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# The Role of Sex Role Egalitarianism and Attitudes towards Math in the Math Achievement of Adolescent Girls

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# The Role of Sex Role Egalitarianism and Attitudes towards Math in the Math Achievement of Adolescent Girls

by

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## Report

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## Abstract


### The Role of Sex Role Egalitarianism and Attitudes towards Math in the Math Achievement of Adolescent Girls



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Despite the fact that boys and girls in the US perform at equal rates on most standardized math exams, girls report lower self-confidence in, positive affect toward, and valuation of this subject. Internationally, the gap between girls' and boys' math scores is mostly accounted for by gender socialization and the rights of women in society. The present research uses Eccles' (Parsons [Eccles] et al., 1983) Expectancy Value framework in considering the importance of math self-confidence, math valuation, and sex role egalitarianism on math achievement. Multiple regression will be used to determine the predictive ability of the independent variables. It is proposed that sex role egalitarianism and attitudes toward math will each significantly predict math achievement scores. Additionally, sex role egalitarianism will add to the prediction of math scores above what attitudes towards math contribute. Implications and future directions are discussed.

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# Chapter 1: Introduction

In 2009, women constituted only 13.76% of architects and engineers and 24.79% mathematical and computer scientists, despite comprising nearly half of the total workforce. While the number of women engineers has increased since 1983, the percentage of mathematical or computer scientists has actually declined over this same period. (U.S. Department of Labor, 2008, 2009a). Furthermore, in 2008, women earned 50.4% of all doctoral degrees, but only 31.1% in math (National Science Foundation [NSF], 2010). Since math-related occupations garner higher salaries (U.S. Department of Labor, 2009b) and greater prestige (Nakao & Treas, 1994) than the average American job, this gender discrepancy is alarming. Men and women are not achieving mathematical success in equal numbers, but why?

In primary and secondary school, boys and girls perform similarly in their math classes (Lindberg, Hyde, Linn, & Petersen, 2010). Yet when choosing careers, women shy away from mathematical fields (U.S. Department of Labor, 2009a, 2009b). Since biology cannot explain this finding (Spelke, 2005), socialization may account for the discrepancy. Parents, teachers, peers, and society overtly and covertly socialize girls and women into perceiving math as a male domain (Lindberg, Hyde, & Hirsch, 2008). Girls who subscribe to this more traditional view may not value or expect success in math. They may display reduced self-confidence and more negative affect toward this subject when compared with boys or nontraditional girls in their class. These discrepancies may translate into differential scoring on math assessments.

Nearly 30 years ago, Eccles and colleagues (Parsons [Eccles], Adler, & Meece, 1984) developed an expectancy-value framework to explain girls' and women's behavioral choices. According to this theory, girls engage and persist in activities in which they expect and value success. Socialization from parents, teachers, and peers greatly contributes to an individual's expectation and valuation of a task. Through socialization, girls learn which activities are appropriate for and valued in their gender. Girls who have received a more traditional gender socialization may perceive math as a male domain. As such, they will not value or expect success in this area. Applying Eccles' expectancy-value framework to this research, I propose that girls with a traditional sex role ideology will perform lower on a math assessment than girls with nontraditional views. Additionally, traditional students will display lower self-confidence in, positive affect toward, and valuation of math. Using multiple regression analysis, I will determine the predictive value of math attitudes and sex role egalitarianism on math achievement. Significant findings could potentially enable schools to target girls who are at risk of failing math. Through identification and intervention, girls may learn to value and achieve in this subject.

# Chapter 2:  Integrative Analysis

Despite lingering inequalities in the work force, the math achievement gap between girls and boys in school is disappearing. Historically, psychologists have erroneously used biological sex to explain discrepancies in this area (Spelke, 2005). Biological sex refers to the genetic, chromosomal, or genital condition that categorizes a person as male or female. Gender, however, is a socio-culturally learned role that makes one a boy, man, masculine, a girl, woman, or feminine (Crawford & Unger, 2000). By using biological sex to explain the math gap, psychologists assumed that males and females had innate, genetic differences in math abilities. Yet the closing of the math gap and its association with cultural factors supports the theory of a social cause for math achievement differences. Girls and women may be receiving the message that they are, or should be, inferior in math (Parsons [Eccles], Adler, & Kaczala, 1982; Sadker, Sadker, & Zittleman, 2009).

Despite the disappearing nature of the math gap, this subject is still considered to be a male domain, both in education and the work force (Smith & Hung, 2008). This stereotype may affect girls' and women's self-perception of their math abilities. Girls who ascribe to a more conventional view of women's roles may not expect to succeed in math classes. On the other hand, girls with nontraditional views of sex roles may exhibit more positive mathematical self-concepts, attitudes, and valuation, which may lead to greater math achievement.

Prior research (Sadker et al., 2009) has shown that girls receive implicit and explicit messages that boys are better in math. Teachers (Li, 1999) and parents (Frome & Eccles, 1998) believe that boys are better than girls in this area. Girls become socialized not to expect or value mathematical success (Lindberg et al., 2008). Their self-confidence (Eccles, Wigfield, Harold, & Blumenfeld., 1993) and affect (Hyde, Fennema, Ryan, Frost, & Hopp, 1990) are lower than boys', despite equal mathematical achievements. Girls who internalize the gendered perception of math may undervalue their own successes and abilities.

This study considers the predictive abilities of self-concept in math, positive affect toward math, valuing of math, and sex role egalitarianism on math achievement. Prior research (Olson, Martin, & Mullis, 2008) has revealed positive correlations among self-concept, positive affect, and valuing of math. Additionally, these three attitudes toward math have shown positive associations with math achievement. This research adds to the literature by considering the relation of sex role egalitarian ideology to these variables. A multiple regression equation will be used to analyze the research questions. Specifically, will an adolescent girl's beliefs about sex roles add to the prediction of her math achievement above what attitudes toward math variables already contribute?

### Expectancy Value Theory

In the 1980s, Eccles and her colleagues (Parsons [Eccles], Adler, Futterman, Goff, Kaczala, Meece, & Midgley, 1983; Parsons [Eccles] et al., 1982; Parsons [Eccles] et al., 1984) developed an expectancy-value framework to explain gender differences in educational and occupational achievement. According to this model, people undertake tasks that they personally value and in which they expect to succeed. Eccles' goal in creating the theory was to legitimize women's choices, rather than question why they differed from men's. As such, expectancy-value theory supplies nonjudgmental justification for an individual's choice in a particular domain. Since different people have varying task valuations and expectations of success, the expectancy-value model provides a unique explanation for each person's behavior in different situations. It relies on the individual's cognitive judgment of her choices, rather than the actual choices themselves.

