail. She succeeds, receives positive feedback, and, may, temporarily, feel relief or positive emotions. However, she soon finds herself back in her original situation, fearful that she will be discovered as an impostor. She may even believe that her suffering led to her achievement; therefore, she must continue the impostor cycle to be successful.

Impostors often engage in certain behaviors that maintain the phenomenon in their lives (Clance & Imes, 1978). Individuals suffering from the impostor phenomenon use others' opinions rather than their own. This intellectual flattery ensures that the impostor's ideas never receive merit or get critiqued. Any praise the impostor receives will be attributed to the other person, as these opinions were the ones used. In addition, the impostor uses charm and perceptiveness to win the approval of her mentor. When she receives it, she believes it is due to her flattery rather than her intellectual abilities. To further enforce the phenomenon, the impostor believes that if she were truly smart, she would not need the approval of others. The final behavior stems from the gender roles in society. According to Clance and Imes (1978), women who achieve success are perceived as unfeminine and receive negative societal consequences. Therefore, the impostor disbelieves her own abilities so she will not receive the costs associated with intellect for women.

Due to its association with several negative outcomes (Clance & O'Toole, 1988), the impostor phenomenon has been targeted for intervention in therapeutic settings. Clance and Imes (1978) strongly advocate for group therapy where impostors can hear others' experiences with the phenomenon as well. The impostor learns to recognize and combat the maladaptive thinking associated with impostorism. Additionally, she begins to notice her dismissal of her successes, and, instead, she learns to accept them as evidence of her own intelligence.

Math Self-Efficacy and the Impostor Phenomenon

To date, no studies have investigated the relation between math self-efficacy and the impostor phenomenon. However, there are several findings that indicate an association may exist. The impostor phenomenon has negatively correlated with generalized self-efficacy (Ives, 2011) and with academic self-efficacy (Pajares, 2001). A few studies (Kumar & Jagacinski, 2006; Want & Kleitman, 2006) have revealed a negative association between the impostor phenomenon and confidence in intelligence, a measure similar to global self-efficacy. Indeed, impostors do not expect future academic success (Clance & Imes, 1978). Ewing and colleagues (1996) found that academic self-concept, a construct similar to academic self-efficacy, predicted the impostor phenomenon. Moreover, a different study (Bandalos, Yates, & Thorndike-Christ, 1995) revealed gender differences in similar concepts. Women who attributed their successes to external causes, like the luck or charm cited by impostors, had lower self-concept than women who believed their own behaviors led to their success. The current study will be the first to investigate the impact of impostor phenomenon on math self-efficacy specifically.

Several studies have investigated the effects of the impostor phenomenon on variables similar to the *sources* of math self-efficacy (MSE). Impostors are more likely to discount the positive influences on MSE and overvalue the negative ones. For example, a successful mastery experience should increase an individual's MSE (Bandura, 1997). However, impostors attribute their achievements to temporary means such as luck or effort, and they doubt that they will succeed on similar tasks in the future (Clance & O'Toole, 1988). Thus, mastery achievements will likely not increase an impostor's math self-efficacy. Conversely, impostors overemphasize the importance of failures and setbacks, considering them evidence of their inability (Clance & Imes, 1978; Harvey & Katz, 1985). A negative experience may greatly diminish an impostor's self-efficacy.

Impostors miscalibrate the importance of the other three sources of self-efficacy as well. They do not use the correct reference group when making social comparisons, but tend to overestimate the abilities of others while underestimating themselves. Impostors interpret the strengths of others as signs of their own weaknesses (Clance & O'Toole, 1988). Thus, the vicarious information source of self-efficacy may be skewed. Instead of perceiving a colleague's achievement as evidence of her own ability to succeed, an impostor will believe that the model is much more able than she. If the model fails or encounters a setback, the impostor may interpret this outcome as support for her own inevitable failure. Impostors also discount the positive verbal persuasion of others, assuming that they have "charmed" the person or that the praise is somehow invalid. However, like with the mastery experiences, negative feedback highly influences impostors by confirming their negative self-beliefs (Clance & Imes, 1978; Clance & O'Toole, 1988). Finally, impostors cannot use emotional arousal as a viable source of their self-efficacy since they experience constant high levels of anxiety (Clance & O'Toole, 1988). Therefore, I expect impostorism to affect the influence of the sources of math self-efficacy on math self-efficacy. The current study is designed to investigate if and how this effect occurs.

Chapter 3: Research Questions and Methods

Statement of Purpose

The general purpose of this research is to add to the understanding of undergraduates' gendered experiences in science, technology, engineering, and math (STEM) courses in order to encourage more women to choose majors in these areas or to persist into STEM graduate school and work. Prior studies (e.g. Eccles et al., 1993; Pajares & Valiante, 1999) have shown that males and females have very different motivational beliefs and affective experiences in these stereotypically-male domains. These self-perceptions and understandings may contribute to the disproportional numbers of women who do not pursue or complete a STEM bachelor's degree.

Specifically, this study purports to examine the impact of the impostor phenomenon on math self-efficacy and future aspirations/expectations. Clance and Imes (1978) identified gender socialization as one of the possible causes of the impostor phenomenon. Thus, it is expected that gender-related variables will affect math self-efficacy and the impostor phenomenon as well, which will subsequently relate to future aspirations and expectations. Figure 1 conceptualizes the effects of the many constructs involved in this experience.

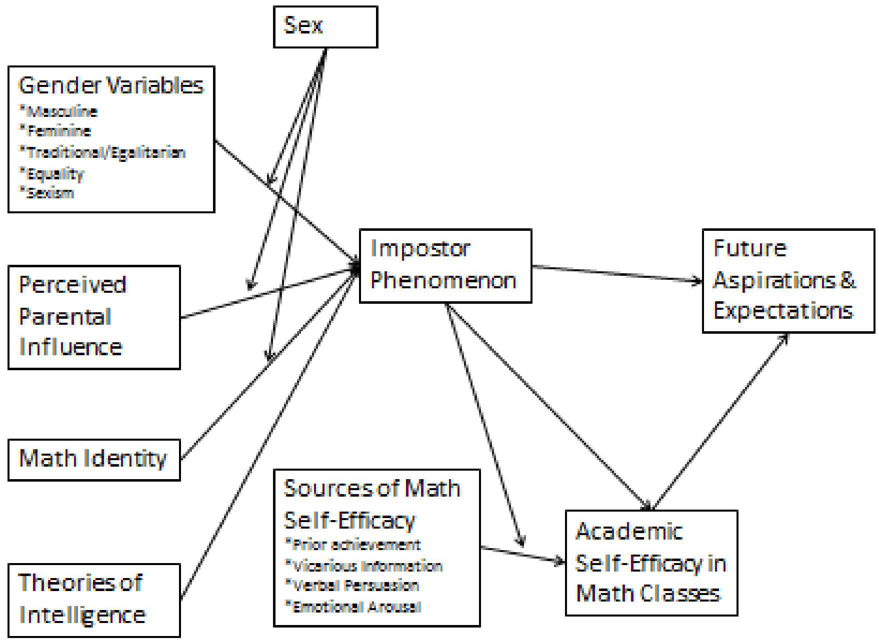

Figure 1. Model displaying the effects of the impostor phenomenon and math self-efficacy on future aspirations and expectations.

Based on prior research, theories, and the above figure, the following specific research questions will be addressed.

Research Questions and Hypotheses

Research question 1. Do males and females in STEM majors differ in levels of the impostor phenomenon, academic self-efficacy in math, and gender role orientation?

Hypothesis 1. (a) Females will report greater impostor phenomenon than males. (b) Females will report lower academic self-efficacy in math than males. (c) Females will identify with more femininity, less traditionality, greater equality, and less sexism than males.

Rationale 1. (a) The impostor phenomenon was initially identified in groups of female participants (Clance & Imes, 1978). Since that time, researchers have found differing results in the amount of impostorism present in males. In some studies (e.g. Kumar & Jagacinski, 2006; McGregor, Gee, & Posey, 2008), females have reported significantly greater levels of the impostor phenomenon than males. However, other studies (e.g. Caselman et al., 2006; Fried-Buchalter, 1997) have found that both males and females experience equal levels of impostorism. The participants in these studies were marketing managers (Caselman et al., 2006) and high school students in non-STEM classes (Fried-Buchalter, 1997), two areas with equal numbers of males and females and few sex-related stereotypes. Therefore, it is not surprising that males and females experienced similar levels of the impostor phenomenon in these environments. However, since males dominate STEM majors at the present university as well as across the US (University of Texas, 2013; U.S. Department of Education, 2010), impostorism may be extremely relevant for females in this domain. Thus, I propose that females will experience greater impostorism than males in the STEM majors.

In addition, numerous studies have shown sex differences in math self-efficacy, expressivity/instrumentality, and traditionalism/egalitarianism. Several researchers (e.g., Betz & Hackett, 1983; Lent, Lopez, & Bieschke, 1991) have reported undergraduate males to have higher math self-efficacy than females. Males have identified with instrumental/masculine traits, while females have with expressive/feminine ones (Spence, & Helmreich, 1978). And, while undergraduates have become more egalitarian over time, female students still report more egalitarian attitudes than male ones (Spence & Hahn, 1997). I expect that the current study will replicate the findings represented in this prior research. On their original study on the Revised Women in Science Scale, Owen and colleagues (2007) found that female respondents espoused greater endorsement of equity and lower acceptance of sexism than the male participants. I expect that students in the present study will replicate these findings.

Research question 2. Will masculinity, perceived parental influence, math identity, and theories of intelligence predict the impostor phenomenon?

Hypothesis 2. Masculinity, perceived parental influence, math identity, and theories of intelligence will all significantly predict the impostor phenomenon. Masculinity will be negatively related to the dependent variable, while perceived parental influence and math identity will be positively associated. Perceived parental influence is the student's recollection of how influential her parents were over her math choices and achievements prior to attending college. Individuals with entity theories of intelligence will be more susceptible to impostorism as well. For these theorists, intelligence is a fixed quality that cannot be changed much through learning or education (Dweck, 1996).

Rationale 2. In their original work on the impostor phenomenon, Clance and Imes (1978) proposed the influence of gender roles and parenting on the construct. Later research (September et al., 2001) found masculinity to negatively correlate with impostorism, as I expect in the present study. Additionally, several studies (e.g. King & Cooley, 1995; Langford & Clance, 1993; Sonnak & Towell, 2002) found family dynamic and parenting styles to relate to impostorism. The present study measures the perceived parental influence over their children's math choices and attitudes in secondary school.

Additionally, I expect that both math identity and theories of intelligence will significantly predict impostorism. Within the stereotype threat literature, individuals who are highly identified in the domain are most susceptible to the negative effects of stereotype threat (Steele, 1997). Similarly, I expect that participants who identify strongly with math to be more likely to worry that others will perceive them as mathematical frauds; therefore, these students will be more prone to impostorism.

According to Dweck's Theory of Intelligence (Dweck et al., 1995), individuals differ in their perception of intellect. Entity theorists believe that intelligence is fixed at birth and cannot be improved. On the other hand, incremental theorists ascribe to a malleable view of intellect, believing that individuals can improve their mental abilities through learning. I propose that impostors will be more likely to have an entity view of their intelligence. People suffering from the impostor phenomenon discount their abilities despite repeated successes and accolades (Clance, 1985; Clance & O'Toole, 1988). Therefore, they are more likely to believe that their own intellect is low and cannot be improved.

Research question 3. Will sex affect the predictive ability of math identity, gender role orientation, and perceived parental influence on impostorism? Will math identity, gender role orientation, and perceived parental influence predict impostorism in the same way for males and females?

Hypothesis 3. (a) Sex will moderate the association between math identity and impostorism. For females, higher math identity will predict higher levels of the impostor phenomenon. However, males will not show an association between math identity and impostorism. (b) Sex will moderate the effect of femininity on the impostor phenomenon. Females higher in femininity will experience greater impostorism than females low in femininity. For male participants, femininity will not relate to the impostor phenomenon.

(c) Sex will moderate the relation of traditionality and impostorism. Traditional females will experience greater impostorism than egalitarian females. However, traditional and egalitarian males will not differ in levels of impostorism. (d) The relation between perceived parental influence and the impostor phenomenon will be moderated by sex. I expect that female participants will show a strong association between their parents' influence and their subsequent impostorism; however, this relation will not be as strong for male students.

Rationale 3. (a) I expect that impostorism will be most salient for females who strongly identify with math. Research from the stereotype threat literature (Steele, 1997) has shown that stereotype threat manipulations do not affect females who are weakly math identified. Participants who do have a high math identity derive some sense of self from their success in math; thus, experimental manipulations that prime their membership in a negatively stereotyped group artificially deflate their math test scores. Similarly, I expect that females without a strong math identity will not be afflicted with the impostor phenomenon, while participants who highly identify with the math domain will experience high levels of impostorism. Since males are not subject to the effects of a negative stereotype in math, I do not expect math identity to relate to their levels of impostorism.

(b,c) In their original research on the impostor phenomenon, Clance and Imes (1978) proposed that "sex-role stereotyping" was one of the two leading causes of impostorism in females. The authors argued that from an early age, females learned that men have greater intellect and are more competent than women. Females who internalized this stereotype were more apt to suffer from the impostor phenomenon. I expect similar findings in the current research—females who describe themselves with feminine attributes will have greater levels of impostorism.

Moreover, STEM occupations have traditionally been held by males (Rayman & Brett, 1995). Individuals who ascribe to a more traditional gender role ideology may believe that males, more than females, belong in these areas (Schmader et al., 2004). Thus, traditional females who are enrolled in STEM majors may feel like they do not belong or deserve any successes there. Therefore, I hypothesize that both expressive/feminine and traditional females will experience greater impostorism than either instrumental/masculine or egalitarian females. Since males do not experience the same negative math stereotype, I do not expect gender role or math identity will relate to impostorism for them.

(d) In their original work on the impostor phenomenon, Clance and Imes (1978) uncovered a parental source for the impostorism found in their female clients. The participants were strongly influenced by the parenting they had received while growing up. The participants believed that they had been ascribed family roles as either the "very smart child" or the "sensitive one." When academic success took effort, they felt that their achievements were undeserved; thus, they developed the impostor phenomenon. Similarly, in the present study, participants rate their parents' influence over the students' math choices and achievement in secondary school. I expect that perceived parental influence will relate to higher impostorism for females in the present study. However, as the original study only included females, I do not expect parental influence to affect the male students' impostorism.

Research question 4. Will Bandura's (1986) proposed four sources of self-efficacy significantly predict academic self-efficacy in math?

Hypothesis 4. Prior achievement, vicarious information, verbal persuasion, and emotional arousal will all significantly predict academic self-efficacy in math.

Rationale 4. Several studies (e.g., Lent, Lopez, & Bieschke, 1991; Usher & Pajares, 2008) have found that prior achievement, vicarious information, verbal persuasion, and emotional arousal do, in fact, predict self-efficacy, as Bandura (1986) proposed. Many of these researchers (e.g., Bandura, 1997; Zeldin, Britner, & Pajares, 2008) reported that prior achievements influence self-efficacy the most strongly. However, not all studies agree on this point (Zeldin & Pajares, 2000). Therefore, in the current study, I theorize that all four sources will significantly academic self-efficacy in math, but I make no hypothesis regarding the relative strengths of the sources.

Research question 5. Will the impostor phenomenon moderate the relation between each source of self-efficacy and academic self-efficacy in math?

Hypothesis 5. (a) The impostor phenomenon will moderate the relation between prior achievement and academic self-efficacy in math. Impostors will have a more strongly positive association between the two variables than non-impostors will (See Fig. 2). That is, the relation between prior achievement and academic self-efficacy will depend on impostor status. Vicarious information and verbal persuasion will display the same pattern as prior achievement. (b) The impostor phenomenon will moderate the relation between vicarious information and academic self-efficacy in math. Again, impostors will have a more strongly positive association between the two variables. (c) The impostor phenomenon will moderate the relation between verbal persuasion and academic self-efficacy in math. As before, impostors will have a more strongly positive association between the two variables. (d) The impostor phenomenon will moderate the relation between coping with emotional arousal and academic self-efficacy in math. For impostors, level of coping with emotions will have no association with academic self-efficacy. However, for non-impostors, level of coping with emotions will have a strongly positive correlation with academic self-efficacy in math (See Fig. 3).

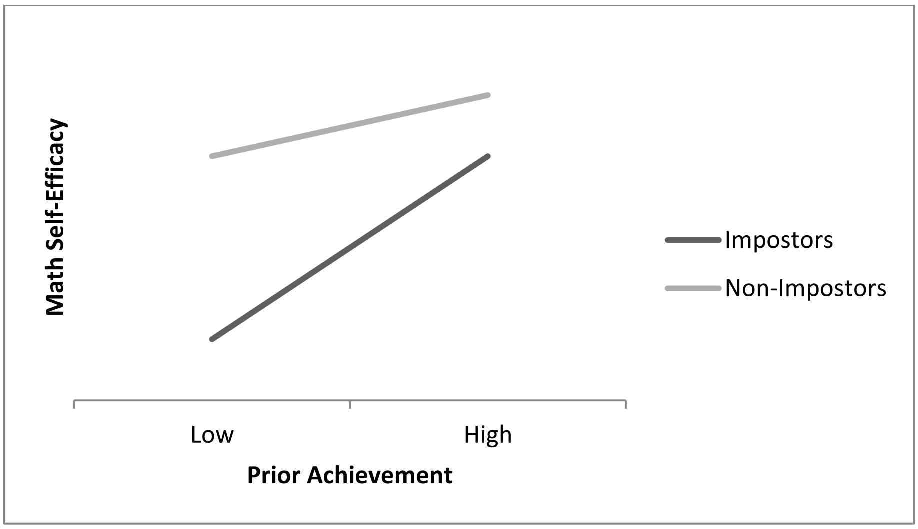

Figure 2. Effect of impostorism on the relation between mastery experiences and math self-efficacy.

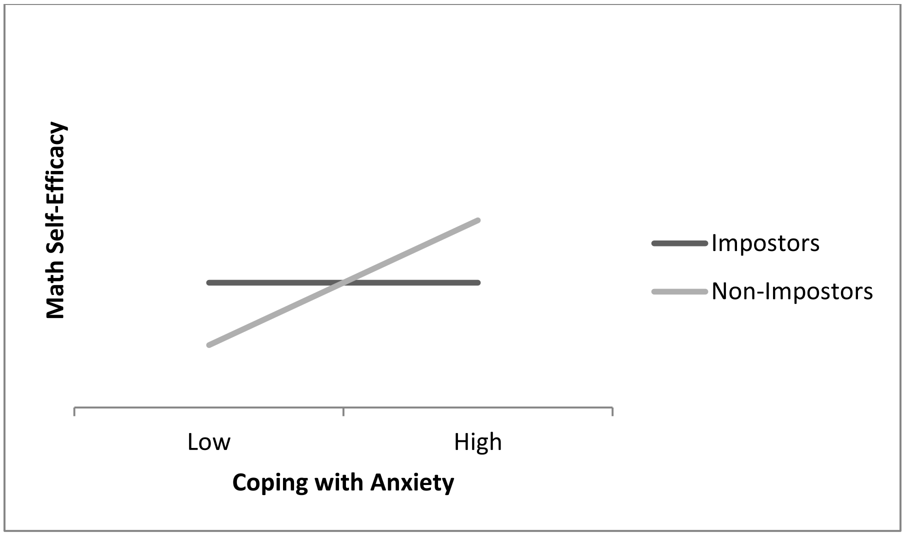

Figure 3. Effect of impostorism on the relation between coping with anxiety and math self-efficacy.

Rationale 5. To date, only one study (Ives, 2011) has investigated the relation between the impostor phenomenon and general self-efficacy, finding a negative correlation between them. Impostors reported a lower sense of self-efficacy than non-impostors. One limitation of Ives's research is her use of general perceived self-efficacy. According to Bandura (1986), self-efficacy should be measured at domain levels, rather than globally. In the current study, I use the more specific construct of academic self-efficacy in math. I expect that I will replicate Ives's findings with the *sources* of math self-efficacy. I presume that greater levels of the sources of math self-efficacy (prior achievement, vicarious information, verbal persuasion, and coping with emotional arousal) will lead to greater academic self-efficacy in math, as theorized by Bandura (1986; 1997) and shown by Lent and colleagues (Lent, Lopez, & Bieschke, 1991). However, I expect that this association will depend on level of impostorism.

(a, b, c) Impostors frequently overvalue the negative influences of self-efficacy. Impostors misconstrue non-successes and negative feedback as evidence of their own inability and failure (Clance & O'Toole, 1988). When considering vicarious experiences, they compare themselves to individuals with abilities lower than their own (Chayer & Bouffard, 2010; Clance & O'Toole, 1988). Where the model fails, the impostor believes that she will fail as well. However, when a colleague at the impostor's actual ability level succeeds, the impostor believes that the model has abilities greater than her own. The impostor may think to herself, "She did well because she is so much smarter than I am." This miscalibrated social comparison prevents the impostor from increasing her self-efficacy when she should. Thus, I propose that impostors low on prior achievement, vicarious information, and verbal persuasion will experience much lower academic self-efficacy in math than non-impostors since impostors overvalue the influence of these negative sources. However, I expect that impostors high on prior achievement, vicarious information, and verbal persuasion will have an academic self-efficacy score closer to, but still lower than, non-impostors.

(d) Additionally, an impostor frequently experiences anxiety over being discovered as a phony (Ross et al., 2001). Since this emotion is fairly pervasive, changes in its levels are unlikely to affect self-efficacy. That is, impostors both high and low in coping with anxiety will have similar levels of math self-efficacy. Conversely, for non-impostors, higher levels of anxiety (lower coping) will decrease math self-efficacy. Thus, the effect of anxiety on math self-efficacy depends on impostorism.

Research question 6. Will impostors have reduced future expectations and aspirations in STEM areas? Will a lowered academic self-efficacy in math account for this relationship?

Hypothesis 6. Impostors will not expect or aspire to succeed as at levels as high as non-impostors do. Academic self-efficacy in math will mediate the relation between impostorism and STEM aspirations/expectations (See Fig. 3).

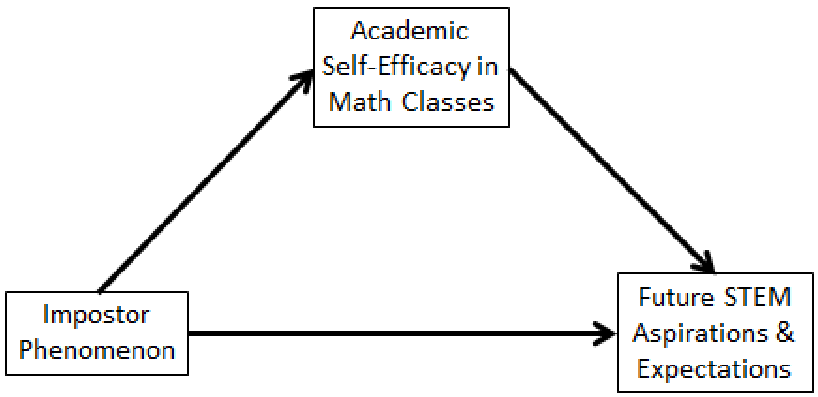

Figure 4: Model of the proposed mediation of math self-efficacy on STEM aspirations/expectations.

Rationale 6. Clance and Imes (1978) reported qualitative findings that impostors have low expectations for future achievements. Moreover, repeated exposure to success did not alter these beliefs. Felder (1988) provided anecdotal evidence that impostors are more likely to drop out of school or change majors due to the psychological toll of the impostor phenomenon. In this study, I will attempt to use quantitative measures of aspirations and expectations to determine the effects of impostorism on future intentions. I expect that impostors will have lower expectations and aspirations than non-impostors, even when their abilities are the same.

Clance and O'Toole (1988) found that impostors turn down higher jobs because they doubt their ability to function at that level. As self-efficacy refers to a confidence in one's abilities, the impostors' doubt could be construed as a reduction in self-efficacy. The impostors have handicapped their own future opportunities due to their lack of self-efficacy in that area. Several studies (e.g. Adedokun et al., 2013; Inda et al., 2013) have found a positive association between self-efficacy and future aspirations and expectations. For the current study, I propose that impostors have reduced STEM aspirations/expectations, and that this association is due to their lower academic self-efficacy in math.

Methods

Participants. Three hundred six undergraduates (64.38% female) from a large, public university in the southwestern US participated in the present research in exchange for partial course credit, extra course credit, or entrance into a raffle for a small prize. Of the original 367 responses, 61 had to be removed for reasons such as the participant was not in a STEM major (N = 32), the participant finished the hour-long survey in less than 10 minutes (N = 23), the participant completed the survey twice (N=4), or the participant was less than 18 years old (N = 4). The largest racial/ethnic group represented was European American (30.39%), closely followed by Asian-American (29.4%) and Latin-American (25.49%). Additionally, 4.90% of students self-reported as African-American, 4.90% as Multiracial, 2.29% as Arab-American, and 0.33% as Native American.

Participants were all enrolled in majors in one of the following schools: engineering, geosciences, or natural sciences. See Table 1 for the number of males and females in each academic college. Pearson Chi-Square analysis revealed that the number of males and females did not significantly differ within each college ($\chi^2 = 5.691$; $p = .128$).

Table 1
Frequency of Males and Females in Given Academic Colleges

	Males		Females		Total	
Academic College	N	% of Males	N	% of Females	N	% of Total
Engineering	27	24.8	31	15.7	58	19
Geosciences	2	1.8	1	0.5	3	1
Natural Sciences	80	73.4	164	83.2	244	79.7
Total	109		197		306	

A power analysis using the statistical program G*Power 3.1.2 (Faul et al., 2009) revealed a necessary sample size of 92 students, assuming an alpha level of $\alpha=.05$, power of $1-\beta=.80$, and effect size of $f^2=.15$, recommended by Faul and colleagues as a conventional value of a medium effect.

Participants were recruited in one of three ways. First, 239 students completed the survey for partial fulfilment of a course requirement within the educational psychology department. These students had the opportunity to complete an alternate assignment if they chose not to participate in the present research as members of the educational psychology (EDP) subject pool. The next group of students (N = 48) came from the statistics department. These participants received extra credit from their professors after completing the study. The final group (N = 19) was recruited from math and engineering courses from the university. These students were entered into a drawing for the chance to earn one of five small gift certificates to a national store.

Procedure. Participants were informed about the survey through their professors or me, either in person during class or via email. Students were provided short background information about the study and told that their participation was voluntary and confidential. They were provided a website address to the online survey hosted by the research portal *Qualtrics (*see Appendix for complete survey). The initial page included basic information about the research as well as the consent form. Students who agreed to participate were directed to the survey, while students who did not agree were directed to a page that informed them of the alternate assignment available to EDP subject pool participants. Research participants were able to complete the surveys from the computer of their choice at any time during the eight-week access period. Students did not have to answer any question they were uncomfortable with, and they were able to sign out of the website and complete the measures at a later time if they wished. The entire study took approximately 60 minutes.

Measures. Measures are included in the Appendix and include the following scales.

Demographics. This study contained a demographics section where participants reported their age, sex, race/ethnicity, socioeconomic status, and year in school. The students provided their current GPA and math scores on the SAT or ACT. To comply with Bandura's (1986) specification that an individual's *perception* of her achievement is more important than the achievement itself, the participants rated their satisfaction with their GPA, SAT, and ACT scores. Additionally, they provided their academic major, their interest in it, and why they chose this area of study. Participants also answered items asking for their perception of gender equity within the classroom.

Math Self-Efficacy Scale, Course Subsection. The Math Self-Efficacy Scale (MSES; Betz & Hackett, 1983) is a 16-item list of math-related college courses. Participants rated how confident they were that they could take the class and receive a final grade of "A" or "B." Sample courses included "Economics" and "Trigonometry." As with Kranzler and Pajares (1997), I changed the original 10-point, Likert-style rating system to a 5-point one to make administration easier and to match the other questionnaires in the present study. Langenfeld and Pajares (1993, cited in Kranzler & Pajares, 1997) found similar reliability scores for the 10-point and the 5-point scales. For the current study, participants rated their confidence of receiving a high grade from 1 (*no confidence at all*) to 5 (*complete confidence*). Scores were summed, with higher values indicating greater math self-efficacy.

The original MSES contained three sections, Tasks, Courses, and Problems, which could be summed into one composite score or analyzed independently (Betz & Hackett, 1983; Hackett, 1985). Kranzler and Pajares (1997) argued that the different subscales should be used as separate measures depending on what was being researched; the study should use the subscale most proximal to the variable being predicted. Thus, the current research used the Courses section of the MSES since an individual's perception about her ability to excel in a math class would most relate to her choice of major as well as experience of impostorism.

Betz and Hackett (1983) reported a Cronbach's alpha of .93 for the Courses subsection, with item-total correlations ranging from .33 to .73. Lent, Lopez, and Bieschke (1991) reported a test-retest reliability of .94. The current study produced a Cronbach's alpha of .93 for the Courses section. The MSES has shown strong convergent validity, correlating .66 with the confidence section of the Fennema-Sherman Mathematics Attitudes Scale (1976). Other research (Betz & Hackett, 1983; Hackett, 1985; Pajares & Miller, 1995) has found the MSES to relate to choice of a STEM-based major and math performance.

Academic Self-Efficacy in Math Courses. For the current study, I, following the example of Fast and colleagues (2010), revised the Academic Self-Efficacy section of the Patterns of Adaptive Learning Scales (Midgley et al., 2000) to reflect self-efficacy in math courses specifically. The scale consisted of five items which participants rated on a 5-point, Likert-style response set from 1 (*strongly disagree*) to 5 (*strongly agree*). A representative item is “I’m certain I can master the skills taught in my math courses.” Scores were summed, and higher values indicated greater math self-efficacy. Midgley and colleagues (2000) found the original subscale to have good internal consistency (Cronbach’s alpha = .78), while Fast and colleagues (2010) reported a high Cronbach’s alpha as well ($\alpha = .84$). The present study had a Cronbach’s alpha of .91 and showed convergent validity by highly correlating with the MSES ($r = .42$; $p < .001$).

Sources of Mathematics Self-Efficacy Scale. The Sources of Mathematics Self-Efficacy Scale (Lent, Lopez, & Bieschke, 1991) is a 40-item scale intended to measure Bandura’s (1986) four sources of self-efficacy: prior achievement (mastery achievement), vicarious information, verbal persuasion, and emotional arousal, each of which constitutes its own subscale. A representative item from the vicarious information subscale is, “While growing up, many of the adults I most admired were good at math.” Participants rate their agreement with the items on a 5-point, Likert-style scale from 1 (*strongly disagree*) to 5 (*strongly agree*). Each subscale contains ten statements, with some worded positively and others negatively and reverse coded. Scores for each section are summed independently, and higher scores indicate more positive math experiences. The scale for emotional arousal (anxiety) is reverse scored such that high scores indicate greater levels of *coping* with anxiety. This scale was obtained via email from the first author (Lent) and used with permission.

This scale has shown strong reliability and validity and has been used extensively in research. In the original study, Lent and colleagues (1991) found the four sources were significantly interrelated (r = .20 to .76), and had strong test-retest reliability (r = .85 to .96). Additionally, internal consistencies for the four items ranged from .56 for vicarious information to .90 for emotional arousal. In the present study, three of the sources, prior achievement, verbal persuasion, and emotional arousal displayed strong reliability (Cronbach's alphas = .85; .75; .91; respectively). As with Lent and colleagues (1991), however, I found low reliability (Cronbach's alpha = .59) for the vicarious information source. Even removing items from the scale failed to produce an alpha above .659; thus, I disregarded the subscale's use in further analysis.

Math Identity. Math Identity (MI) was measured by a 4-item scale from the work of Lesko and Corpus (2006) and based on Schmader and colleagues' (2001) research. Respondents indicated how much they agreed with the statements on a 7-point, Likert-style scale from 1 (*strongly disagree*) to 7 (*strongly agree*). "Doing well on mathematical tasks is very important to me" is a representative item. Two items were reverse scored and all items were summed to create a scale score. Higher scores indicate a stronger math identity. Lesko and Corpus (2006) found the scale to demonstrate strong internal reliability (alpha = .85), and the present research revealed a Cronbach's alpha of .84.

Clance Impostor Phenomenon Scale. The 20-item Clance Impostor Phenomenon Scale (CIPS; Clance, 1985) was created to measure the level of impostorism an individual was experiencing. Participants rated how strongly each statement applied to them on a 5-point scale from 1 (*not at all true*) to 5 (*very true*). A sample item is, "At times, I feel my success has been due to some kind of luck." Responses were summed, and higher scores indicated greater levels of impostorism. The CIPS was used with permission from the author.

Chrisman and colleagues (1995) and French and colleagues (2008) reviewed the CIPS and found it to have strong psychometric properties. The scale showed strong construct validity, as impostors reported higher depression, self-monitoring, and social anxiety than non-impostors. But although the CIPS related to these constructs, it produced different enough scores to display discriminate validity from these variables. Additionally, the CIPS has demonstrated high internal consistency, with researchers reporting Cronbach's alphas between .84 (Prince, 1989) to .96 (Holmes et al., 1993). The present study had a strong reliability of .92.