Eccles noted that gender socialization greatly influences an individual's perception of a situation. That is, how a person has been socialized will affect her expectancy and valuation of a task, thereby influencing her motivation. Parents, teachers, peers, media, and others contribute to the gendered environment that shapes an individual's perception of viable options. Gender socialization may lead to differential valuing and importance of activities, definitions of success, and exposure to experiences. Eccles and her colleagues (Parsons [Eccles] et al., 1982) found that parents' gender stereotypes influenced their perception of their children's abilities. Parents of daughters thought their children had to work harder than parents of sons; the latter of whom thought advanced math was more important than the former did. These parental beliefs directly affected the children's self-concepts and expectancies more than the children's past performance. Later work (Bleeker & Jacobs, 2004; Fredericks & Eccles, 2002; Frome & Eccles, 1998; Jacobs & Eccles, 1992) found similar results: parents' gendered perceptions were stronger predictors of children's beliefs than prior experience and performance in math classes.

Eccles has applied her expectancy-value framework to stereotypically male domains, including math classes for schoolchildren and engineering jobs for adults. She has found that the expectancy-value theory explains an individual's choice whether to participate and persist in these areas or not. In her research, Eccles explores motivational differences between sexes, males and females. However, despite her emphasis on the importance of gender socialization, Eccles has not directly investigated this area. Gender socialization is an important vehicle for the development of sex role perceptions in children (Parsons [Eccles] et al., 1982). Sex roles[1] refer to the socio-culturally constructed positions deemed acceptable and desirable for the different genders (Bem, 1974). In this paper, I will use the term to refer to the roles that a society considers appropriate for women and men. Sex role ideology will include a person's adoption of these roles, irrespective of gender. Will an individual's view of appropriate sex roles, that is, her individual sex role ideology, influence her expectancy and valuation of success on a task?

Several variables affect a person's expectancy and valuation of an activity, including past experiences, individual goals, perception, and interpretation. Eccles and colleagues have used the expectancy-value framework to explain girls' involvement in math and women's choice in career, among other decisions. According to Eccles, women

[1] Eccles (1987) uses the term "gender roles," rather than the "sex roles" that Bem (1974) employs. In this paper, I will use "sex roles" to describe the phenomenon.

and girls are influenced by the limiting nature of sex roles; the culturally-constructed roles dictate which options are acceptable and influence related evaluation and expectation of success (Eccles, 1987; Parsons [Eccles] et al., 1982). Here, I review the literature on sex differences in the mathematical findings of Eccles's expectancy-value theory.

**Components of Expectancy Value Theory**

One of the major components of Eccles's theory is a person's expectancy of success at a given task. Individuals will be more likely to undertake achievement tasks in which they expect to succeed. Parsons [Eccles] et al. (1983) operationalized expectancy for success as the belief about how well an individual herself will do on an upcoming task. Two components comprise these task-specific beliefs: the person's self-concept of ability and her perception of task difficulty. An individual with high self-ability beliefs related to a given activity will most likely engage in it.

Notably, girls often have lower self-ability beliefs than boys in stereotypically male domains such as math, despite their equal or even superior skills in this area. Girls have reported diminished math self-concept (Antunes & Fontaine, 2007), self-efficacy (Bleeker & Jacobs, 2004), self-competence (Eccles et al., 1993; Fredericks & Eccles, 2002), self-perception of ability (Frome & Eccles, 1998), and self-confidence (Hyde et al., 1990), although these differences may change with age. In an Australian sample, Watt's (2004) research showed that girls' expectancies for mathematical success declined more rapidly than boys' during adolescence. Jacobs and colleagues (2002) found that first grade boys rated their mathematical competence much higher than girls, but this gap disappeared by middle school. If girls and women do believe that their math abilities are inferior, they will not expect to succeed in this area as much as boys and men will. As such, they will be less likely to engage or achieve in this domain according to Eccles's expectancy-value theory. People will be more likely to participate and persist in activities in which they expect to succeed, a variable strongly influenced by one's various self-concepts in that domain.

Another major component of expectancy-value theory is the individual's evaluation of a given activity. Some studies (Meece, Wigfield, & Eccles, 1990; Parsons [Eccles] et al., 1984; Wigfield & Eccles, 2000) have found that a positive evaluation of math predicted later participation in math classes or careers. Girls in Watt's (2004) research rated math as less valuable than the boys did, even though both genders reported equal levels of its usefulness. This valuation may change over time, as Fredericks and Eccles's (2002) longitudinal research showed an overall decline in students' ratings of math importance and interest from first to twelfth grade.

Eccles identified four components that people use either consciously or unconsciously to evaluate tasks: attainment, incentive, utility, and cost. An individual's interpretation of these components can be shaped by past experience, socialization and cultural norms, and information from others. In particular, gender socialization contributes to a person's evaluation of choices, affecting which options are valued or even considered by particular genders.

When determining attainment value, individuals decide how important success on a given task is to them. People will value tasks that they deem essential to their goals and self-concepts. The internalization of society's sex role ideology will influence an individual's valuation of particular activities (Eccles, 1987). More traditional women may perceive math as less important due to its association with males. Earlier research (Parsons [Eccles] et al.,1984) revealed this finding in adolescent girls. The girls were less likely to enroll in advanced mathematics because they felt it was less important, useful, and enjoyable than the boys did. According to expectancy-value theory, women and girls whose socialization has led them to perceive math as important will value this domain and engage in math-related classes and careers.

Secondly, people consider the incentives, either intrinsic or extrinsic, when evaluating a situation. A person is more likely to undertake a task that is rewarding and avoid one that is punitive. Some research has found that girls experienced more math-related anxiety (negative intrinsic motivation) than boys (Eccles & Jacobs, 1986; Parajas & Miller, 1994). In addition, this anxiety negatively correlated with both math grades and intention to take more math classes. Anxiety may act as a punisher, leading girls to undervalue math and avoid involvement in related activities. On the other hand, Newcombe and colleagues (Newcombe, Ambady, Eccles, Gomez, Klahr, Linn, Miller, & Mix, 2009) argued that girls may not dislike math, they may just have higher intrinsic motivation to take other classes. Given the limited space in high school curricula, the adolescent girls in their study took more biological and social science classes because they enjoyed these subjects more. Of Watt's (2004) adolescent participants, the boys reported higher intrinsic motivation for taking math. The discrepancy in liking math continues into adulthood. Female university faculty in science, technology, engineering, and math positions experienced less job satisfaction than their male coworkers (Hill, Corbett, & St. Rose, 2010). Whether through intrinsic or extrinsic influences, girls and women may learn to undervalue math. In this study, I will measure students' positive affect toward math, a variable associated with intrinsic motivation, and determine its relation with math achievement and sex role ideology.