Perceived Parental Influence. Kleanthous and Williams (2013) developed the Perceived Parental Influence (PPI) scale to measure the influence of family on students' attitude toward math. The original scale contained questions about parental influence in two areas: Schooling and Higher Education. The present study includes the seven items from the Schooling subsection reworded to address mathematics classes specifically. Additionally, they have been rewritten in past tense so the participants can recall their parents' influence in the years before their college matriculation. A sample item is "My parents encouraged me to do my best in math." Participants rate the statements on a 5-

point, Likert-style scale from 1 (*strongly disagree*) to 5 (*strongly agree*). The researchers found a Cronbach's alpha of .54 for the Schooling subsection and .72 for the full scale. The survey showed strong construct validity, as indicated by fit statistics. The present data produced acceptable reliability (Cronbach's alpha = .78) for the reworded Schooling scale as well.

Gender role variables. The gender role variables contained three measures: the Personal Attributes Questionnaire, the Traditional-Egalitarian Sex Role Scale, and the Revised Women in Science Scale (see below). These three scales measure the degree to which a participant has internalized gender role stereotypes. On the Personal Attributes Questionnaire, respondents indicated how closely they resemble stereotypically masculine or feminine attributes. The remaining scales determined the level of traditionality in a participant's views about the rights and roles of women. The present study includes three separate scales to measure the construct from the most distal to the most proximal level.

Personal Attributes Questionnaire (Short Form). The Personal Attributes Questionnaire (PAQ; Spence, & Helmreich, 1978) is a 24-item survey of bipolar adjectives intended to measure gender role in masculinity (instrumentality) and femininity (expressiveness). Participants rated themselves on a 5-point rating scale with the bipolar traits as the endpoints. The questionnaire contains eight items that are more common in men than women (M subscale), and eight items that are more common in women (F subscale). Each of these sixteen items is desirable in both genders. The remaining eight items were not included in the analyses, but represent traits that are more desirable in one gender than another (M-F subscale). A representative pair of a masculine trait is “very independent,” as contrasted from “not at all independent”; and a feminine trait is “very gentle,” as opposed to “very rough.” The PAQ has shown strong psychometric properties. Spence & Helmreich (1978) found the subscales on the short form to have internal consistencies of .85 (M), .82 (F), and .78 (M-F). Additionally, the short form subscales correlated at levels of .91 and above with the original version. The current study produced acceptable Cronbach’s alphas of .75 (M) and .78 (F). Using a Multitrait-Multimethod analysis, Choi (2004) found the PAQ to show convergent validity (greater than .60) when measuring the same construct with different methods. Additionally, it demonstrated divergent validity as shown by measuring different constructs with the same method.

Traditional-Egalitarian Sex Role Scale. The Traditional-Egalitarian Sex Role Scale (TRES; Larsen & Long, 1988) measures an individual’s beliefs about sex roles in varying domains. The scale contains 20 items which espouse either a traditional view or an egalitarian view of sex roles. Respondents rate the statements on a 5-point, Likert-style scale from 1 (*strongly disagree*) to 5 (*strongly agree*). Scores are summed, and higher scores indicate a more egalitarian attitude. A representative item is, “It is just as important to educate daughters as it is to educate sons.” Larsen and Long (1988) reported a Spearman-Brown reliability of .91. Additionally, they found the scale to demonstrate concurrent validity with the Sex Role Orientation Scale (Brogan & Kutner, 1976), with a correlation of .79. In the present research, the items had a reliability of .87.

Revised Women in Science Scale. The Revised Women in Science Scale (Owen et al., 2007) was based on the Erb and Smith (1984) measure of attitudes about women studying and working in science domains. The revised version contains 14 statements which participants rate on a 6-point, Likert-style scale from 1 (*strongly disagree*) to 6 *(strongly agree*). The scale consists of two subscales: Equality, which contains 6 items; and Sexism, which contains 8 items. For this study, the scale was altered for the mathematical domain, so that the term “science” was changed to “math” on items number 1, 5, 7, and 8; the term “scientific” was changed to “mathematical” on items 2 and 3; and the term “chemistry” was changed to “calculus” on item 12. A sample statement includes, “Women can be as good in math careers as men can.” The revised scale demonstrated strong reliability, with alphas of .75 and .78 for the two subsections, Sexism and Equality, respectively. Additionally, the revised scale demonstrated factorial validity. The authors recommend calculating mean scores for each subsection when using them for analysis. The present data displayed Cronbach’s alphas of .86 and .88 for the Equality and Sexism subsections.

Theory of Intelligence. Dweck and colleagues (1995) developed the 3-item Theory of Intelligence to measure an individual’s implicit beliefs about intelligence, as fixed or malleable. A sample item includes “You have a certain amount of intelligence and you really can’t do much to change it.” Participants rate the items on a 6-point, Likert-type scale from 1 (*strongly disagree*) to 6 (*strongly agree*). Response anchors were reversed from the original study to match the endpoints of the other questionnaires in the present research. Dweck and colleagues (1995) recommend that the respondents be sorted into two categories: those who believe that intelligence is determined at birth (entity theorists), and those who believe that intelligence can be changed (incremental theorists).

The original study found the scale to demonstrate strong psychometric properties. The measure had high internal reliability, with Cronbach’s alphas ranging from .94 to

.98, and a test-retest alpha of .80. Convergent validity was demonstrated by showing that the scale related to other implicit measures. Additionally, the items did not relate to sex, age, political affiliation, or religion, findings which indicate the measure has good divergent validity. Moreover, the scale had no association with self-presentation variables, so participants were not simply responding in socially desirable ways. Reliability in the present study was a strong .89.

Impression Management. Impression Management (IM; Paulhus, 1988) is a 20-item measure of the level to which an individual deliberately modifies her self-presentation for an audience. Participants rate each statement on a 7-point scale from 1 (*not true [of me*]) to 7 (*very true [of me]*). Scores of 6 or 7 (1 or 2 on reverse-coded items) receive one point. These values are then summed to create a composite IM score, with higher scores indicating that the participant's answers were exaggeratedly desirable. A sample statement includes, "I never cover up my mistakes." Paulhus (1991) reported coefficient alphas ranging from .75 to .86 and a test-retest reliability of .65. In addition, the IM scale has demonstrated strong convergent validity with other lie scales (Paulhus, 1991). In the present study, reliability was acceptable with a Cronbach's alpha of .77.

Future Aspirations and Expectations. The measure of future aspirations and expectations was created based on the findings of Xie and Shauman (2003). The researchers studied sex differences in the occupational and educational activities of students in STEM majors. In the present study, participants were directly asked about their aspirations and expectations for graduation, work, and graduate school both in and out of STEM-related areas. Respondents indicated on a 5-point, Likert-style scale how much they agree with each item from 1 (*strongly disagree*) to 5 (*strongly agree*). "I expect to attend graduate school in an area related to my major" is a sample item. Items number 2 and 4 in each sections were added together to create one composite scale score for both STEM aspirations and STEM expectations.

Chapter 4: Results

Preliminary analysis. Initially, I reviewed the results and performed general data cleaning. Since the participants were recruited from different areas (EDP subject pool, statistics classes, and math/engineering classes), I compared the groups to determine if they significantly differed on any major study variables. Due to the small numbers of students in groups two (statistics) and three (math/engineering), I combined these participants into one group to compare their responses with the EDP students'. The participants who came from the EDP subject pool reported significantly higher anxiety, traditionality, and sexism. Additionally, the EDP students listed lower parental influence, equality, STEM aspirations, and STEM expectations when compared to the other participants (See Table 2). Since the two groups significantly differed in these seven areas, subsequent analyses with these constructs also included a dummy coded variable to indicate group membership.

Table 2

Participant Group Differences on Major Study Variables

	EDP Group			Other Group				
Variable	Mean	SD	N	Mean	SD	N	r	p
Math Self-Efficacy	59.87	11.81	231	61.89	11.31	65	.072	.218
Academic Self-Efficacy	19.69	3.09	234	20.19	3.57	67	.066	.255
Prior Achievement	36.06	6.42	232	37.14	6.11	64	.070	.228
Verbal Persuasion	35.47	5.53	232	36.43	4.77	65	.074	.204
Emotional Arousal	32.80	7.79	230	35.33	6.99	64	.136*	.020
Math Identity	20.43	4.98	238	20.52	4.74	67	.008	.896
Impostor Phenomenon	61.22	14.25	228	62.06	15.52	67	.024	.678
Parental Influence	22.67	4.78	236	24.06	4.70	67	.121*	.036
Masculinity	19.58	4.78	233	19.48	4.99	67	-.008	.884
Femininity	23.81	4.06	230	23.34	5.29	67	-.045	.439
Traditionality	75.78	9.18	233	80.00	8.03	67	.194***	.001
Sexism	4.22	0.74	236	4.48	0.62	67	.147**	.010
Equality	4.45	0.60	236	4.69	0.51	66	.169***	.003
Theories of Intelligence	8.66	3.43	237	7.91	3.15	67	-.092	.108
Impression Management	4.73	3.41	233	5.37	3.60	65	.077	.184
Aspire STEM	7.19	2.05	237	7.78	1.91	67	.120*	.037
Expect STEM	6.98	2.04	237	7.81	1.88	67	.168***	.003

Note. EDP group was coded as 1, while Other group was coded as 2. Emotional arousal is scored such that higher scores indicate lower anxiety. Traditionality is scored such that lower scores indicate a more traditional view. Sexism is reverse scored such that higher scores indicate lower sexism. Higher scores on Theories of Intelligence indicate and entity theory.
* $p < .05$. ** $p < .01$. *** $p < .005$.

At the specified university, the majority of students use the SAT as their college entrance exam. However, some students choose to take the ACT and report these scores on their admissions application. Therefore, I converted ACT scores into comparable SAT scores based on concordance tables provided by the present university (The University of Texas at Austin, 2011).

In the Demographics section, participants listed their academic college and major. Using university statistics from the previous year (The University of Texas, 2013), I determined the percent of female graduates in each major at the present university. Then, using categories developed by Brady and Eisler (1999), I classified the participants as belonging to male-dominated majors (0 – 35 % female graduates), female-dominated majors (65 – 100% female graduates), or mixed-sex majors (36 – 64% female graduates). As expected, more females than males were in the female-dominated majors, and vice versa (see Table 3). The three most popular majors listed were Human Development and Family Science (N = 46), Biology (N = 41), and Nutritional Sciences (N = 31).

Table 3
Frequency of Males and Females in Different Categories of Major

	Males		Females		Total	
Major Category	N	% of Males	N	% of Females	N	% of Total
Male-dominated	38	34.9	28	14.2	66	21.6
Mixed-sex	59	54.1	78	39.6	137	44.8
Female-dominated	12	11.0	91	46.2	103	33.7
Total	109		197		306	

Note. As with Brady & Eisler (1999), Male-dominated majors graduated 0 - 35 % females in 2011-2012. Mixed-sex majors graduated 36 - 65 % females. Female-dominated majors graduated 66 - 100% females.

Descriptive statistics. Descriptive statistics of all the major variables were calculated. Table 4 contains the means and standard deviations for the continuous data separated by sex. Males reported significantly higher SAT scores, math self-efficacy, math identity, prior achievement in math, verbal persuasion in math, coping with emotional arousal, traditionality, and masculinity. Females, on the other hand, had higher egalitarianism, equality, and femininity. No mean sex differences were found on GPA, impostorism, theories of intelligence, impression management, STEM aspirations of expectations, or perceived parental influence.

Table 4

Means, Standard Deviations, and Sex Differences on Major Variables

	Males		Females			
Variable	Mean	SD	Mean	SD	t	P
GPA	3.19	0.57	3.14	0.49	0.718	.397
SAT	683.52	91.92	646.67	88.99	9.345**	.002
Math Self-Efficacy	65.04	11.60	57.63	10.92	29.986***	.000
Academic Self-Efficacy	20.69	3.07	19.31	3.18	13.355***	.000
Prior Achievement	38.04	5.70	35.29	6.51	13.374***	.000
Verbal Persuasion	36.87	4.83	35.01	5.57	8.372**	.004
Emotional Arousal	35.82	6.53	31.94	7.95	18.452***	.000
Math Identity	21.26	4.90	20.01	4.89	4.583*	.033
Impostor Phenomenon	61.68	14.04	61.26	14.83	.057	.812
Parental Influence	22.66	4.41	23.15	5.00	-0.861	.390
Masculinity	20.34	4.69	19.11	4.84	4.586*	.033
Femininity	22.80	4.27	24.21	4.35	7.238**	.008
Traditionality	72.35	9.66	79.11	7.82	43.236***	.000
Sexism	3.97	0.87	4.45	0.56	33.676***	.000
Equality	4.28	0.66	4.62	0.50	25.045***	.000
Theories of Intelligence	8.78	3.60	8.34	3.25	1.192	.276
Impression Management	4.42	3.28	5.11	3.53	2.701	.101
Aspire STEM	7.32	2.05	7.32	2.03	0.013	.990
Expect STEM	7.06	2.22	7.22	1.93	-0.641	.522

Note. Emotional arousal is scored such that higher scores indicate lower anxiety. Traditionality is scored such that lower scores indicate a more traditional view. Sexism is reverse scored such that higher scores indicate lower sexism. Higher scores on Theories of Intelligence indicate an entity theory.

* $p < .05$. **$p < .01$. ***$p < .005$.

Zero-order correlations are provided for males and females separately on all the variables of interest in Table 5.

Table 5
Correlations Among Major Study Variables

Variable	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
1. Percent females in major		-.213*	-.094	-.049	-.175	.042	-.259**	-.018	-.005	.113	.187	.019	.046	.006	-.108	-.194*	.186	.194*
2. Math Self-Efficacy	-.356***	.93	.419***	.283***	.337***	.303***	.260**	-.070	-.067	.051	-.023	.112	.113	.291***	.035	.287***	.147	.143
3. Academic Self-Efficacy	-.141	.360***	.91	.507***	.480***	.478***	.189	.032	.053	.228*	.197*	.162	.172	.441***	-.023	.281***	.279***	.232*
4. Prior Achievement	-.346***	.502***	.482***	.85	.675***	.672***	.472***	.101	.165	.214*	.315***	.050	.138	.255**	-.127	.268**	.004	-.062
5. Verbal Persuasion	-.392***	.414***	.396***	.786***	.75	.567***	.402***	.154	.215*	.193*	.172	.071	.151	.289***	.042	.355***	.146	.026
6. Emotional Arousal	-.266***	.444***	.495***	.791***	.608***	.91	.308***	-.173	.170	.264**	.297***	.065	.140	.304***	-.100	.310***	.044	.031
7. Math Identity	-.348***	.336***	.247***	.558***	.460***	.496***	.84	.118	-.035	.127	.112	-.020	.052	.051	-.018	.245*	-.070	-.141
8. Impostor Phenomenon	-.161*	.056	-.013	-.020	-.002	-.116	.085	.92	.312***	-.344***	-.055	.029	-.069	.008	.128	-.074	-.107	-.269**
9. Perceived Parental Influence	-.065	.225***	.023	.167*	.205**	.063	.195**	.057	.78	-.140	.120	.024	-.021	.081	-.133	.071	-.260**	-.247**
10. Masculinity	-.049	.155*	.214***	.123	.016	.208**	.093	-.426***	-.059	.75	.372***	-.101	.009	-.026	-.026	.143	.182	.172
11. Femininity	.163*	-.014	.129	.029	.022	.014	-.012	-.016	.039	.020	.78	.040	.052	.169	-.148	.209*	-.001	.020
12. Traditionality	.026	.183*	.163*	-.027	.084	.014	-.038	-.033	.067	.010	.113	.87	.788***	.659***	-.135	-.132	.024	.118
13. Sexism	-.031	.210***	.197**	.053	.127	.022	.056	-.011	.117	-.039	.042	.583***	.75	.685***	-.178	.020	.013	.124
14. Equality	-.043	.227***	.259***	.124	.207**	.058	.091	.037	.087	-.058	.154*	.567***	.742***	.78	-.149	.117	.077	.063
15. Theories of Intelligence	-.166*	.055	-.152*	.098	.028	.051	.098	.196**	-.012	-.067	-.101	-.236***	-.120	-.129	.89	-.003	-.007	-.042
16. Impression Management	-.044	.036	.155*	.021	.045	.012	-.053	-.211***	.035	.102	.202**	.260***	.282***	.270***	-.138	.77	.017	-.005
17. Aspire STEM	.057	.104	.122	.116	.070	.056	-.048	-.094	-.145*	.122	-.017	.170*	.186**	.149*	.014	.042		.833***
18. Expect STEM	.074	.107	.065	.079	.042	.064	-.028	-.150*	-.038	.163*	-.058	.115	.171*	.099	.067	.038	.856***	

Note. Correlations above the diagonal are for male participants, and correlations below the diagonal are for female participants. Values on the diagonal represent Cronbach's alpha for each scale. Females are coded as 1 and males as 2. Traditionality and sexism are reverse scored such that higher scores indicate less traditional and sexist beliefs. Higher scores on Theories of Intelligence indicate an entity theory.
*$p < .05$. ** $p < .01$. ***$p < .005$.

For easier readability, Table 6 provides the means, standard deviations, and correlations for sex and the gender variables. Results indicate that most of the constructs, with the exclusion of masculinity, strongly interrelate. Thus, the gender variables were analyzed together for Hypothesis 1.

Table 6
Summary of Intercorrelations, Means, and Standard Deviations for Scores on the Gender Variables

Measure	1	2	3	4	5	6
1. Sex						
2. Masculinity	-.123*					
3. Femininity	.155**	.120*				
4. Traditionality	.356**	-.075	.131*			
5. Equality	.278**	-.075	.192**	.645		
6. Sexism	.317**	-.053	.093	.720**	.734**	
M		19.55	23.71	76.72	4.50	4.28
SD		4.82	4.36	9.09	.59	.72
N	306	300	297	300	302	303

Note. Sex was coded as males = 0, females = 1.
$*p < .05$. $**p < .01$.

Reliability of instruments. For the final stages of the preliminary analysis, I determined the reliability of each scale using Cronbach's alpha and checked that the assumptions for my analyses were met. Reliabilities are given in the description of each instrument in the Measures section as well as in Table 5. Christmann and Van Aelst (2005) note that the internal reliability statistic Cronbach's alpha usually must be above a value of .75 to be considered a reliable instrument. Only one measure, the Vicarious Information section of the Sources of Math Self-Efficacy Scale, failed to meet this criterion ($\alpha = .59$). Therefore, it was not included in subsequent analyses.

Assumptions. In order for statistical analyses to be valid, certain assumptions must be met prior to primary investigation procedures. Hypotheses 1a and 1b were tested using independent samples t-tests. Stevens (2007) indicates that this type of analysis requires that the data meet three assumptions. First, each group must have normally distributed scores on the dependent variables. Next, the error variance must display homoscedasticity. Finally, the observations should be independent from each other. All three assumptions were met, indicating that analysis on these hypotheses could continue.

Due to the intercorrelation of the gender variables in Hypothesis 1c, this hypothesis was tested using a Multivariate Analysis of Variance (MANOVA). According to Stevens (2009), for this type of analysis, the data must meet three assumptions. The observations should be independent from each other, and the dependent variables should display multivariate normality. Finally, the populations must display equal covariance matrices. The present data met the first two assumptions, but failed the third. However, Stevens (2009) indicates that this assumption is rarely met, and that analyses remain robust to a violation. Therefore, testing of this hypothesis continued.

Finally, the remaining hypotheses were tested using either simultaneous or hierarchical multiple regression equations. According to Keith (2006), this analysis requires four assumptions to be met. First, the predictor variables must have a linear relation with the dependent variable. Additionally, the errors need to be independent and normally distributed. The error variance should also display homoscedasticity. The data for Hypotheses 2, 3, 4, 5, and 6 met these assumptions, so primary analyses could be conducted.

Primary analysis 1. In Hypothesis 1, I proposed that females and males would have different levels of impostorism, academic self-efficacy in math classes, femininity, traditionality/egalitarianism, equality, and sexism. The first two dependent variables were tested with independent samples t-tests. I compared the means of males and females on both impostorism and academic self-efficacy in math to determine if the sexes' scores significantly differed at an α-level of .025 or less. This value of alpha has been adjusted to account for the increase in Type I errors due to multiple tests. I used the Bonferroni correction to divide the original alpha (.05) by the number of t-tests (2) to obtain the given value. As shown in Table 4, males and females did not differ in their levels of impostorism ($t = .238$, $p = .812$). However, Hypothesis 1b was supported, as males reported significantly greater academic self-efficacy in math than females ($t = 13.355$, $p = .000$).

Since the gender role orientation variables strongly correlated (see Table 6), I analyzed sex differences in these constructs using a multivariate analysis of variance (MANOVA). Because masculinity did not relate to the other constructs, I omitted it from other gender hypotheses and analyses. I used a MANOVA since this type of analysis considers the dependent variables jointly, thereby increasing the power over using multiple ANOVAs (Stevens, 2007). The dependent variables were femininity, traditionality, equality, and sexism, measured by the Personal Attributes Questionnaire, the Traditional-Egalitarian Sex Role Scale, and the Revised Women in Science Scale. Again, I used an α-level of .05 to indicate if males and females significantly differed on these variables. The omnibus test for the MANOVA indicated a significant effect had occurred ($F = 12.423$, $p < .001$).

Stevens (2009) recommends further analyzing significant MANOVAS by using multiple t-tests at the α/p level of significance. Here, I had four dependent variables, so I used a test alpha of .0125 to control for the increase in Type I errors due to multiple testing. Results from the t-tests are shown in Table 7 and indicate that males and females differed on all of the gender variables. Females reported significantly greater femininity and equality, while males had higher traditionality and sexism.

Table 7

Means, Standard Deviations, and Sex Differences on Gender Variables

	Males		Females			
Variable	Mean	SD	Mean	SD	T	P
Femininity	22.80	4.27	24.21	4.35	-2.690**	.008
Traditionality	72.35	9.66	79.11	7.82	-6.575***	.000
Equality	4.28	0.66	4.62	0.50	-5.004***	.000
Sexism	3.97	0.87	4.45	0.56	-5.803***	.000

Note. Traditionality and sexism are reverse scored such that higher scores indicate less traditionality and sexism. $^{**}p < .01$. $^{***}p < .001$.

Thus, Hypotheses 1c was supported.

Primary analysis 2. For Hypothesis 2, the variables masculinity, perceived parental influence, math identity, and theories of intelligence, were regressed on impostor phenomenon. The two major participant groups, EDP subject pool and other students, significantly differed on their responses to the Perceived Parental Influence Scale. Thus, to control for group membership, a dummy-coded variable was included as Step 1 in the hierarchical multiple regression. It was expected that masculinity would negatively predict the dependent variable, while parental influence, math identity, and an entity theory of intelligence would positively predict it. Perceived parental influence is the student's recollection of her parents' influence over her math choices and achievement prior to attending college. Since Clance and Imes (1978) reported this familial source as one of the causes of impostorism, it was expected that parental influence would positively relate to the impostor phenomenon. Results are shown in Table 8.

Table 8

Hierarchical Multiple Regression Analyses Predicting the Impostor Phenomenon From Group Membership, Masculinity, Perceived Parental Influence, Math Identity, and Theories of Intelligence

Predictor	B	p	sr^2	R^2	p_{R2}	ΔR^2	$p_{\Delta R2}$
Step 1							
Group Membership	.025	.669	.001	.001	.669		
Step 2							
Group Membership	.025	.646	.001				
Masculinity	-.388***	.000	.156				
Parental Influence	.101	.062	.012				
Math Identity	.116*	.032	.016				
Theories of Intelligence	.162***	.003	.032	.208***	.000	.208***	.000

Note. Group was coded 0 = non-EDP subject pool, 1 = EDP subject pool. For Theories of Intelligence, higher scores indicate an entity theory.
$^*p < .05$. $^{**}p < .01$. $^{***}p < .005$.

The results supported the hypothesis. Masculinity, parental influence, math identity, and theories of intelligence together significantly predicted the impostor phenomenon in the expected directions. The variables together explained 20.8% of the variance in the outcome. Masculinity negatively related to the impostor phenomenon such that participants lower in masculinity reported higher impostor feelings. Masculinity alone accounted for the most variance in impostorism, 15.6%. Additionally, math identity and an entity theory of intelligence both positively predicted the dependent variable. Students reporting greater parental influence over their math choices had a tendency to have higher levels of the impostor phenomenon. Participants who highly identified with math and held entity theories of intelligence were more likely to experience impostorism.

These two variables explained 1.6% and 3.2% of the variance in the outcome, respectively.

Primary analysis 3. I used hierarchical multiple regressions in Hypothesis 3 to analyze the effect of math identity and sex on the impostor phenomenon (Aiken & West, 1991). After centering math identity, I created an interaction term (math identity * sex) to include in the regression since I expected sex to moderate the effect of math identity on the impostor phenomenon. In Step 1, I had math identity and sex predicting the impostor phenomenon. I expected that the variables would each be significant at the $\alpha = .05$ level, as well as explain a significant amount of variance in the dependent variable together. I did not include group membership as a control since the participant groups did not differ on these variables. In Step 2, I added the interaction term to the equation. A significant beta coefficient for the interaction term would indicate that a moderation had occurred; the effect of math identity on impostorism depended on sex. Additionally, I calculated the change in R^2 from Step 1 to Step 2 to determine if the interaction explained a significant amount of variance above the singular variables themselves. Results are shown in Table 9.

Table 9

Hierarchical Multiple Regression Analyses Predicting the Impostor Phenomenon From Math Identity and Sex

Predictor		B	P	sr^2	R^2	p_{R2}	ΔR^2	$p_{\Delta R2}$
Step 1								
	Math Identity	.097	.099	.009				
	Sex	-.006	.992	.000	.010	.244		
Step 2								
	Math Identity	.098	.098	.009				
	Sex	-.005	.934	.000				
	Math Identity * Sex	-.014	.814	.000	.010	.412	.000	.814

Note. Sex was coded 0 = males, 1 = females. All results non-significant.

As indicated by the table, none of the predictors or overall equations were significant. Thus, Hypothesis 3a was not supported.

Hierarchical multiple regression was also used for Hypothesis 3b, the theory that sex moderated the effect of femininity on impostorism. Again, after centering the femininity scores, I created an interaction term of femininity*sex to test the moderation. In Step 1 of the regression, femininity and sex predicted the impostor phenomenon. In Step 2, the interaction term was added to the equation. The results are shown in Table 10 below.

Table 10

Hierarchical Multiple Regression Analyses Predicting the Impostor Phenomenon From Femininity and Sex

Predictor	B	P	sr^2	R^2	p_{R2}	ΔR^2	$p_{\Delta R2}$
Step 1							
Femininity	-.029	.624	.001				
Sex			.000	.001	.871		
Step 2							
Femininity	-.030	.614	.001				
Sex	-.005	.938	.000				
Femininity * Sex	.018	.761	.000	.001	.947	.000	.761

Note. Sex was coded 0 = males, 1 = females. All results non-significant.

Again, all results were non-significant, and Hypothesis 3b was not supported.

Hypotheses 3c was also analyzed using hierarchical multiple regression. For this hypothesis, traditionality and sex were the variables of interest in predicting impostorism. Individuals who support traditionality believe that women should have more traditional, and less egalitarian, roles in varying societal domains. The two participant populations, the EDP subject pool and the other students, significantly differed on their traditionality (see Table 2), so an additional step was included in the analysis to control for group membership. In Step 1, a dummy coded variable for group membership predicted the impostor phenomenon. Traditionality and sex were added to the predictors for Step 2. Finally, in Step 3, an interaction term (traditionality*sex) was added to the equation. Table 11 displays the results from the multiple regression.

Table 11

Hierarchical Multiple Regression Analyses Predicting the Impostor Phenomenon From Traditionality and Sex

Predictor	B	P	sr^2	R^2	p_{R2}	ΔR^2	$p_{\Delta R2}$
Step 1							
Group Membership	.026	.653	.001	.001	.653		
Step 2							
Group Membership	.031	.607	.001				
Traditionality	-.013	.833	.000				
Sex	-.011	.869	.000	.001	.959	.000	.949
Step 3							
Group Membership	.036	.557	.001				
Traditionality	-.021	.743	.000				
Sex	-.017	.799	.000				
Traditionality * Sex	-.037	.556	.001	.002	.957	.001	.556

Note. Group membership was coded 0 = non-EDP subject pool and 1 = EDP subject pool. Sex was coded 0 = males, 1 = females. All results non-significant.

As with the other analyses for Hypothesis 3, neither the regression equations nor the individual variables predicted any significant variance in the dependent variable. Thus Hypothesis 3c was not supported.

In Hypothesis 3d, I proposed that sex would moderate the effect of perceived parental influence on the impostor phenomenon. Perceived parental influence is a measure of the student's perception of her parents' influence on her math choices and successes prior to attending college. Again, the two participant groups differed on their reported levels of perceived parental influence, so a dummy coded variable was included in Step 1 to control for this difference. In Step 2, perceived parental influence, sex, and group membership predicted impostorism. In the third step, I added an interaction term of parental influence*sex to the equation. Results are shown in Table 12.

Table 12

Hierarchical Multiple Regression Analyses Predicting the Impostor Phenomenon From Perceived Parental Influence and Sex

Predictor	β	p	sr^2	R^2	p_{R2}	ΔR^2	$p_{\Delta R2}$
Step 1							
Group Membership	.023	.695	.001	.001	.695		
Step 2							
Group Membership	.012	.848	.000				
Parental Influence	.138*	.019	.019				
Sex	-.022	.719	.000	.020	.125	.019	.061
Step 3							
Group Membership	.021	.726	.000				
Parental Influence	.598**	.007	.025				
Sex	-.027	.652	.001				
Parental Influence * Sex	-.478*	.031	.016	.035*	.034	.016*	.031

Note. Group membership was coded 0 = non-EDP subject pool and 1 = EDP subject pool. Sex was coded 0 = males, 1 = females.
*p < .05. **p < .01.

While Step 2 was not significant, the addition of the interaction term contributed a significant amount to the variance and created a significant prediction equation in Step 3. In the third step, both perceived parental influence and the interaction term parental influence*sex added significant explanation to the variance in impostorism. The moderation was significant, in that sex did moderate the relation between parental influence and impostorism. The overall regression equation explained 3.5% of the variance in the impostor phenomenon, while perceived parental influence and the interaction term individually explained 2.5% and 1.6%, respectively.

Due to the significant moderation (β = -.478, p = .031), a simple slopes analysis was conducted (Aiken & West, 1991). For males, perceived parental influence significantly related to the impostor phenomenon (β = .320, p = .002). This result indicates that when parents influence their sons' math choices and achievement in secondary school, those children are likely to report feeling like impostors in college. However, the relation was not significant for females (β = .056, p = .438). The perceived influence of parents did not relate to their daughters' impostorism later in life. This finding was the opposite of my initially proposed hypothesis. Graphs for the male and female equations are given in Figure 5.

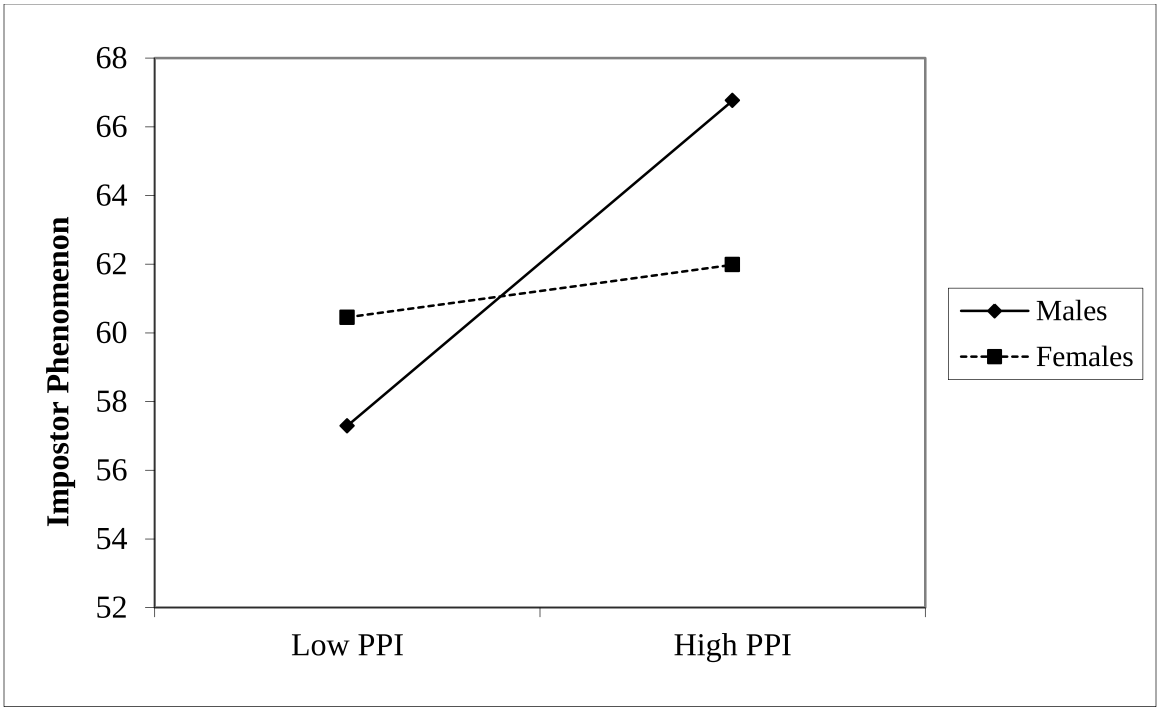

Figure 5. Simple regression lines for males and females predicting the impostor phenomenon from perceived parental influence. Graphed using macro from Dawson (2014).