Utility also affects a person's evaluation of a task. Humans are more likely undergo a task that they think will be useful in accomplishing their short- and long-term goals. Eccles (1987) argued that sex role socialization leads to the evaluation of certain activities as useful or not in achieving a proscribed identity. Following this logic, a woman or girl who espouses a more traditional feminine sex role ideology, one learned through gender socialization, should find math less useful than a nontraditional one. Since she presumably perceives math as not purposeful, she will not value this subject and will not participate in it when given the choice. Interestingly, Watt (2004) found no difference in the mathematical utility ratings of adolescent boys and girls. Both genders recognized that math was important for future success, but the boys found it more intrinsically valuable.

Finally, a person must weigh costs and benefits when making a choice. A task with few costs will be highly evaluated, and, thus, more likely to be undertaken. Costs can be psychological, social, or economic (Eccles, 1994). In a study of women in math-intensive occupations, Ceci, Williams, and Barnett (2009) reported that some women were penalized in promotion rates because they had children. Messersmith and colleagues (Messersmith, Garrett, Davis-Kean, Malanchuk, & Eccles, 2008) found that technologically-oriented women failed to enter (or left) the information technology field due to feared or realized sexism at work. This harassment has begun by middle school; Leaper and Brown (2008) found that 90% of their sample of adolescent girls reported sexual harassment in school. Equally alarmingly, another 52% responded that they had been harassed due to their participation in science, math, or technology classes. Girls and women may fear the consequences of participating in a male-dominated environment, leading them to undervalue success in this area.

Even when not being overtly harassed, girls and women may decide the costs of succeeding in math are too high. Girls and women may perceive that they have to apply more effort in male sex-typed activities than boys and men do. The girls and women may believe that they can succeed, but that they will have to expend more time, effort, and work (Eccles, 1987). Indeed, Steele, James, and Barnett (2002; Steele, 1997) found that undergraduate women in math, science, and engineering experienced more discrimination and stereotype threat than women in other academic areas or than men. The women in male-dominated subjects expected to encounter future job discrimination and were also more likely to have thought about changing majors. If women perceive the costs of math achievement as too high, they will not value this domain and will not engage in related classes or occupations. Since gender socialization contributes to these perceptions, will views about sex roles relate to mathematical choice as well? Will women socialized into more traditional sex role ideology be more likely to perceive the costs of math as too high, thereby undervaluing it? The present research measures students' valuing of math and its relation to math achievement.

## NATION-LEVEL SEX ROLES AND MATH ACHIEVEMENT

Many researchers have related Eccles' expectancy-value theory to girls' achievements in math. In countries where women's contribution to society is valued, girls are more likely to score at the same level as boys on math tests. Nations that do not permit women in politics or research usually produce girls with low math achievement (Else-Quest, Hyde, & Linn, 2010) Applying Eccles' theory, the girls in the egalitarian societies have a much higher expectation of success as an adult and reason to value mathematics. Therefore, they will be more likely to enroll in and work hard in those classes.

As expectancy-value theory predicts, researchers looking at cross-national data have found that girls' math performance positively correlates to women's rights in society. Baker and Jones (1993) analyzed math scores from as far back as 1964 and 1982 and found that the variation in their cross-national data came from the differences in educational and occupational prospects for women. In nations that had limited opportunities, the girls tested at substantially lower levels than the boys. Similarly, Guiso, Monte, Sapienze, and Zingales (2008) found that the improvement in girls' math scores correlated to the elevation of women's roles in individual nations. Interestingly, the increase had nothing to do with changes in the nation's Gross Domestic Product (GDP). Therefore, they concluded that the equalizing of the girls' and boys' abilities was not due to increasing economic status, but to women's societal gains. Hyde and Mertz (2009) noted that the equalizing of boys' and girls' scores in the United States occurred at the same time that Title IX and the second wave of feminism enabled more females to take high school and college math. Girls are not innately worse at math (Spelke, 2005), but they become socialized to discount their abilities. In countries where they have limited economic, political, and educational opportunities and role models, they have no reason to value mathematics.

Most recently, a cross-national meta-analysis (Else-Quest et al., 2010) found large variability when comparing girls' and boys' mathematical abilities. In most nations, the students performed equally or nearly equally as well; the overall effect size for sex differences in math was a non-significant d=-0.01. Girls performed slightly better in algebra (d=-0.11), while boys showed slightly higher measurement abilities (d=0.07). Although significant, these effect sizes are considered small. In several nations, boys scored higher overall, whereas a few countries showed the opposite pattern.[2]

Consistent with the earlier studies, the Else-Quest and colleagues (2010) found an association between math scores and the rights of women in society. According to the Gender Stratification Hypothesis (Baker & Jones, 1993; Else-Quest et al., 2010), the

[2] Boys outperformed girls most strongly in Tunisia (d=0.40), Ghana (d=0.19), Chile (d=0.18), Morocco (d=0.18), Austria (d=0.15), and Lebanon (d=0.15). The sex gap most strongly favored girls in Bahrain (d=-0.42), Jordan (d=-0.30), Cyprus (d=-0.19), and the Philippines (d=-0.15).

variation in math abilities is related to differences in women's opportunities. Specifically, lower girls' scores reflected inequality in school enrollment as well as research and parliamentary positions. Nations with more opportunities for women produced girls with more egalitarian mathematical abilities.

Both internationally and in the United States, girls' gains in math correlate to greater societal opportunities for women in school and work. According to expectancy-value theory, girls who see women in high-power positions such as researcher or politician will be more likely to expect that they themselves can succeed in school (Else-Quest et al., 2010). They will value their math education more highly because they know it can lead to success. Girls who have no women role models may not work hard in math because they have no reason to value it (Else-Quest et al., 2010). The United States is becoming more egalitarian in their views of women in work and in school (McHugh & Frieze, 1997; Twenge, 1997). So will these findings hold true on an individual level within the United States? Instead of nations having more equal (that is, nontraditional) opportunities for women, what if individual girls hold nontraditional views of women in math? These girls may value math more, have greater mathematical self-concepts, and score higher on math assessments than those students with a traditional sex role ideology.

## GENDER DIFFERENCES IN MATH ACHIEVEMENT

Contrary to earlier theories, biological sex does not account for differences in math abilities (Spelke, 2005). Today, boys and girls in the United States have equal, or nearly equal, skills in math (Hyde, Lindberg, Linn, Ellis, & Williams, 2008; Lindberg et al., 2010). The two genders are now taking equal numbers of high-level math classes and scoring similarly on state and national assessments. Hyde and Mertz (2009) found that girls and boys now perform at equal levels in primary and secondary school mathematics. This similarity was found on state assessments within all ethnic groups studied.[3] Eighth grade girls scored only two points out of a possible 500 lower than boys on the 2009 National Assessment of Educational Progress [NAEP] math test (National Assessment of Educational Progress, *n.d.*). In high school, girls complete 0.2 more math and science credits than boys, a figure that translates to an extra 24 hours of classroom instruction (National Center for Education Statistics, 2005). Women intending to enroll in college reported nearly the same math grade point averages (G.P.A.s) as the men in their age group (3.17/4.0 for men, 3.16/4.0 for women; College Board, 2010). Both men and women reported an average of 3.9 years of math in high school. A total of 56% of college-bound seniors reported completing pre-calculus or calculus; of those, 53% were women (College Board, 2010). Girls overall earn higher grades than boys, and even in math they are on par with the boys. This equalizing trend continues in college where women now earn 43.9% of bachelor's degrees in mathematics and statistics, an area traditionally dominated by men (National Science Foundation, 2009). Both genders now receive nearly comparable education in high school and undergraduate math, which translates into equal scoring on many standardized assessments.

[3] Notably, however, college-bound women still score substantially lower than men on the SAT-Math (http://professionals.collegeboard.com/profdownload/2010-total-group-profile-report-cbs.pdf)

## Sex Role Ideology and Math Achievement

Regardless their biological sex, some people ascribe to characteristics that have been traditionally associated with women. Bem (1974) characterized these individuals as "feminine," a label independent of their sex or gender. These people were more likely to describe themselves with terms such as affectionate, cheerful, childlike, and compassionate. "Masculine" individuals used self-descriptions such as aggressive, ambitious, analytical, and assertive, terms that have been traditionally ascribed to men. Participants who labeled themselves with both masculine and feminine traits were considered "androgynous." Many researchers have continued to use this terminology in their studies of sex roles and sex role ideology.

Whereas sex does not account for differences in math abilities, sex role ideology does seem to relate to academic achievement. Burke (1989) found that for middle school children, femininity positively correlated to G.P.A. This result held true for students regardless of their biological sex. Rose and Montemayor's (1994) research uncovered similar results, finding that feminine boys had high academic self-competence. In addition, they discovered that androgynous children, that is, teenagers high in both masculinity and femininity, had the highest scholastic competency. Similarly, Greene, DeBacker, Ravindram, and Krows (1999) found feminine high school students gave more effort than masculine ones. These studies suggest that students with more feminine beliefs put forth more effort, have greater academic self-competence, and higher G.P.A.s than masculine ones. Sex role ideology has strong associations with overall competence and grades.

Other research has found sex role ideology to relate to specific areas of academia. For instance, Sappington, Martin, Smith, and Cowan (1996) discovered that masculine students displayed greater spatial ability in a drawing task. When looking at writing ability, Pajares and Valiante's (2001) researchers rated feminine participants higher than masculine ones. These studies show that sex role ideology has an association with academia in general and in specific subjects. Does this association further relate to achievement in mathematics?

## SELF-CONCEPT

### Self-Concept Defined

Self-concepts are the judgments individuals make about various aspects of themselves and their abilities; this self-perception influences future action and thought (Bissell-Havren & Loken, 2009; Bong & Skaalvik, 2003; Shavelson, Hubner, & Stanton, 1976). Some, such as self-worth and self-esteem, consider larger, more global constructs of the self. Others, such as self-efficacy and self-confidence, usually are applied to specific domains, such as self-confidence *in math*. However, all self-perceptions are similar in that they involve a judgment about one's abilities and competences. Although my research considers only self-confidence in math, studies in this area are limited. As such, I will review different types of evaluations of the self in this analysis; these include self-concept, self-esteem, self-confidence, and self-efficacy.

Self-concept is a hierarchical, composite construct representing all self-perceptions. One's global self-concept is comprised of multiple domain-specific self-concepts, each of which is composed of more specific self-concepts. Therefore, a person's math self-concept contributes to an academic self-concept, which, in turn, factors into a general self-concept (Shavelson et al., 1976). Self-esteem, self-confidence, and self-efficacy are all types of self-concepts. Both self-concept and the more specific self-efficacy involve perceived competence and can affect academic motivation, emotion, cognition, and engagement (Bong & Skaalvik, 2003). Self-efficacy is future-oriented; it is an individual's perception about what she can do with her existing skills (Bandura, 1977). Self-efficacy and self-confidence are highly related. Some researchers (e.g. Bong & Skaalvik, 2003) define self-confidence as a part of a larger self-efficacy. Other researchers (e.g. Cramer, Neal, & Brodsky, 2009) place the terms on the same hierarchical level. Cramer and colleagues (2009) noted that while self-efficacy is a perception of one's abilities, self-confidence is a measure of how certain the individual is in those beliefs. Self-esteem, however, is more emotional in nature. People with high self-esteem have strong, positive self-perceptions of their own qualities in areas they deem important (Rosenberg, 1968). In the following review, I will consider all of these self perceptions, as they are highly related to each other. Additionally, my research will consider a particular self-concept, self-confidence in mathematics, and its relation to sex role egalitarianism and math achievement.

**Self-Concept and Sex Role Egalitarianism**

Notions about the self and sex role ideology are inextricably related. Bem (1981) argued that sex-typing, the process of socializing individuals into gendered beings, arises from the development of gender-based self-schemata. These schemata result from the assimilation of self-concept with gender. That is, individuals' judgments about themselves are strongly influenced by the sex roles they have been socialized into.

Of the limited research in this area, most studies have found that a masculine sex role ideology correlates with a more positive view of self. Johnson, Zava, and McCoy (2000) found that, in female undergraduates, masculinity scores positively related to overall self-confidence. This finding replicated earlier work with adolescents. Rose and Montemayor's (1994) research with sixth through twelfth graders showed that masculinity in girls positively predicted their perceived global self-worth. Notably, however, adolescents with an androgynous ideology had the highest scholastic competence and global self-worth. Priess, Lindberg, and Hyde (2009) found that increases in masculinity related to fewer reports of depressive symptomology in adolescents.

Whereas masculinity or androgyny relates to more positive outcomes, femininity correlates with more negative self-perceptions. Tolman (1998, cited in Spencer, Porche, & Tolman, 2003) reported that a conventional feminine sex role ideology in early adolescent girls related to lower self-esteem and greater depression. In research with undergraduates, Choi (2004) found that feminine and undifferentiated students had lower general and academic self-efficacy than masculine and androgynous ones. In other college populations, femininity has positively correlated with depression (Brazelton, Greene, & Gynther, 1996) and bulimia (Brown, Cross, & Nelson, 1990), and negatively associated with well-being (Johnson, McNair, Vojick, Congdon, Monacelli, & Lamont, 2006). Femininity relates to negative psychological events and self-perceptions in college-age men and women.