Primary analysis 4. For Hypothesis 4, I used hierarchical multiple regression to test if the three sources of math self-efficacy, prior achievement, verbal persuasion, and emotional arousal, predicted academic self-efficacy for math classes. Vicarious information was not included as a source because the measurement failed to produce adequate reliability. Again, the two participant groups (EDP subject pool and other) differed in their levels of one of the constructs, emotional arousal, so Step 1 of the regression included a dummy coded variable to control for group membership. In Step 2, prior achievement, verbal persuasion, and emotional arousal were entered as predictor variables of academic self-efficacy for math. Results from the multiple regression are shown in Table 13.

Table 13

Hierarchical Multiple Regression Analyses Predicting Academic Self-Efficacy in Math Classes from Prior Achievement, Verbal Persuasion, and Emotional Arousal

Predictor	β	P	sr^2	R^2	p_{R2}	ΔR^2	$p_{\Delta R2}$
Step 1							
Group Membership	.057	.338	.003	.003	.338		
Step 2							
Group Membership	-.005	.919	.000				
Prior Achievement	.217*	.024	.018				
Verbal Persuasion	.096	.218	.005				
Emotional Arousal	.288***	.000	.046	.301***	.000	.298***	.000

Note. Group Membership was coded 0 = non-EDP subject pool, 1 = EDP subject pool. Emotional arousal was reverse coded such that higher scores indicate greater coping with emotional arousal.

*p < .05. **p < .01. ***p < .005.

Step 2 significantly explained academic self-efficacy for math, accounting for 30.1% of the variance in the outcome variable. Both prior achievement and emotional arousal were significant predictors, explaining 1.8% and 4.6% of the variance, respectively.

Primary analysis 5. In Hypothesis 5, I used hierarchical multiple regressions to analyze the moderation effect of the impostor phenomenon on the relation between each source of math self-efficacy and academic self-efficacy in math classes (Aiken & West, 1991). While Bandura (1997) argued for the *perception* of prior achievement as a source of math self-efficacy, impostors may be more likely to discount their past successes. Therefore, their perception of the event may be skewed compared to non-impostors. To account for this possible bias, I used a quantifiable variable, college GPA, to represent prior achievement. In Step 1 for Hypothesis 5a, I had college GPA and the impostor phenomenon predict academic self-efficacy in math. In Step 2, I added an interaction term, GPA*impostor phenomenon to the equation. Results are listed in Table 14.

Table 14

Hierarchical Multiple Regression Analyses Predicting Academic Self-Efficacy in Math from College GPA and the Impostor Phenomenon

Predictor	β	p	sr^2	R^2	p_{R2}	ΔR^2	$p_{\Delta R2}$
Step 1							
College GPA	.129*	.032	.016				
Impostor Phenomenon	.029	.632	.001	.017	.097		
Step 2							
College GPA	.648**	.008	.025				
Impostor Phenomenon	.790*	.022	.019				
GPA * Impostor	-.892*	.025	.018	.034*	.022	.018*	.025

Note. *p < .05. **p < .01. ***p < .005.

The overall equation predicted 3.4% of the variance in academic self-efficacy in math, with college GPA and impostorism alone adding 2.5% and 1.9% to that explanation. The addition of the interaction term was significant (β = -.892, p = .025), indicating that the effect of GPA on math self-efficacy depended on impostorism. To further probe this relation, I analyzed the simple slopes at high (one standard deviation above the mean) and low (one standard deviation below the mean) levels of impostorism. For high impostors, GPA was unrelated to academic self-efficacy in math (β = .011, p = .895). However, for low impostors, GPA positively associated with academic self-efficacy (β = .279, p = .001). That is, for participants not suffering from impostorism, students with high math self-efficacy tended to have higher grades, as well. The graph of the simple regression equations is given in Figure 6.

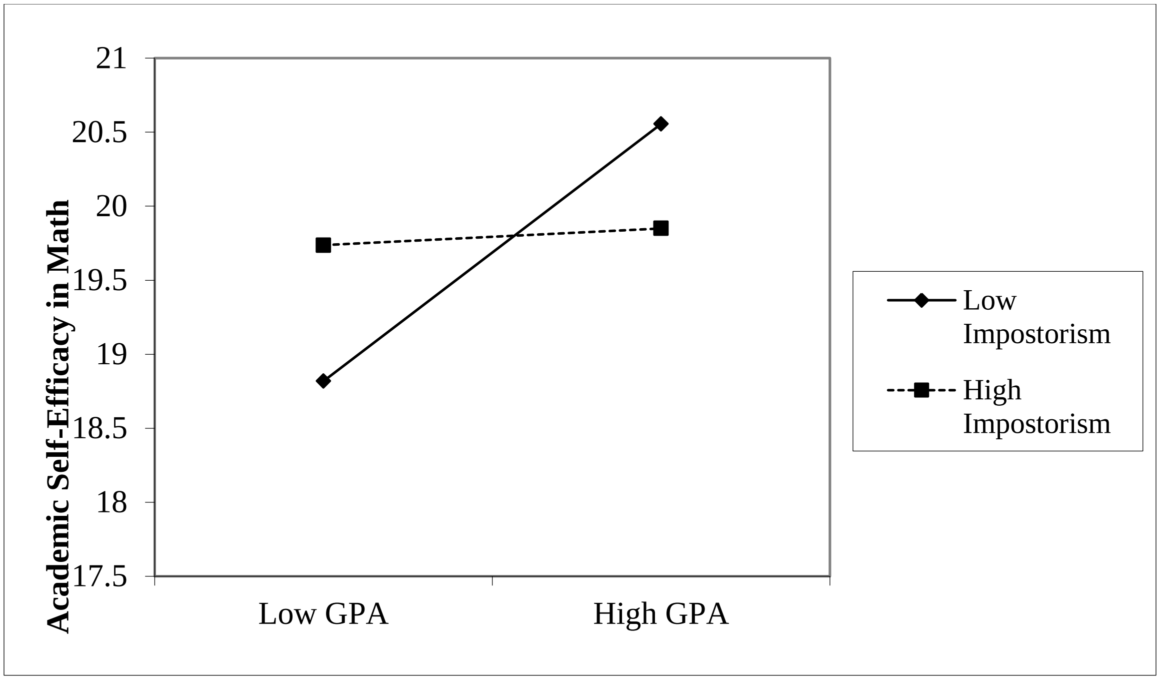

Figure 6. Graph of the effect of GPA on academic self-efficacy in math for low- and high-impostors. Graphed using macro from Dawson (2014).

Hypothesis 5b was not analyzed due to the low reliability of the vicarious information scale. For Hypothesis 5c, the multiple regression analysis of Hypothesis 5a was replicated using verbal persuasion, rather than prior achievement. Step 1 included verbal persuasion and the impostor phenomenon. In Step 2, the interaction term of verbal persuasion*impostor phenomenon was added as a predictor to academic self-efficacy in math. Results are listed in Table 15.

Table 15

Hierarchical Multiple Regression Analyses Predicting Academic Self-Efficacy in Math from Verbal Persuasion and the Impostor Phenomenon

Predictor	β	p	sr^2	R^2	p_{R2}	ΔR^2	$p_{\Delta R2}$
Step 1							
Verbal Persuasion	.512***	.000	.262				
Impostor Phenomenon	.012	.821	.000	.262***	.000		
Step 2							
Verbal Persuasion	.512***	.000	.262				
Impostor Phenomenon	.008	.874	.000				
Verbal Pers * Impostor	.026	.623	.001	.263***	.000	.001	.623

Note. *p < .05. **p < .01. ***p < .005.

Both Step 1 and Step 2 were significant predictors of academic self-efficacy in math. In Step 1, only verbal persuasion added a significant amount, 26.2%, to the variance in the outcome variable. Moreover, the addition of the interaction term did not add any explanation to academic self-efficacy in math. Thus, Hypothesis 5c was not supported.

For Hypothesis 5d, emotional arousal and the impostor phenomenon were analyzed as predictors of academic self-efficacy in math classes. The two participant groups, EDP subject pool and other students, significantly differed on their levels of emotional arousal, so group membership was included as a control variable in Step 1. In Step 2, emotional arousal and the impostor phenomenon were added to the prediction. An interaction term of emotional arousal*impostor phenomenon was created and added to Step 3 of the regression. Table 16 lists the results of the hierarchical multiple regression analysis.

Table 16

Hierarchical Multiple Regression Analyses Predicting Academic Self-Efficacy in Math from Emotional Arousal and the Impostor Phenomenon

Predictor	B	p	sr^2	R^2	p_{R2}	ΔR^2	$p_{\Delta R2}$
Step 1							
Group Membership	.062	.300	.004	.004	.300		
Step 2							
Group Membership	-.012	.819	.000				
Emotional Arousal	.527***	.000	.269				
Impostor Phenomenon	.089	.085	.011	.272***	.000	.268***	.000
Step 3							
Group Membership	-.017	.737	.000				
Emotional Arousal	.526***	.000	.271				
Impostor Phenomenon	.098	.059	.013				
Emotion Arous * Impostor	-.105*	.041	.015	.283***	.000	.011*	.041

Note. Group membership was coded 0 = non-EDP subject pool and 1 = EDP subject pool. Emotional arousal was reverse coded such that higher scores indicate greater coping with emotional arousal.

*p < .05. **p < .01. ***p < .005.

Both Steps 2 and 3 produced significant regression equations, explaining 27.2% and 28.3% of the variance in academic self-efficacy in math, respectively. In the second step, only emotional arousal was a significant predictor of the outcome variable. The interaction term added in Step 3 also significantly added to the equation. Emotional arousal alone accounted for 27.2% of the variance in the dependent variable, while the interaction of emotional arousal and impostorism added another 1.5% to the prediction. An increase in emotional arousal related to an increase in academic self-efficacy in math, such that students who coped with their emotions well (i.e., had lower anxiety) tended to have greater self-efficacy. However, as indicated by the interaction term, this increase depended on impostor status.

Since a moderation occurred, I probed the findings to determine the simple regression lines (Aiken & West, 1991). For both high and low impostors, those individuals one standard deviation above and below the mean, respectively, emotional arousal was related to academic self-efficacy. The slopes for individuals high ($\beta = .421$, $p = .000$) and low ($\beta = .631$, $p = .000$) in impostorism significantly differed from zero. Students who were able to cope with their negative emotions (that is, had low anxiety) also reported high academic self-efficacy in math. However, the association between emotional arousal and academic self-efficacy was much stronger for low impostors. Figure 7 contains the graph of these equations plotted on emotional arousal and predicted academic self-efficacy in math.

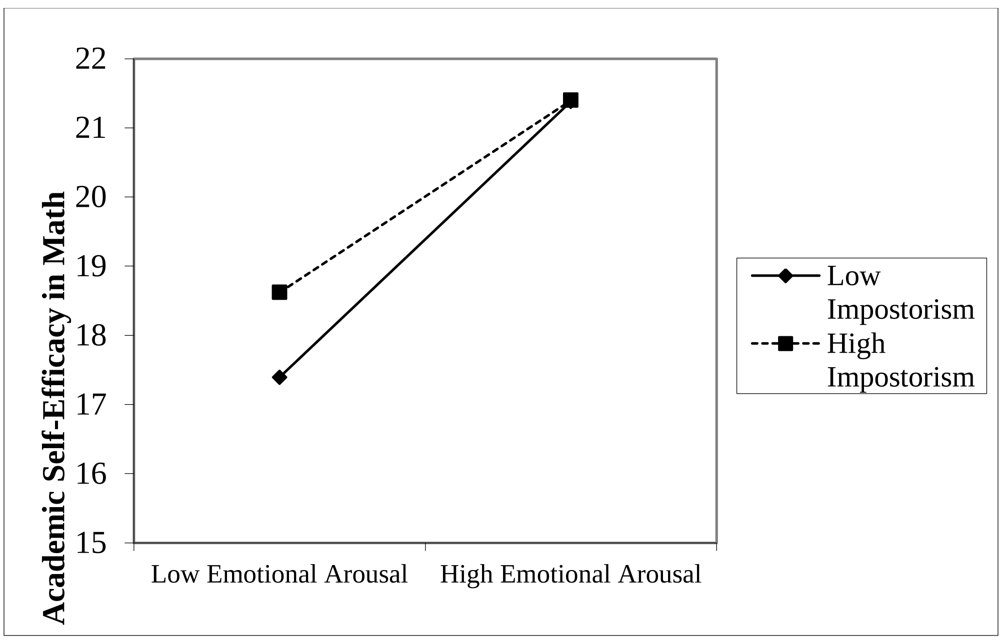

Figure 7. Graph of the predicted academic self-efficacy in math of low- and high-impostors based on emotional arousal. Emotional arousal is reverse scored such that higher scores indicate stronger coping with negative emotions. Graphed using macros from Dawson (2014).

Primary analysis 6. For Hypothesis 6, I proposed that academic self-efficacy in math would mediate the relation between the impostor phenomenon and future aspirations and expectations. The outcome variable was a measure of how much students aspired or expected to work or attend graduate school in a STEM area. It was expected that impostorism would negatively affect future aspirations and expectations, but that this relation would be due to impostorism's negative association with academic self-efficacy. Mediation analyses using Preacher and Hayes (2008) were used to test this hypothesis. This type of analysis utilizes bootstrapping and bias corrected confidence intervals to determine if the mediation was significant. Preacher and Hayes (2008) argue that it has greater power than the traditional methods given by Baron and Kenny (1986).

For Hypothesis 6a, I proposed that academic self-efficacy in math would mediate the relation between impostorism and aspirations to work in or study STEM fields in the future. Results of the analysis are shown below in Figure 8.

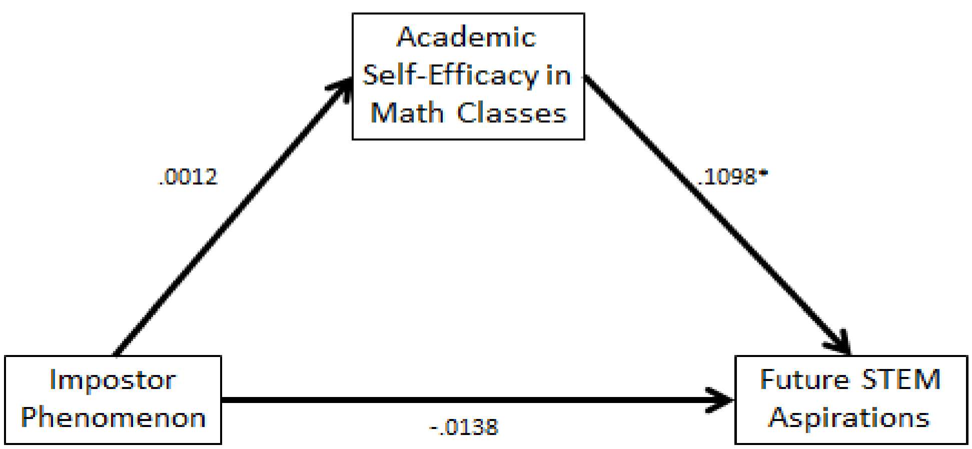

Figure 8. Diagram showing academic self-efficacy mediating the relation between the impostor phenomenon and future aspirations.

Note. Unstandardized weights are shown on the paths, including the direct effect from the impostor phenomenon to future aspirations.
*p < .05.

The entire model did explain a significant amount of variance in aspirations (R^2 = .0397, p = .0029), but only the path from academic self-efficacy to future aspirations was significant. The total unstandardized effect was -.0136 (*ns*) on the outcome variable. Additionally, bootstrapping methods revealed an indirect effect of only .0001 with a confidence interval that included zero (-.0030, .0035); therefore, the mediation was not significant.

Hypothesis 6b proposed a similar relation: academic self-efficacy in math would mediate the association between the impostor phenomenon and future expectations to attend graduate school in or work in STEM-related fields. The results of the mediation are shown in Figure 9.

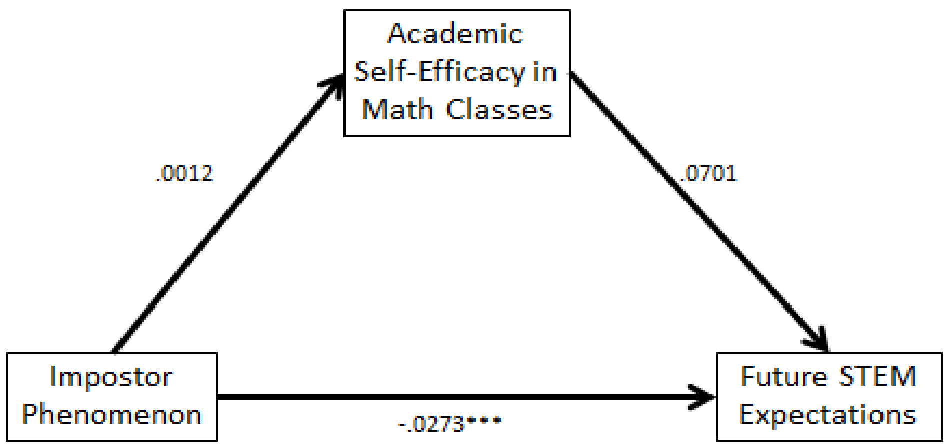

Figure 9. Diagram showing academic self-efficacy mediating the relation between the impostor phenomenon and future expectations.

Note. Unstandardized weights are shown on the paths, including the direct effect from the impostor phenomenon to future aspirations.
***p < .005.

Again, the full model produced a significant result, with the variables explaining 5.0% of the variance in future expectations (p = .0006). The effect of academic self-efficacy in math on future expectations neared significance (p = .0549), but failed to meet the necessary level. Unlike in the previous hypothesis, the impostor phenomenon had a significant relation with the outcome variable. However, bootstrapping and bias corrected confidence intervals revealed that this association was not mediated by academic self-efficacy in math. The indirect effect was only .0001, with a confidence interval that contained zero. Although the analysis of Hypotheses 6a and 6b revealed some interesting associations, neither showed significant mediation.

Further analysis using data from math-intensive majors. Much of the research in Chapter 2 is based on the theory that STEM majors require several, math-intensive courses. However, at the present university and across the US, this is not the case; majors within the STEM designation have differing levels of mandatory mathematics. (The University of Texas, 2013). Therefore, using the undergraduate course catalog (The University of Texas, 2012), I divided the participants into groups based on the number of required math classes for their individual majors. Areas that necessitated zero to three math courses were labeled as “math-light,” while those needing four our more courses for graduation were termed “math-intensive.” Under these designations, 121 participants (47.1% female) listed a math-intensive major. The most frequently listed majors were computer science (N = 19), biochemistry (N = 18), and mechanical engineering (N = 18).

Next, I reanalyzed the hypotheses using data from participants in math-intensive majors only. Results mostly replicated the findings from the full data set, but with a few notable exceptions. For both sets of data, analysis of Hypothesis 1 revealed that males and females reported statistically similar levels of impostorism, while females listed lower levels of traditionality and sexism and higher levels of equality than males. However, unlike in the full data set, in the math-intensive one, males and females reported statistically equal amounts of academic self-efficacy in math ($p = .057$) and femininity ($p = .324$). Thus, the sexes in math-intensive majors did not display as many differences on the measured variables as did males and females in all STEM majors.

For Hypothesis 2, I proposed that masculinity, perceived parental influence, math identity, and theories of intelligence would predict impostorism. The overall regression equation for the full data set was significant, with masculinity, math identity, and theories of intelligence all significantly adding to the prediction. However, analysis using the math-intensive data revealed that masculinity was the only significant contributor to impostorism ($\beta = -.467$, $p = .000$).

Results from the math-intensive majors mostly replicated findings from the full data set on Hypothesis 3. Sex failed to significantly moderate the relation between (a) math identity and impostorism, (b) femininity and impostorism, or (c) traditionality and impostorism. However, while analysis of the full data revealed that sex did moderate the relation between perceived parental influence and the impostorism, examination of the math-intensive data merely trended toward a significant moderation ($p = .060$). Thus, the analysis of the data from participants in math-intensive majors failed to find sex to moderate any of the proposed associations.

In Hypothesis 4, I analyzed whether Bandura’s (1986) proposed four sources of self-efficacy predicted academic self-efficacy in math. The full data set revealed that prior achievement added a small, but significant, amount of variance to the outcome variable. Additionally, emotional arousal greatly contributed to the prediction of academic self-efficacy in math. Using findings from the math-intensive majors only, emotional arousal again emerged as a significant predictor (β = .367, p = .000). However, prior achievement's contribution was non-significant.

I predicted the impostorism would moderate the relation between each source of self-efficacy and academic self-efficacy in math for Hypothesis 5. While the full data set supported this prediction for the relation between prior achievement and academic self-efficacy, findings were non-significant for the math-intensive majors. Both data sets found verbal persuasion to significantly predict academic self-efficacy in math, but the interaction between verbal persuasion and impostorism was non-significant, indicating that no moderation occurred. When considering emotional arousal as a source, both the full data set and the math-intensive one produced similar results. Emotional arousal alone as well as its interaction with impostorism significantly predicted academic self-efficacy in math.

Due to the significant moderation, I conducted simple slopes analysis of the math-intensive data at high (one standard deviation above the mean) and low (one standatd deviation below the mean) levels of impostorism (Aiken & West, 1991). Results are shown in Fig. 10 below. Slopes for high impostors (β = .433, p = .000) and low impostors (β = .829, p = .000) significantly differed from zero, indicating a significant relation between emotional arousal and academic self-efficacy. For individuals high and low on impostorism, a greater ability to cope with emotional arousal related to higher levels of academic self-efficacy. This association was especially strong for low impostors, a finding which replicated the analysis from the full data set.

Figure 10. Graph of the predicted academic self-efficacy in math of low- and high-impostors based on emotional arousal for participants in math-intensive majors. Emotional arousal is reverse scored such that higher scores indicate stronger coping with negative emotions. Graphed using macros from Dawson (2014).

For the final hypothesis, I analyzed the mediating effect of academic self-efficacy on the relation between impostorism and future aspirations/expectations using macros from Dawson (2014). Both the full and the math-intensive data sets revealed a significant, positive association between academic self-efficacy in math and future aspirations (for math-intensive data: $\beta = .1565$, $p = .0127$). However, impostorism did not relate to either self-efficacy or aspirations; thus, the data failed to support a significant mediation.

For Hypothesis 6b, I proposed that academic self-efficacy in math would mediate the relation between impostorism and future expectations. For both the full and math-intensive data, impostorism significantly and negatively related to future expectations (for math-intensive data, direct effects: $\beta = -.0309$, $p = .034$). Analysis of the full data set failed to support an association of academic self-efficacy with either impostorism or future expectations. However, using the data from math-intensive majors only, academic self-efficacy did significantly relate to future expectations ($\beta = .1296$, $p = .0440$). Both data sets included zero in their bias-corrected confidence intervals, indicating that no mediation occurred.

Based on the results from the analysis, a new model of the situation was proposed (see Fig. 11). Paths that were supported by the present research are marked in solid black lines, while suggested paths are given in dashed lines.

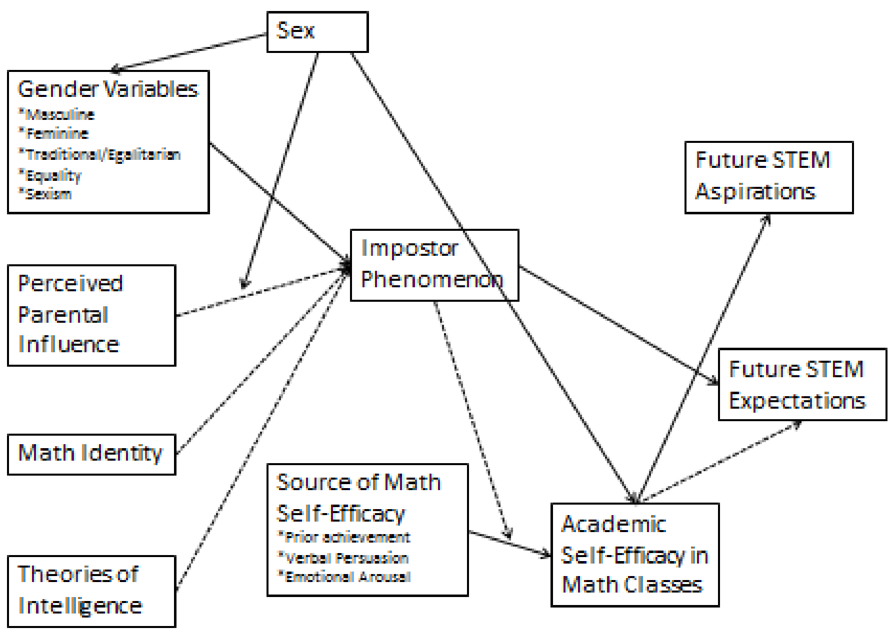

Figure 11. Revised model based on results. Suggested paths are given in dashed lines.

Chapter 5: Discussion

The purpose of this study was to probe the differential experiences of males and females in science, technology, engineering, and math (STEM) majors. Females are still disproportionately underrepresented in many STEM areas in school and the workplace despite having equal qualifications and abilities as their male peers (U.S. Department of Education, 2010; U.S. Department of Labor, 2012). Thus, understanding the reasons for this discrepancy is an important first step to encourage more females to enter and persist in these fields.

The present study considered several variables that may have related to the different experiences of males and females. A model of the constructs was created with future expectations and aspirations of continuing in the STEM field as the overall outcome. It was expected that math self-efficacy and the impostor phenomenon would affect these future goals. Additionally, gender role orientation, perceived parental influence, math identity, and theories of intelligence were proposed to influence students' experiences. Analysis partially supported the hypotheses, and a revised model (Fig. 11, p. 85) was created based on the findings.

Research Question 1

For the first hypothesis, I proposed that male and female students in STEM majors would report different levels of the major study variables. The results revealed a male advantage in academic self-efficacy in math, but no significant sex differences on the impostor phenomenon. While previous research (Langford & Clance, 1993) has reviewed sex differences in the impostor phenomenon, no study to date has analyzed this variable in a population of STEM majors. I expected that females would feel more like impostors in a “masculine” environment like STEM classes. However, this hypothesis was not supported. This nonsignificant finding supports Langford and Clance’s (1993) view that the women and men experience impostorism at similar rates. Despite what I predicted given the masculine environment of STEM classes, both males and females suffer from feelings of the impostor phenomenon. Due to the rigorous academic environment in STEM classes at the present university, many students, regardless of sex, may experience the negative effects of the impostor phenomenon. It is possible that they feel like they do not deserve to be in STEM classes at a top-tier university.

Sex differences in the remaining variables in Hypothesis 1 produced mostly expected results. As in previous studies (e.g. Huang, 2013; Pajares & Miller, 1994), males reported greater academic self-efficacy in math than females. However, the analysis of the data from students in math-intensive majors failed to show this mean difference. Both males and females in math-intensive majors had elevated levels of academic self-efficacy in math as compared to their peers in non-intensive majors. This latter finding replicates Hackett’s (1985) finding that math self-efficacy correlates with choice of a math-based major. However, Hackett’s data was still attenuated by sex: the males reported greater math self-efficacy than the females. As the prior research was conducted nearly 30 years ago, sex differences in math self-efficacy may no longer exist for students of high ability.

In the final section of Hypothesis 1, analysis of the full data set indicated that females reported more feminine characteristics and endorsed greater sex equality in math classes and careers when compared to male students. The latter findings replicate Spence and Hahn’s (1997) results that female students were less traditional than male students in their beliefs about the roles of women in society. Additionally, male students reported more traditional beliefs and greater sexism toward females' societal roles; however both sexes' scores favored the egalitarianism and non-sexist side of the scales. That is, male students in STEM majors may be slightly more sexist than their female peers, but overall they are still quite liberal in their beliefs. This trend toward egalitarianism may reflect an overall societal change in attitudes toward females' roles. It is not surprising that college students, and especially female ones, are becoming more liberal in their gender beliefs, as these individuals are most likely to benefit from the change in attitudes.

Interestingly, female students in math-intensive majors did not report greater feminine characteristics than their male peers. Males in math-intensive and non-intensive majors listed similar levels of femininity; however, females reported greater femininity in non-intensive majors. This difference is interesting and should be explored further. Perhaps females with lower feminine characteristics are more likely to enter or persist in math-intensive majors. Additionally, females may have found an advantage to eschewing a more feminine persona within this area. Whatever the reason, females in math-intensive majors report less feminine characteristics than the females in non-intensive majors; a difference not found in the male participants.

Research Question 2

For the second hypothesis, I proposed that masculinity, perceived parental influence, math identity, and theories of intelligence would predict the impostor phenomenon. For the perceived parental influence scale, students recalled how much their parents influenced their math choices and achievements in secondary school. I expected this to positively relate to impostorism, as Langford and Clance (1993) reported that impostors often report a high need to meet their parents' approval. I also expected that an entity theory of intelligence (Dweck, 1996) would positively relate to impostorism. Langford and Clance (1993) revealed that impostors often had this stable view of intelligence and believed that any small failure was evidence of their inabilities.

In the full data set, the overall equation as well as the predictors masculinity, math identity, and theories of intelligence were significant. Masculinity was the strongest variable, explaining most of the overall variance in impostorism. Students lower in masculinity were much more likely to experience impostorism. Analysis with data from the math-intensive participants also revealed a strong, negative association between the two variables. This finding mirrors September and colleagues' (2001) finding that individuals high in masculinity or androgyny were less likely to report feelings of impostorism. In the present study as well as September and colleagues' (2001), masculinity was measured with the Personal Attributes Questionnaire (Spence & Helmreich, 1978). On this scale, masculinity includes a set of traits such as "self-confident," "feels superior," and "stands up well under pressure." These characteristics stand in stark contrast to Clance's (Clance & Imes, 1978; Clance & O'Toole, 1988; Langford & Clance, 1993) description of impostors as individuals who lack self-confidence in their abilities and feel inferior to their colleagues. Therefore, it is not surprising that this predictor emerged with a strong, negative relation to the impostor phenomenon.

Based on these findings, researchers and therapists should consider gender role orientation as an important correlate to the impostor phenomenon. Future studies should consider this relation: Does masculinity causally relate to impostorism? Does increasing a participant's masculinity (or the traits listed on the scale) subsequently decrease her impostorism? Interventions designed to increase self-confidence and other masculine traits may reduce the negative affect associated with the impostor phenomenon.

Although it approached significance in the full data set, Perceived Parental Influence was not a significant predictor of impostorism. One possible reason for this finding may be due to the measure itself lacking specificity. The scale asked students about their parents' involvement in their pre-college lives, but it failed to address the children's interpretation of this participation. For instance, the students may have perceived their parents as being overbearing or controlling; alternatively, the children may have welcomed the involvement and blossomed under their parents' guidance. Impostorism, as reported by Clance and Imes (1978), is influenced by the former type of involvement. A more specific measure would tease out the differences in parental influence and how it affects impostorism.

In addition to masculinity, math identity and theories of intelligence predicted the impostor phenomenon for the full data set. Students whose identities were strongly tied to their math abilities were more likely to experience impostorism. Individuals with strong math identities believe they are good at math and that this ability is an important part of their notion of self (Schmader, 2002). Highly math-identified people want to continue to succeed in math in order to maintain a positive self-image. Conversely, students without a strong math identity do not derive a sense of self from their math successes or failures. For these participants, math-related failures do not equate to personal attacks on their abilities. Therefore, highly math-identified students would be most concerned with continual success, and they would be more susceptible to the negative effects of impostorism. For participants with high math identities, a failure would confirm that they were indeed impostors, masquerading as students strong in math while secretly lacking that ability.

This result fits with prior research where highly and moderately identified participants experienced stereotype threat, while lowly identified students did not (Nguyen & Ryan, 2008). The highly identified participants derived their sense of self from their math abilities. Therefore, a stereotype that maintained that their group had inferior math skills was personally threatening and resulted in decreased math scores. These students were negatively affected by the stereotype because it attacked an important part of their identity. However, for the lowly-identified students, the stereotype was not as threatening because the relation between math ability and personal identity was less salient to them. It did not matter as much to the lowly identified group if they failed at math, as this result did not decrease their sense of identity. The findings on impostorism supported this idea; only participants whose identities were highly tied to the domain in question were affected by the negative outcomes, as the lowly identified students would not experience at attack on their sense of self due to a failure.

Interestingly, in analysis using the math-intensive data set, math identity did not emerge as a significant predictor of impostorism. One reason may be that students in math-intensive majors reported greater math identity overall when compared to their peers in other STEM classes. It is not surprising that participants taking several math courses for their major would identify strongly with math. However, the restriction of the range on this variable may have eliminated its importance in predicting impostorism in the math-intensive group.

Finally for hypothesis two in the full data set, theories of intelligence predicted imposter feelings in that students with entity beliefs were more likely to experience the impostor phenomenon. Entity theorists believe that intelligence is fixed and that education and learning cannot not improve it very much (Dweck et al., 1995). These students are contrasted with incremental theorists who think that intelligence is malleable and can be increased through learning. Impostors believe that their abilities are lower than their peers', despite repeated successes in their fields. Since the impostors' increase in achievement does not change their views on their own abilities, they would be more likely to hold entity theories of intelligence. Therefore, if impostors hold entity views of intelligence, repeated achievements would do nothing to change their view of their own innate inferiority. Interventions designed to reduce feelings of impostorism may also need to consider theories of intelligence. Langford and Clance (1993) recommend that psychotherapists address the rigid belief of entity theorists directly with the goal of allowing the client to realize how this view can promote impostorism.