Some researchers have proposed that gendered notions of the self actually increase during early adolescence. According to the gender intensification hypothesis (Hill & Lynch, 1983), gender socialization from parents and peers increases during these years, pressuring the children to act in ways consistent with society's sex roles. Hill and Lynch noted that girls may be especially susceptible to these influences, conforming to a more traditional notion of femininity. Later research (Galambos, Almeida, & Petersen, 1990) found some support for the gender intensification hypothesis, but only for middle school boys. The adolescent boys increased in masculinity relative to the girls, but the reverse was not true for girls and femininity. Most recent research (Priess et al., 2009; Watt, 2004) failed to find evidence to support an increase in gendered attitudes and behaviors during adolescence. Perhaps society's changing sex roles have made the gender intensification hypothesis obsolete; alternatively, updated measures of sex role ideology may provide a more accurate picture of this phenomenon. However, regardless whether or not sex role ideology intensifies during middle school, adolescents' self-perceptions are affected by this variable.

**Self-Concept and Mathematics**

In addition to sex role ideology, self-concepts are also related to math achievement. Not surprisingly, self-concept, specifically in the math domain, positively correlates to greater achievement in this area. In a study of Portuguese adolescents, Antunes & Fontaine (2007) found that greater math self-concept in seventh or eighth grade predicted math achievement the following school year. Due to the longitudinal nature of the study, the authors concluded that the variables were causally linked: a positive math self-concept caused an increase in achievement at a later time. This correlation held true in other international populations. Ninth and tenth grade Greek students' math confidence positively related to their math achievement (Barkatsas, Kasimatis, & Gialamas, 2009). Two large, cross-national assessments showed the same association. Chiu & Klassen (2010) found that math self-concept and achievement were positively related on the Programme for International Student Assessment (PISA). Similar variables on the Trends in International Mathematics and Science Study (TIMSS) had the same association (Eklof, 2007). Overall, students with a more positive math self-concept display greater achievement in this domain.

If, as Antunes & Fontaine (2007) proposed, greater self-confidence in math causes an increase in achievement, how can we amplify this initial self-evaluation? Hyde and Kling (2001) argued that self-confidence in math is related to sex role socialization. Indeed, Beyer and Bowden (1997) found that female undergraduates undervalued their ability to perform a masculine task (answering sports trivia); they had low expectancy of success. However, this inaccurate self-evaluation did not hold true on feminine or neutral tasks. The female participants undervalued their abilities when the task conflicted with their sex. Following this logic, perhaps female students who perceive math as a male domain are more likely to possess an inaccurately low self-perception in this area. With a reduced self-concept, the participants would likely display a lowered achievement in math. That is, adolescent females who subscribe to traditional sex role stereotypes may experience reduced self-confidence in this area, which, in turn, may cause them to underperform on math assessments.

**Self-Concept, Mathematics, and Gender**

Indeed, several studies have investigated the relation among self-concept, math, and gender. Research on all ages and nationalities has shown that boys and men have a more positive math self-concept than girls and women. As early as first grade, boys have higher ratings of self-competence in math than girls (Eccles et al., 1993). Italian fourth and fifth grade girls were less confident in their math ability than boys. In fact, all fourth and fifth graders rated boys as better in math (Muzzatti & Agnoli, 2007). Even in elementary school, children ascribe to the traditional sex role ideology that boys are better than girls in math.

The discrepancy in self-concept continues through adolescence. Frome and Eccles (1998) reported lower perception of math ability for sixth grade girls than boys. Bleeker and Jacobs (2004) found the same results with seventh through twelfth grade participants. This difference exists internationally, too. In Portugal, seventh through tenth grade boys showed higher self-concept in math, even in cases where little or no difference in performance existed (Antunes & Fontaine, 2007). Greek ninth and tenth grade boys had more positive views of math than girls. In addition, high achieving boys were more confident in their math abilities than high achieving girls (Barkatsas et al., 2009). Watt's (2004) research of Australian adolescents revealed that boys had higher mathematical self-perceptions than girls. In multiple nations, adolescent girls have less confidence in their math abilities than the boys in their classes.

Even undergraduate populations report differences in math self-concept. Pajares and Miller (1994) found that women reported higher anxiety and lower self-efficacy in math than men. In an earlier study (Zuckerman, 1985), women rated themselves lower than men in math/science ability. In a study with undergraduate women, Schmader and colleagues (Schmader, Johns, & Barquissau, 2004) found that participants who endorsed gender stereotypes about math, rather than rejecting them, reported lower confidence and esteem related to math performance. Similarly, undergraduate women who implicitly associated math with males reported more negative math attitudes (Nosek, Banaji, & Greenwald, 2002). Additionally, women overall reported more negative evaluations of math and science. Girls and women of all ages and nationalities report lower abilities, competence, and confidence in their own math performance.

The discrepancy in self-concept may change with development. In a meta-analysis, Hyde and colleagues (Hyde, Fennema, & Lamon, 1990) found that sex differences in math self-confidence were larger for high school and college students than younger students. However, a longitudinal study (Fredricks & Eccles, 2002) found the opposite results: the gap in self-competence between boys and girls actually declined from first to twelfth grade. Regardless of the developmental trajectory, both studies found that girls and women rated their math abilities and attitudes lower than boys and men overall.

Some studies have shown that self-concepts may actually be mediators of the association between sex and math achievement. A study of high school students (Casey, Nutall, & Pezaris, 1997) found that self-confidence (along with mental rotation skills) mediated the relation between sex and scores on the SAT math section. Moreover, sex had no direct effects on math achievement. A later report by the same authors (Casey, Nuttall, & Pezaris, 2001) replicated these results with an international sample of eighth grade students. Self-confidence accounted for 26% of the indirect effects of sex on math scores on the TIMSS. In a population of undergraduate students, Pajares and Miller (1994) found that sex directly affected self-efficacy, but not math performance. These studies found a mediating role of math self-concept on the relation between sex and math achievement. The present research will consider the effects of math self-confidence on math achievement, while also taking sex role egalitarianism and math affect and valuation into account.

**Self-Concept, Mathematics, and Sex Roles**

In fact, very little research has investigated the relation among sex role ideology, math, and self-concept. Steele and Ambady (2006) found that undergraduate women shifted their working self-concept when subliminally primed with the category male or female. Women who were primed with female-related words reported a greater affinity for the arts than math. Women primed with the male category did not show this pattern. Subliminal processing actually altered the participants' self-concept related to math. However, the researchers did not investigate the effects of this shift on math achievement. Hackett (1985) did look at this variable, finding that gender socialization (along with math preparation) predicted math achievement. This achievement, in turn, predicted self-efficacy in math. I hope to find similar results in this research, but using self-confidence as a predictor and math achievement as the dependent variable.