Research Question 3

For the third hypothesis, in both the full and the math-intensive data sets, the analysis failed to support the theory of sex as a moderator of the relation between math identity, femininity, or traditionality on the impostor phenomenon. Sex alone did not relate to impostorism, as shown in the first hypothesis, and neither did the interaction of sex with other variables. One possible reason for the lack of significance may be due to the specific measures of gender used in the present study. The Personal Attributes Questionnaire (Spence & Helmreich, 1978) considers traits related to emotionality (e.g. "emotional," "kind," and "warm in relationships with others") and relatedness ("very aware of the feelings of others" and "very understanding of others") as feminine. However, these characteristics, whether representative of femininity or not, have little relation to typical impostor attributes. Therefore, this scale may not have been measuring the gendered construct as Clance and Imes (1978) initially proposed it. In that study, femininity was defined as contrasting with professional achievement; that is, succeeding in a typically non-feminine environment. Yet being successful in work and at school may no longer be perceived as at odds with traditional femininity. Additionally, in the original study, the only emotion related to impostorism was anxiety. Other than worrying about how others' perceive them, impostors do not overly concern themselves with the well-being of others. Therefore, the femininity subscale of the Personal Attributes Questionnaire is not congruent with the gender role that Clance and Imes (1978) reported and may be the reason for the non-significant results.

However, "traditionality," as measured by the Traditional-Egalitarian Sex Role Scale (Larsen & Long, 1988), did relate to the initial concept of gender role in relation to impostorism. This measure considers the role of women at work and school, the two places where Clance and Imes (1978) described women's successes as conflicting with societal norms for their gender. Yet despite Clance and Imes's (1978) claim of a gendered cause of impostorism, traditionality did not seem to relate to the variable. Due to the changing nature of a woman's role in society and work, gendered beliefs may no longer relate to feelings of phoniness. Clance and Imes argued that women who succeed in school violate gender norms, causing internal conflict. However, in the US presently, more women than men attend post-secondary education, and they earn higher grades while there (National Association of Educational Progress, 2009; US Department of

Education, 2010). Thus, academic success may no longer be considered a violation of femininity or a reason for feeling like an impostor, even within the male-dominated STEM fields.

For the final part of Hypothesis 3, the full data set revealed that sex moderated the relation between perceived parental influence and the impostor phenomenon, albeit not in the predicted direction. Even though male and female students reported receiving statistically similar parental messages about math during their secondary school years, male students' impostorism was more affected by perceived parental influence than was females'. One possible reason for this discrepancy may be that parental influence has a stronger effect over male students than female students (Zhang et al., 2011). Or, parents of male students may have expected their children to succeed in math at higher levels than parents of females (Frome & Eccles, 1998). Additionally, the female students may have been successful in other areas and felt less pressure to succeed in math specifically (Wang, Eccles, & Kenny, 2013). Regardless of the sex difference, for both males and females, greater parental influence led to higher levels of the impostor phenomenon, as is consistent with Clance's (Clance & Imes, 1978; Clance & O'Toole, 1988; Langford & Clance, 1993) findings.

Research Question 4

In the fourth hypothesis, Bandura's (1986; 1997) proposed sources of self-efficacy were analyzed with academic self-efficacy in math. Prior achievement, verbal persuasion, and emotional arousal were expected to significantly predict self-efficacy. Vicarious interaction was not included in the analysis due to the scale's low reliability. Results from the full data set indicated that academic self-efficacy in math positively related to both prior achievement and emotional arousal. Students who had succeeded in the past and were able to cope with their emotions were more likely to expect to succeed in future math tasks. Of these two predictors, emotional arousal provided the most explanation of self-efficacy. Participants with high anxiety, that is, a low ability to cope with emotions, reported low levels of academic self-efficacy in math.

In data from both the full and the math-intensive sets, emotional arousal emerged as an important contributor to the prediction of academic self-efficacy in math. The strength of this finding was somewhat surprising given that many studies have found prior achievement to be the greatest predictor of self-efficacy (e.g. Liu, 2009; Multon, Brown, & Lent, 1991). One possible reason for the current results may be due to a restriction of range. At the present university, most of the students in STEM majors have had strong prior achievements, and, presumably, verbal persuasion, in mathematics. Therefore, with the majority of participants scoring high on prior achievement and verbal persuasion, no strong relation to academic self-efficacy could emerge. Emotional arousal, however, would continue to be an influential factor in self-efficacy, even at a top-tier university. Students may even experience greater anxiety at the present university due to the exceptionally difficult nature of the courses. Therefore, emotional arousal would emerge as an important source of self-efficacy, even if the influences of the other sources were diminished.

These findings contradict Zeldin and Pajares' (2000; 2008) results, where females were most influenced by verbal persuasion and vicarious information, while males were by influenced by prior achievement. One reason for the discrepancy may be due to the populations studied. Zeldin and Pajares investigated individuals in STEM careers, while the present study considered undergraduate students in STEM majors. As employment data and research shows (Landivar, 2013; Xie & Shauman, 2003), many females who earn STEM degrees choose not to work in related careers. Thus, the females who persist in STEM fields after earning a degree may be especially influenced by verbal persuasion and vicarious information as compared to the other female STEM graduates. Prior achievement may be less likely to encourage females to enter these careers than others' words or actions. Males in STEM employment, however, may be more likely to rely on their past successes as evidence that they should work in STEM fields.

Research Question 5

For Hypothesis 5, I analyzed the moderating effects of the impostor phenomenon on the relation between each source of self-efficacy and academic self-efficacy in math. In Hypothesis 5a, I considered college GPA as a student's prior achievement. Although Bandura (1997) argued that the individual's own perception was more influential on self-efficacy than actual achievements, this may not be true for impostors. If impostors are discounting their previous successes, they may be undervaluing and underreporting their levels of prior achievement. Therefore, I used GPA to represent prior achievement rather than the students' own self-reported perception of their past successes since GPA is an objective measure that could not be skewed by the students' interpretation of their scores. Data from the full set revealed impostorism was a significant moderator of prior achievement on academic self-efficacy in math. For low-impostors, GPA and self-efficacy were strongly, positively related. This result for low impostors supports other findings that that math self-efficacy and achievement are positively related (Multon et al., 1991). However, for high-impostors, the association was not significant: GPA and academic self-efficacy were unrelated. Since individuals suffering from feelings of impostorism discount their achievements as evidence of their abilities (Clance & Imes, 1978), they are less likely to believe they can be successful in subsequent endeavors. In a student population, individuals who have earned high grades yet feel like impostors are not likely to have the confidence that they will score well in the future when compared to low-impostors. Therefore, even with an increase in GPA, a student with impostorism would be less likely to increase her academic self-efficacy. This finding has important implications for interventions designed to increase self-efficacy (Cordero et al., 2010; Luzzo et al., 1999). If these programs purport to increase self-efficacy through increased achievement as Cordero and colleagues' (2010) intervention did, they may not work for impostors.

Interestingly, analysis from responses of participants in math-intensive majors failed to produce a significant prediction of academic self-efficacy from prior achievement or the impostor phenomenon. For these students, mastery experiences did not relate to their present self-efficacy, nor did impostorism clarify this association. Again, this non-significant finding may have been due to a restriction of range, as many of the participants in math-intensive majors have succeeded in the past on math-related tasks.

I next investigated the moderating effects of impostorism on the relation between verbal persuasion and academic self-efficacy in math. Neither the impostor phenomenon nor the interaction of verbal persuasion and impostorism emerged as significantly related to academic self-efficacy. Only verbal persuasion alone added to the prediction; students who had received verbal encouragement from others tended to have high academic self-efficacy in math. However, impostorism did not affect this positive relation. This outcome held true for both the full data set and the math-intensive one. The result contradicted Clance and O'Toole's (1988) finding that individuals suffering from the impostor phenomenon were more likely to discount positive feedback than non-impostors. The present analysis revealed that both impostors and non-impostors alike responded to verbal persuasion with a related increase in self-efficacy.

One possible reason for why these results differed from my hypothesis is that I failed to consider the difference between an increase in negative feedback and a decrease in positive feedback. Although for my hypothesis I considered the former, the items on my survey asked about the later. While impostors (as compared to non-impostors) may be more strongly influenced by negative feedback, positive feedback, even a reduction in said construct, would probably not affect impostors very much. Since they discount positive feedback anyway (Clance & Imes, 1978; Clance & O'Toole, 1988), a lack of it would not be as detrimental to them as to non-impostors.

Analysis of Hypothesis 5d using both the full data set and the one from math-intensive majors revealed that the impostor phenomenon moderated the effect of emotional arousal on math self-efficacy. For low-impostors, coping with emotional arousal strongly and positively related to academic self-efficacy in math. Students who had low coping levels (that is, had higher anxiety), were more likely not to expect future successes in math. However, this association was not as strong for the individuals with high levels of impostorism. For these students, a decrease in coping ability (i.e., higher anxiety) did decrease self-efficacy, but not as strongly as for the low-impostors. Furthermore, at high levels of coping, both low- and high-impostors reported statistically similar levels of academic self-efficacy in math. One possible explanation for this finding is that participants with high levels of the impostor phenomenon are used to experiencing pervasive levels of anxiety, guilt, and dread (Clance & O'Toole, 1988). Therefore, minor changes in their affect are unlikely to change their math self-efficacy as much as for non-impostors who are not used to experiencing anxiety. For non-impostors, an increase in emotional arousal acts as a signal that they are unlikely to be successful. However, impostors are less likely to interpret the anxiety this way since they are used to its presence.

Research Question 6

For the final hypothesis, I expected that academic self-efficacy in math would mediate the relation between the impostor phenomenon and aspirations or expectations of continuing school or work in STEM fields. I proposed that, like in prior studies (Clance & O'Toole, 1988; Hirschfield, 1982), impostors would have artificially deflated future goals. However, I believed that this relation would be due to an impostor's decreased self-efficacy. Unfortunately, this hypothesis was not supported by the data. Impostors did have lower future expectations, but this association was not related to a reduced level of self-efficacy.

Despite the non-significant mediation, some of the proposed relations did produce significant results. In Hypothesis 6a, academic self-efficacy in math did positively relate to STEM aspirations for data from the full and math-intensive set. Students who expected to succeed in future math tasks aspired to attend graduate school or work in careers related to STEM areas. This finding supports Betz and Hackett's (1981) data that self-efficacy positively relates to career interest. Additionally, both the total and direct effects of impostorism on STEM aspirations trended toward significance, but failed to reach it. Both impostors and non-impostors aspired to attend graduate school or work in STEM fields at statistically similar levels. Perhaps, impostorism does not affect an individual's future aspirations; that is, both impostors and non-impostors want to achieve at high levels. However, when considering actual chances of attending graduate school or working in STEM fields, impostors may have lower expectations.

Therefore, in Hypothesis 6b, I investigated the same relation, but considered STEM expectations rather than aspirations. For the full data set, academic self-efficacy in math trended toward positively relating to STEM expectations, but failed to reach significance. Interestingly, students high in academic self-efficacy in math *aspired* to study or work in STEM areas at greater levels than students with low self-efficacy; however, there was no statistical difference between high and low self-efficacy participants in STEM *expectations*. This latter finding may reflect the many factors, not just self-efficacy, that affect an individual's expectation of future achievement. For instance, financial or familial constraints may have been more influential on participants' future expectations than self-efficacy alone.

However, an analysis of the data from math-intensive majors did reveal a significant relation between academic self-efficacy and future expectations. That is, for students required to complete four or more math courses, academic self-efficacy in math positively related to a future expectation to continue in the STEM field. This finding may be due to the more restrictive nature of the math-intensive majors. For instance, participants studying engineering would be quite likely to continue in the same field for graduate school or employment. However, a major such as human development (one of the non-math-intensive majors in the College of Natural Sciences) would allow for greater possibilities in different fields after graduation. Thus, the students in math-intensive majors may have been more likely to report that they expected to remain in their same field for graduate school or work.

In addition, both the total and direct effects of the impostor phenomenon on future STEM expectations were significant and negative for both data sets. Individuals suffering from high levels of impostorism were less likely to expect to continue school or work in STEM areas. As Clance and O'Toole (1988) suggested, impostorism is a strong enough deterrent that individuals suffering from the phenomenon actually reduce their future goals. They believe they have earned their current accolades from external or temporary means; thus, they do not expect that they could continue succeeding in the future. If a student thinks she earned her good grades due to luck or charm, then she would most likely not believe she could earn acceptance into graduate school or obtain a job in a related field. Interestingly, impostorism did not have a significant effect on STEM *aspirations*, only on expectations. Apparently, impostor status does not affect what a student would like to accomplish, only what she expects that she can actually do.

Summary of Findings and Implications

Within postsecondary education and the employment sector, females are underrepresented in several science, technology, engineering, and math (STEM) areas (U.S. Department of Education, 2010; U.S. Department of Labor, 2012). The present study and its research questions were designed to investigate this phenomenon further. A model of constructs related to the motivational and affective experiences of students in STEM majors was created to analyze possible reasons why males and females may have different career and graduate school aspirations and expectations. Sex did not directly influence either future aspirations or expectations of continuing in STEM fields; however it did affect these outcomes through its relation with gender role, perceived parental influence, and academic self-efficacy in math. Future research and interventions should address these relations specifically.

One area of particular consideration should be future expectations. What students expect to accomplish is highly correlated with actual behavior (Armstrong & Crombie, 2000). Therefore, any effort to modify students' behavior should also address what these students expect they can accomplish, more so than what they would like to achieve. Moreover, the present research revealed that impostorism did not relate to graduate school or career *aspirations*, only *expectations*; therefore, subsequent studies should focus on the latter variable.

Additionally, despite my initial hypotheses, self-efficacy had no association with future expectations in a population of STEM students. However, a positive relation was found between these variables for individuals majoring in math-intensive subjects. Thus, interventions designed to address math self-efficacy in all undergraduates (e.g. Cordero et al., 2010) may be misguided; researchers should concentrate on this variable for students in math-intensive majors only.

Researchers should also consider reducing impostorism in the undergraduate classroom. Since this construct negatively associated with future expectations, a decrease in impostor levels may relate to a subsequent increase in expectations. As revealed in the present study, gender role, perceived parental influence, math identity, and theories of intelligence should be considered as important correlates.

This study has several implications for universities, STEM professors, and STEM students. First, impostorism does seem to limit the future expectations of students, although not females exclusively. Professors and students should be made aware of this fact as impostorism may be limiting the achievements and psychological well-being of their undergraduates.

Moreover, math self-efficacy continues to display sex differences in the STEM classroom, (Huang, 2003; Pajares & Miller, 1995). Males benefit from their pervasively high math self-efficacy, and interventions to increase females' levels should be investigated. Additionally, impostors seem to be less affected by increases in prior achievement and emotional arousal. Therefore interventions designed to increase math self-efficacy may not be as effective for impostors. This phenomenon needs to be studied further both in undergraduate and working populations.

Limitations and Future Research

As with all studies, this one had some limitations. For sampling ease, students in all STEM-related majors were considered despite the differing requirements and environments of varying courses. I attempted to address this shortcoming by analyzing data from math-intensive majors only; however, future studies may want to consider participants in a single major only. Additionally, this research was conducted at a top-tier university where all students may be especially susceptible to the impostor phenomenon. Subsequent work should investigate these variables at less prestigious institutes and compare them to the present findings.

Moreover, the measures included had limitations as some were not reliable, specific, or valid enough for the present hypotheses. First, as stated previously, the

Vicarious Information subscale of the Sources of Math Self-Efficacy Scale was unreliable. Attempts to remove items or otherwise manipulate the scale failed to produce an alpha above .70. Additionally, the purpose of the inclusion of the Math Identity Scale was to determine which students were more likely to be affected by an affront to their math abilities. However, the measure instead became more of an indicator of which students were in math-intensive majors. Participants in non-intensive majors were much less likely to report that they identified with the math domain.

Measuring parental influence also posed some limitations. The measure included in the present study, the Perceived Parental Influence Scale, was more of a global measure of parental involvement. It did not address the children's interpretation of this influence. That is, did the students feel that their parents were being overbearing and controlling, or helpful and guiding. A more specific measure would differentiate between types of parental influence on their children's behavior.

As with the parental scale, the Clance Impostor Phenomenon Scale needed to be at a higher level of specificity. In this instance, the measure accounted for impostorism in a variety of domains, rather than in math courses alone. A less generalized scale may have supported some of the math-based hypotheses more strongly. Indeed, some of the measures (e.g. Future Expectations/Aspirations) asked students about experiences in their major, while others (e.g. Academic Self-Efficacy in Math) referred to math courses specifically. I attempted to address this discrepancy by reanalyzing the hypotheses using data from participants in math-intensive majors only. However, for students in the non-math-intensive majors, items dealing with math courses may have been irrelevant to their experiences. Using participants from a single, math-intensive major would help alleviate this issue.