In sum, past research has shown self-concept to relate positively to achievement in mathematics. Additionally, sex role ideology has correlated to different perceptions of self and valuing of math. And although some studies have investigated the relation among self-concept, achievement, and sex, none has researched the association of sex role egalitarianism with these variables.

### SUMMARY

Eccles and her colleagues (Parsons [Eccles] et al., 1982; Parsons [Eccles] et al., 1983; Parsons [Eccles] et al., 1984) have developed an expectancy-value framework to explain girls' and women's choices. According to this theory, individuals participate and persist in activities that they value and expect positive outcomes. Applying this theory to the mathematical domain, I expect adolescent girls to engage more in their mathematical classes when they expect to succeed in them and value that achievement. Measurements of valuing math and positive affect will gauge the students' expectancy-value in this domain. I propose that girls with higher expectancy-value for math will demonstrate stronger mathematical skills, as measured by an international assessment.

Cross-nationally, girls have performed well in math in nations where women have more egalitarian sex roles in society (Else-Quest et al., 2010). Although men and women in the United States still lack occupational equality, boys and girls are performing equally well on national and international math assessments (Else-Quest et al., 2010; Lindberg et al., 2010). Yet individuals within the United States have differing views on egalitarianism. Students with more a more traditional sex role ideology may believe that boys and men are better at math. Girls with a traditional ideology may learn, through gender socialization, not to expect to succeed in mathematical areas because it is a male domain. In this research, I will determine if egalitarian attitudes and mathematical achievement do, in fact, relate to one another.

Self-concept is another area that has shown gender differences. Both domestically and internationally, girls and women have reported lower self-concepts in math than boys and men, despite their actual abilities (Antunes & Fontaine, 2007; Barkatsas et al., 2009; Bleeker & Jacobs, 2004; Frome & Eccles, 1998). Since self-concept in math is highly related to achievement in this domain (Antunes & Fontaine, 2007; Barkatsas et al., 2009 Chiu & Klassen, 2010; Eklof, 2007), the gender discrepancy is alarming. Girls with a traditional sex role ideology may undervalue their math abilities, thereby reducing their self-confidence on math assessments. In this study, I will measure math self-confidence to determine if it relates to math achievement and sex role ideology. Together, I expect valuing of math, positive affect toward math, self-confidence in math, and sex role egalitarianism to relate to and predict math achievement.

# Chapter 3: Proposed Study

Historically, math has been perceived as a male domain (Meece, Parsons [Eccles], Kaczala, Goff, & Futterman, 1982). As such, girls were socialized not to expect or value success in math. Girls and women who subscribe to a more traditional sex role ideology may still hold these values. Eccles's research emphasizes the importance of gender socialization on math-related choices, yet she does not directly measure this variable or sex role ideology. In this research, I will investigate the relation between sex role egalitarianism, math self-confidence, positive affect toward math, valuing of math, and math achievement. I propose that adolescent girls with a more traditional sex role ideology will have reduced math self-confidence, affect toward math, and valuing of math. Also, these girls will have lower math achievement scores than nontraditional girls. That is, I hypothesize that self-confidence in math, positive affect towards math, and valuing of math will significantly predict math achievement scores. Also, sex role egalitarianism will add to this prediction when the attitudes toward math variables are already considered. Will girls with nontraditional orientations concerning females in mathematics score higher than traditional ones on related assessments?

Although studies have shown a link between math self-concepts and gender, few have investigated the association with sex role egalitarianism. The current study will attempt to fill this gap in the literature by determining the relation among three attitudes towards math variables and sex role egalitarianism. Also, this study purports to find a correlation between sex role egalitarianism and math achievement. Once these relations have been established, I will seek to show that sex role egalitarianism predicts an additional significant amount of variance in math scores above what the three math attitude variables predict. Notably, Schmader and colleagues (Schmader et al., 2004) found that undergraduate women who endorsed, rather than rejected, gender stereotypes about math reported lower confidence and esteem related to math performance. The present research will investigate similar variables, using a measure of sex role egalitarianism (C. Beere, D. King, D. Beere, & L. King, 1984) rather than stereotype endorsement, in a sample of adolescent girls. Will the girls who espouse a more traditional sex role report lower math confidence as the women in Schmader et al.'s (2004) research did? Will girls with nontraditional sex roles, that is, more egalitarian views, have greater confidence and score higher on the math assessment?

### STATEMENT OF PURPOSE

This study advances research by determining if sex role ideology, in addition to attitudes towards math, relates to math achievement. Numerous studies have shown the predictive ability of attitudes on achievement, especially within the field of mathematics (e.g. Barkatsas et al., 2009; Casey et al., 2001; Chiu & Klassen, 2010; Meece et al., 1990). Here, I hope to recreate these findings, but also to investigate the predictive role of sex role egalitarianism attitudes on math achievement. People implicitly associate mathematics with males (Nosek et al., 2002), even girls as young as nine display this stereotype (Steffens, Jelenee, & Noack, 2010). Girls with more traditional sex role egalitarianism attitudes may believe that males are better at this subject. These girls may not expect to succeed mathematically since this achievement does not fit with their conceptions of sex roles; that is, they may believe that only boys are successful in math. This lowered expectation of success may result in lowered mathematical participation, persistence, and achievement (Eccles, 1994). As such, sex role egalitarianism is an important variable to consider in the prediction of math achievement. Additionally, this research will analyze the relation among these variables and attitudes towards math.

## METHODS

### Participants

Participants will be a convenience sample of 82 eighth grade students in Central Texas schools. The TIMSS math assessment and student questionnaire were created for and normed on eighth grade students. As such, the participants in this study will also be in that grade. In the United States, children typically begin the eighth grade at age 13 and turn 14 during the school year; so participants' mean age should fall in this range. Students in public, private, and parochial schools will be considered for participation in this study.

The sample will contain only students who self-identify as girls, as this gender has been shown to undervalue their ability in math (Antunes & Fontaine, 2007; Parajes & Miller, 1994; Stetsenko, Little, Gordeeva, Grasshof, & Oettingen, 2000). Additionally, girls report lower math competence and confidence than boys (Fredericks & Eccles, 2002; Muzzatti & Agnoli, 2007; Parajes & Miller, 1994). This lowered attitude toward math may relate to sex role egalitarianism and math achievement.

Ideally, the sample will be heterogeneous with respect to race, ethnicity, and SES, and not significantly different from the general population of the US in any of these areas. Due to logistical constraints, the study will be limited to participants who can understand and read either Spanish or English. Also, children who do not attend public, private, or parochial schools (e.g. they are home schooled, hospitalized, no longer going to school, etc.) will not be part of our initial pool of possible participants.

Different researchers recommend different methods for determining adequate sample size prior to beginning an experiment. Green (1991) suggests that the number of participants in a regression study should equal or exceed 50 more than eight times the number of independent variables ($N \geq 50 + 8m$). Using this equation, this study of four independent variables necessitates a sample of 82 participants in order to achieve a power level of .80 at a significance of alpha at .05. A different power analysis, using the statistical program G*Power 3.1 (Faul, Erfelder, Buchner, & Lang, 2009), revealed a necessary sample size of 77 students. Assuming a medium effect size (d=0.15) of the predictor variables on math achievement, this number of participants will achieve a power level of .80 at an alpha of .05 significance. Seventy-seven students will provide a large enough sample size to show a significant change in the coefficient of determination $R^2$ when comparing the full model to one that excludes sex role egalitarianism as a predictor. Stevens (2009) recommends including 15 participants per predictor variable, a total of 60 students for this research. Here, I will aim to meet or exceed the largest of the three values, 82 participants.

## Instruments

### *Sex-Role Egalitarianism Scale (SRES)—Educational Domain*

The Sex-Role Egalitarianism Scale (SRES) (C. Beere et al., 1984) is an instrument designed to measure sex role ideology across five domains: marital, parental, employee, social-interpersonal-heterosexual, and educational. It is intended to reflect a bidirectional movement of men and women from traditional to nontraditional roles. That is, not only does it include women in stereotypically male domains, but also men in female ones. Participants receive a score that indicates how traditional or nontraditional their views of sex roles are. A nontraditional score indicates that the participant has more egalitarian views about the role of men and women in society. In this study, the participants will take only the section corresponding to the educational domain on the long forms.

The scale exists in four different forms, two long and two short versions. The long ones, termed B and K, contain nineteen items in each of the five domains, for a total of 95 statements. Scores can be calculated for the individual domains or for the scale as a whole. The short versions, BB and KK, contain 25 items used to calculate an overall SRES score. On all forms, participants indicate how strongly they agree or disagree with each item using a 5-point Likert scale. Sample educational statements include “Choice of college is not as important for women as for men” and “Home economics courses should be as acceptable for male students as for female students.” Although the SRES was normed on adults, it contains statements about participants’ attitudes, not personal traits.

Adolescents undoubtedly have attitudes about the roles of men and women, especially in a domain as salient to them as education. Therefore, the eighth grade students will fill out the SRES, even though its reliability and validity have not been established for adolescents.

Several studies have tested the psychometric properties of the SRES (see King & King, 1997 for a review). The original researchers used a college sample to create the scale, but a heterogeneous adult sample to determine the reliability and validity. Measures of internal consistency for all items on forms B and K were .97 each, with values between .84 and .89 for the individual domains.

Subsequent research tested for convergent and discriminant validity (See King & King, 1997 for a review). The SRES did not correlate strongly with either the Edwards Social Desirability Scale (Edwards, 1957, as compared in Beere et al., 1984) or the Marlowe-Crowne Social Desirability Scale (Crowne & Marlowe, 1964). Therefore, respondents were most likely answering in congruence with their true attitudes, rather than just socially desirable ones. Also, the SRES did not correlate with the Bem Sex-Role Inventory (Bem, 1974). The authors wanted the scale to differ from the BSRI in that the SRES measures attitudes towards women and men's roles rather than personal traits (all above citations from King & King, 1997). Overall, the SRES is a reliable and valid way to measure attitudes toward men and women in nontraditional roles in different domains.

***Trends in International Mathematics and Science Study, 2007 (TIMSS)—Eighth Grade Math***

The Trends in International Mathematics and Science Study (TIMSS; formerly Third International Mathematics and Science Study) is an assessment given every four years to students in the fourth and eighth grades worldwide (Olson et al., 2008; U.S. Department of Education, *n.d.*b). The test is sponsored by the International Association for the Evaluation of Educational Achievement (IEA) and meant to assess the math and science knowledge of students cross-nationally and over time. The 2007 version was the most recent administration, with 49 countries participating in the eighth grade math portion.

This study will use the eighth grade math section of the 2007 TIMSS. This part has several parallel forms that contain 20 to 30 items across five content areas: number, algebra, geometry, data, and chance. The questions measure math skills at the knowing, applying, and reasoning levels of cognitive ability. Math experts worldwide contribute to the development of the items, which are intended to reflect the regular school curriculum in this area. Students will complete two blocks of ten to fifteen math items each, with 22.5 minutes allocated for each block. About two-thirds of the questions are multiple-choice, and the rest are constructed-response. For the latter item, students have to provide a written explanation or interpretation of the data. Sample constructed-response questions include the following (U.S. Department of Education, *n.d.*a):

> A computer club had 40 members, and 60% of the members were girls. Later, 10 boys joined the club. What percent of the members now are girls? Show the calculations that led to your answer.

A representative multiple choice question is

If x = -3, what is the value of -3x?

(a) -9

(b) -6

(c) -1

(d) 1

(e) 9

Some of the constructed-response questions are worth more points than the multiple-choice ones, causing about half the points to come from each type of question. Students may use calculators on the entire test.

The 2007 eighth grade math TIMSS showed strong psychometric properties. The overall reliability coefficient (Cronbach's alpha) had a median value of 0.88 across countries and 0.89 within the US. The constructed-response questions had a mean interrater reliability of 98% within each country (US: 97%) and 91% between English-speaking ones.

The TIMSS also demonstrates many types of validity. The researchers attempted to use large, nationally-representative samples from each country, thereby enabling the generalization (external validity) of their results. To ensure content validity, international math experts and educators developed the test questions. The TIMSS guidelines contained very specific frameworks for each type of question. This blueprint verified construct validity and that parallel versions of the test were similar. In addition, the researchers had to demonstrate comparative validity to ensure that different countries were receiving comparable versions of the assessment. To accomplish this goal, the test was created in English and translated by experts from each country itself. The nations then had to present their materials to the IEA for verification before administering the test. All nations had part in creating the new items on the TIMSS, so that no nation would have an advantage. Later studies (e.g. Else-Quest et al., 2010) demonstrated convergent validity by comparing the TIMSS with other math assessments. The 2003 TIMSS math did not significantly differ from the Programme for International Student Assessment (PISA) of that same year. In addition, the TIMSS and the National Assessment of Educational Progress (NAEP) had "largely consistent" findings (U.S. Department of Education, *n.d.*b). Overall, the TIMSS reliably and validly measures the mathematics skills of eighth grade students worldwide.