In future studies, these variables should be studied longitudinally, following students from high school, through their choice of major, and on into the employment field. That way, researchers could understand better what constructs are affecting students' decision to enter or persist in the science pipeline. Impostors in math-intensive STEM majors are displaying exceptional resiliency; what is the cause of this finding?

Conclusion

The purpose of conducting this research was to investigate possible reasons why sex discrepancies in STEM fields persist. By understanding the differential experiences of males and females in these areas, I hoped to gain some insight as to why some females choose non-STEM majors and careers, while others remained in STEM. Overall, I found that sex and gender role affected students' academic self-efficacy; but, unlike what I had predicted, self-efficacy did not relate to expectations to attend graduate school or work in STEM fields for all participants. Impostorism, however, may be limiting the future expectations of students in STEM majors; but, this relation was not directly attenuated by sex. Gender role did affect future expectations through its association with the impostor phenomenon. The present research is a first step in understanding the complex relation among gender role, impostorism, and future expectations.

Appendix

Scales Included:

I. Demographics
II. Math Self-Efficacy Scale
III. Academic Self-Efficacy in Math Classes
IV. Sources of Math Self-Efficacy Scale
V. Math Identity
VI. Clance Impostor Phenomenon Scale
VII. Perceived Parental Influence Scale
VIII. Personal Attributes Questionnaire
IX. Traditional-Egalitarian Sex Role Scale
X. Revised Women in Science Scale
XI. Theories of Intelligence
XII. Impression Management
XIII. Future Aspirations & Expectations

I. Demographics

1. How old are you?
2. What is your sex?
    - Male
    - Female
3. How would you describe your racial/ethnic background?
    - African-American/Black
    - Arab-American
    - Asian-American
    - Caucasian/European-American
    - Hispanic/Latin-American/Chicano(a)
    - Native-American
    - Multiracial (Please specify)
    - Other (Please specify)
4. How would you describe your socioeconomic status?
    - Working Class/Lower Class
    - Lower-Middle Class
    - Middle Class
    - Upper-Middle Class
    - Upper Class
5. In what academic college or school of study are you currently enrolled?
    - Cockrell School of Engineering
    - Jackson School of Geosciences
    - College of Natural Sciences
    - Other (Please specify)
6. What is your current academic major?

Please read each statement and indicate how strongly you agree or disagree. (5-point, Likert-style from Strongly Disagree to Strongly Agree)
7. I like my major.
8. I am interested in my major.
9. I want to work in a field related to my major.

10. Why did you choose this major?

Please read each statement and indicate how strongly you agree or disagree. (5-point, Likert-style from Strongly Disagree to Strongly Agree)
11. In classes for my major, I feel like there are equal numbers of men and women.
12. Men and women are typically treated equally in classes for my major.
13. I feel like I am one of the few students of my gender in classes for my major.
14. I feel like I have been treated unfairly in classes for my major because of my gender.

15. What year of school are you in?
    Freshman
    Sophomore
    Junior
    Senior
    Other (Please Specify)
16. Based on a 4.0 scale, please estimate your GPA.

Please read the statement and indicate how strongly you agree or disagree. (5-point, Likert-style from Strongly Disagree to Strongly Agree)
17. I am satisfied with my GPA.

18. If you took the SAT, what was your score on the **math** (quantitative) section?

Please read the statement and indicate how strongly you agree or disagree. (5-point, Likert-style from Strongly Disagree to Strongly Agree)
19. How satisfied were you with your score on the SAT-Math? (5-point, Likert-style)

20. If you took the ACT, what was your score on the **math** section?

Please read the statement and indicate how strongly you agree or disagree. (5-point, Likert-style from Strongly Disagree to Strongly Agree)
21. How satisfied were you with your score on the ACT-Math? (5-point Likert)

22. Please indicate which of the following classes you completed in high school. Also, please mark if your class was considered "Advanced." Advanced classes include AP, IB, and Honors courses.

Pre-Algebra
Algebra I
Geometry
Algebra II
Trigonometry
Pre-Calculus
Calculus AB
Calculus BC
IB Mathematics Standard, Further, or Higher Level
Statistics
Computer Science
Engineering Mathematics
Other math class (Please Specify)

23. Please list any math classes you have completed since graduating from high school. These classes may have been at community colleges, The University of Texas, different colleges/universities, or other institutions.

II. Math Self-Efficacy (Betz & Hackett, 1983) [5-point, Likert-style; no confidence at all, very little confidence, some confidence, much confidence, complete confidence]
Please rate the following college courses according to how much confidence you have that you could complete the course with a final grade of "A" or "B."

1. Basic college math
2. Economics
3. Statistics
4. Physiology
5. Calculus
6. Business administration
7. Algebra II
8. Philosophy
9. Geometry
10. Computer science
11. Accounting
12. Zoology
13. Algebra
14. Trigonometry
15. Advanced calculus

16. Biochemistry

III. Academic Self-Efficacy in Math Courses (Fast et al., 2010)
1. I'm certain I can master the skills taught in my math courses.
2. I'm certain I can figure out how to do the most difficult class work in my math course.
3. I can do almost all the work in math class if I don't give up.
4. Even if the work in my math class is hard, I can learn it.
5. I can do even the hardest work in my math class if I try.

IV. Sources of Math Self-Efficacy (Lent et al., 1991)

Directions: Using the scale listed below, choose the response which represents your level of agreement with each statement. [5-point, Likert-style; from strongly disagree to strongly agree]
1. I got high scores on the math part of my college entrance exams (e.g., ACT, SAT).
2. My favorite teachers were usually math teachers.
3. My friends have discouraged me from taking math classes.
4. I get a sinking feeling when I think of trying hard math problems.
5. I received good grades in my high school math classes.
6. While growing up, many of the adults I most admired were good at math.
7. Other people generally see me as being poor at math.
8. I would be upset if I had to take more math courses.
9. In math classes, I rarely get the answer before my classmates do.
10. Most friends of mine did poorly in high school math courses.
11. I get really uptight while taking math tests.
12. My adviser has singled me out as having good math skills and has encouraged me to take college math courses.
13. Among my friends I'm usually the one who figures out math problems (e.g., like dividing up a restaurant bill).
14. My parents have encouraged me to be proud of my math ability.
15. My mind goes blank and I am unable to think clearly when working mathematics.
16. I have received special awards for my math ability.
17. My career role models (i.e., those people I'd like to be like) are mostly in fields that do not involve math.
18. My friends have encouraged me to take higher level math classes.
19. Math has always been a very difficult subject for me.
20. I almost never get uptight while taking math tests.
21. My friends tended to avoid taking high school math courses.
22. My parents are not very good at math.
23. Teachers have discouraged me from pursuing occupations that require a strong math background.
24. I am rarely able to help my classmates with difficult math problems.
25. People I look up to (like parents, friends, or teachers) are good at math.
26. I usually don't worry about my ability to solve math problems.

27. I was often encouraged to join clubs in high school which required math ability (i.e., Math Club, Computer Club).
28. I took fewer high school math courses than most other students did.
29. Some of my closest high school friends excelled on the math part of their college entrance exams.
30. Mathematics makes me feel uneasy and confused.
31. People I look up to have told me not to consider a math-related major.
32. When I come across a tough math problem, I work at it until I solve it.
33. Many of the adults I know are in occupations that require a good understanding of math.
34. I have usually been at ease during math tests.
35. I have always had a natural talent for math.
36. High school teachers rarely encouraged me to continue taking math classes.
37. Mathematics makes me feel uncomfortable and nervous.
38. Many of my friends are in, or intend to enter, fields that do not require strong math skills.
39. My parents have encouraged me to do well in math.
40. I have usually been at ease in math classes.

V. Math Identity (Spencer et al., 1999; Lesko & Corpus, 2006)

Please read the statement and indicate how strongly you agree or disagree. [7-point, Likert-style; strongly disagree to strongly agree]

1. Being good at math is <u>not</u> an important part of who I am.
2. Doing well on mathematical tasks is very important to me.
3. Success in math is very valuable to me.
4. It usually doesn't matter one way or the other how I do in math.

VI. Clance Imposter Phenomenon Scale [5-point, Likert-style; from not at all true to very true]

For each question, please circle the number that best indicates how true the statement is of you. It is best to give the first response that enters your mind rather than dwelling on each statement and thinking about it over and over.

1. I have often succeeded on a test or task even though I was afraid that I would not do well before I undertook the task.
2. I can give the impression that I'm more competent than I really am.
3. I avoid evaluations if possible and have a dread of others evaluating me.
4. When people praise me for something I've accomplished, I'm afraid I won't be able to live up to their expectations of me in the future.
5. I sometimes think I obtained my present position or gained my present success because I happened to be in the right place at the right time or knew the right people.

6. I’m afraid people important to me may find out that I’m not as capable as they think I am.
7. I tend to remember the incidents in which I have not done my best more than those times I have done my best.
8. I rarely do a project or task as well as I’d like to do it.
9. Sometimes I feel or believe that my success in my life or in my job has been the result of some kind of error.
10. It’s hard for me to accept compliments or praise about my intelligence or accomplishments.
11. At times, I feel my own success has been due to some kind of luck.
12. I’m disappointed at times in my present accomplishments and think I should have accomplished much more.
13. Sometimes I’m afraid others will discover how much knowledge or ability I really lack.
14. I’m often afraid that I may fail at a new assignment or undertaking even though I generally do well at what I attempt.
15. When I’ve succeeded at something and received recognition for my accomplishments, I have doubts that I can keep repeating that success.
16. If I receive a great deal of praise and recognition for something I’ve accomplished, I tend to discount the importance of what I’ve done.
17. I often compare my ability to those around me and think they may be more intelligent than I am.
18. I often worry about not succeeding with a project or examination, even though others around me have considerable confidence that I will do well.
19. If I’m going to receive a promotion or gain recognition of some kind, I hesitate to tell others until it is an accomplished fact.
20. I feel bad and discouraged if I’m not “the best” or at least “very special” in situations that involve achievement.

VII. Perceived Parental Influence (Kleanthous & Williams, 2013) [5-point, Likert-style from strongly disagree to strongly agree]
1. My parents encouraged me to do my best in math.
2. My parents thought that succeeding in math was important.
3. My parents were demanding about my school work in math class.
4. My parents didn’t pressure me about my math work.
5. My parents thought it was more important to be happy than to worry about grades in math.
6. My parents allowed me to decide on my own what subjects to choose at school.
7. My parents stressed the importance of mathematics more compared to other subjects.

VIII. Personal Attributes Questionnaire (Short Form) (Spence & Helmreich, 1978)
Instructions:
The items below inquire about what kind of person you think you are. Each item consists of a PAIR of characteristics, with the letters A-E in between. For example,

Not at all artistic A…..B…..C…..D…..E Very artistic

Each pair describes contradictory characteristics—that is, you cannot be both at the same time, such as very artistic and not at all artistic.
The letters form a scale between the two extremes. You are to choose a letter which describes where YOU fall on the scale. For example, if you think that you have no artistic ability, you would choose A. If you think that you are pretty good, you might choose D. If you are only medium, you might choose C, and so forth.

1. Not at all aggressive	Very aggressive
2. Not at all independent	Very independent
3. Not at all emotional	Very emotional
4. Very submissive	Very dominant
5. Not at all excitable in a major crisis	Very excitable in a major crisis
6. Very passive	Very active
7. Not at all able to devote self completely to others	Able to devote self completely to others
8. Very rough	Very gentle
9. Not at all helpful to others	Very helpful to others
10. Not at all competitive	Very competitive
11. Very home oriented	Very worldly
12. Not at all kind	Very kind
13. Indifferent to others' approval	Highly needful of others' approval
14. Feelings not easily hurt	Feelings easily hurt
15. Not at all aware of feelings of others	Very aware of feelings of others
16. Can make decisions easily	Has difficulty making decisions
17. Gives up very easily	Never gives up easily
18. Never cries	Cries very easily
19. Not at all self-confident	Very self-confident
20. Feels very inferior	Feels very superior
21. Not at all understanding of others	Very understanding of others
22. Very cold in relations with others	Very warm in relations with others
23. Very little need for security	Very strong need for security
24. Goes to pieces under pressure	Stands up well under pressure

IX. Traditional-Egalitarian Sex Role Scale (TRES); Larsen & Long, 1988 [5-point, Likert-style; from strongly disagree to strongly agree]

Please read the following items and choose the response that best represents how you feel.

1. It is just as important to educate daughters as it is to educate sons.
2. Women should be more concerned with clothing and appearance than men.
3. Women should have as much sexual freedom as men.
4. The man should be more responsible for the economic support of the family than the woman.
5. The belief that women cannot make as good supervisors or executives as men is a myth.
6. The word "obey" should be removed from wedding vows.
7. Ultimately a woman should submit to her husband's decision.
8. Some equality in marriage is good, but by and large the husband ought to have the main say-so in family matters.
9. Having a job is just as important for a wife as it is for her husband.
10. In groups that have both male and female members, it is more appropriate that leadership positions be held by males.
11. I would not allow my son to play with dolls.
12. Having a challenging job or career is as important as being a wife and mother.
13. Men make better leaders.
14. Almost any woman is better off in her home than in a job or profession.
15. A woman's place is in the home.
16. The role of teaching in the elementary schools belongs to women.
17. The changing of diapers is the responsibility of both parents.
18. Men who cry have weak character.
19. A man who has chosen to stay at home and be a house-husband is not less masculine.
20. As head of the household, the father should have the final authority over the children.

X. Revised Women in Science Scale (RWiSS); (Owen et al., 2007) [6-point, Likert-style; from strongly disagree to strongly agree]

Directions: Please read each item carefully. Choose a response that represents how much you agree or disagree with each statement.

1. Women can be as good in math careers as men can.
2. Women can make important mathematical discoveries.
3. Women are not reliable enough to hold top positions in mathematical and technical fields.
4. A woman's basic responsibility is raising her children.
5. A woman with a math career will have and unhappy life.

6. A wife should spend more effort to help her husband's career than she spends on her own.
7. A woman should have the same job opportunities in math careers as a man.
8. Woman should not have the same chances for advancement in math careers as men do.
9. Women should have the same educational opportunities as men.
10. Women have less need to study math and science than men do.
11. Men need more math and science careers than women do.
12. It is better for a woman to study home economics than calculus.
13. It is wrong for women to seek jobs when there aren't enough jobs for all the men who want them.
14. A successful career is as important to a woman as it is to a man.

XI. Theories of Intelligence (Dweck et al., 1995)
1. You have a certain amount of intelligence and you really can't do much to change it.
2. Your intelligence is something about you that you can't change very much.
3. You can learn new things, but you can't really change your basic intelligence.

XII. Impression Management (Paulhus, 1988) [7-point, Likert-style; strongly disagree to strongly agree]
Directions: Please read each item carefully. Choose a response that represents how much you agree or disagree with each statement.
1. I sometimes tell lies if I have to
2. I never cover up my mistakes
3. There have been occasions I have taken advantage of someone

4. I never swear
5. I sometimes try to get even rather than forgive and forget
6. I always obey laws, even if I am unlikely to get caught
7. I have said something bad about a friend behind his or her back
8. When I hear people talking privately, I avoid listening
9. I have received too much change from a salesperson without telling him or her
10. I always declare everything at customs
11.When I was young, I sometimes stole things
12. I have never dropped litter on the street
13. I sometimes drive faster than the speed limit
14. I never read racy books or magazines
15. I have done things that I don't tell other people about
16. I never take things that don't belong to me
17. I have taken sick-leave from work or school even though I wasn't really sick
18. I have never damaged a library book or store merchandise without reporting it
19. I have some pretty awful habits
20. I don't gossip about other people's business

XII. Future Aspirations & Expectations [5-point, Likert-style; strongly disagree to strongly agree]

ASPIRATIONS

Directions: Please read each item carefully. Consider what you **want to do** in college and once you graduate. Choose the response that best represents your wants.

1. I **want** to graduate from college with a degree in my current major.
2. I **want** to attend graduate school in an area related to my major.
3. I **want** to attend graduate school in an area NOT related to my major.
4. I **want** to work in an area related to my major.
5. I **want** to work in an area NOT related to my major.

EXPECTATIONS

Directions: Please read each item carefully. Consider what you **expect to do** in college and once you graduate. Choose the response that best represents your expectations.

1. I **expect** to graduate from college with a degree in my current major.
2. I **expect** to attend graduate school in an area related to my major.
3. I **expect** to attend graduate school in an area NOT related to my major.
4. I **expect** to work in an area related to my major.
5. I **expect** to work in an area NOT related to my major.

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