***Trends in International Math and Science Study 2007--Student Questionnaire, Attitudes Toward Math***

The TIMSS also contains a background questionnaire that asks about students' home environments, school experiences, and attitudes toward mathematics (Olson et al., 2008; U.S. Department of Education, 2007; See Appendix). The Attitudes Toward Math section on the TIMSS student questionnaire contains 4-point Likert-style questions where students indicate how strongly they agree or disagree with a statement about their math-related beliefs (see Appendix). This measure contains three indices: Index of Students' Self-Confidence in Learning Mathematics (SCM), Index of Students' Positive Affect Toward Mathematics (PATM), and Index of Students' Valuing Mathematics (SVM). The three scales are highly intercorrelated, with correlations ranging from 0.421 (SCM and SVM) to 0.724 (PATM and SCM).

*Index of Students' Self-Confidence in Learning Mathematics*

The Index of Students' Self-Confidence in Learning Mathematics (SCM) comprises four questions on the TIMSS student questionnaire. In this study, I will use the SCM as a measure of students' self-confidence in math. The SCM is comprised of 4-point, Likert-style statements such as "I usually do well in mathematics" and "I learn things quickly in mathematics." On the last TIMSS, the four statements had a reliability score of .73, and they accounted for 21% of the variance in math achievement.

*Index of Students' Positive Affect Toward Mathematics*

The Index of Students' Positive Affect Toward Mathematics (PATM) is comprised of three statements on the TIMSS student questionnaire. Examples include statements such as "I enjoy learning mathematics," which participants rate on a 4-point, Likert-style scale. The PATM has an internal consistency level of .81. These three statements accounted for 8% of the variance in math scores on the 2007 test.

*Index of Students' Valuing Mathematics*

The third part of the math student questionnaire on the TIMSS is comprised of The Index of Students' Valuing Mathematics (SVM). The four statements ask about how important students think math is for their current and future lives. “I would like to do well in mathematics to get the job I want” is one example of an item in this section. Cronbach’s alpha for the SVM was .70. The four statements accounted for 4% of the variance on 2007 math scores.

**Procedure**

Prior to beginning the collection of data, I will submit the research proposal to the Institutional Review Board of The University of Texas at Austin as well as the participating school districts. After obtaining permission to conduct the study, researchers will visit the participating middle schools to recruit participants. They will visit each eighth grade math classroom and spend a few minutes explaining the purpose of the research. Then, they will distribute to each student a preassembled packet containing information about the study and a parental consent form. This paper will contain a place for parents to indicate whether or not they will allow their children to participate. All materials will be given in both Spanish and English. Students who return the consent form will receive a small prize, even if their parents have not allowed them in the study. A few weeks later, the researchers will revisit the campuses to collect the consent forms.

On a day convenient for the principal and the teachers, the researchers will return to the school to administer the questionnaires and TIMSS math test. All the participating students on a given campus will fill out the packets simultaneously in the cafeteria or other large space. Some research (Huguet & Régner, 2007; Inzlicht & Ben-Zeev, 2000) has shown that girls and women in single-gender environments do not experience stereotype threat as compared to mixed-gender groups. Therefore, the single-gender environment of this experiment, while possibly decreasing ecological validity, should reduce or eliminate deficits related to stereotype threat. Manila envelopes containing an assent form (on green paper), the math section of the TIMSS (on white paper), the TIMSS student questionnaire (on yellow paper), and the SRES (on yellow paper) will be given to the children. Again, all forms will contain English and Spanish versions. Both the TIMSS math test and student questionnaire already exist in validated English and Spanish forms. The SRES will be translated into Spanish and then back translated into English to ensure that the two versions convey the same information. On the day of the study, the researchers will briefly explain general directions to the children, including how to fill out the forms. Participants will remove, read, and sign an assent form, indicating that they wish to participate in the study. This paper will be easily identifiable due to its green color. To ensure anonymity, researchers will collect the assent forms so that the packets will not contain any identifying information. Students who do not agree to participate will be returned to their regular classrooms.

Next, the students will remove only the math section of the TIMSS from the manila envelope. This part will be first so that the children do not become inadvertently primed with sex roles or math-related attitudes. This section will be identified by its white paper, the same color as on the actual international test. As per the guidelines, the students will have two blocks of 22.5 minutes, a total of 45 minutes, to complete the math questions. After that time, the researchers will instruct the children to return their math work to the manila envelope and take a short break.

Finally, the students will remove the TIMSS student questionnaire and SRES from the packet to complete. These items will be printed on yellow paper and stapled together so that they are easily accessible and distinguishable from the math and assent sections. After taking as long as they need to finish, the participants will return the forms to the same envelope with their TIMSS math assessment. The researchers will then collect the manila envelopes and give the students a small prize. The entire packet should take about 1.5 to two hours to complete.

## RESEARCH QUESTIONS AND HYPOTHESES

### Research Question One

Do attitudes toward math relate to math achievement scores? Does a girl's self-confidence in math, positive affect towards math, and valuing of math predict her scores on a math assessment? Will girls with more positive attitudes display higher math achievement scores?

### Hypothesis One

Attitudes towards math will positively predict math achievement. Self-confidence in math, positive affect towards math, and valuing of math together will significantly predict math scores.

### Research Question Two

Does sex role egalitarianism add to the prediction of math scores above what attitudes toward math contribute?

### Hypothesis Two

Sex role egalitarianism will significantly add to the prediction of math scores above what attitudes towards math contribute. With self-confidence in math, positive affect towards math, and valuing of math already considered, girls with more nontraditional sex role beliefs will score higher in math achievement than girls with traditional beliefs.

## PROPOSED DATA ANALYSIS AND EXPECTED RESULTS

### Preliminary Data Analysis

This research investigates the relation among math achievement scores and four predictor variables: sex role egalitarianism, self-confidence in math, positive affect toward math, and valuing math. Initially, I will find the zero-order correlations among the variables. I expect to find high, positive correlations between each individual predictor variable and math achievement. Additionally, I anticipate low, positive correlations among the four predictor variables.[4] That way, the assumption of multicollinearity will not be violated and each independent variable will have a unique contribution to the prediction of math achievement. If two or more of the independent variables are highly correlated ($r > .90$; Tabachnick & Fidell, 2001), then I will conduct an exploratory factor

[4] If the predictor variables are highly correlated, I will conduct an exploratory factor analysis of the individual items to determine how many factors I actually have. For instance, SCM, PATM, and SVM may all combine to form one factor of attitude toward math. Then, I can continue the analysis with the newly-found factor or factors (Stevens, 2009).

analysis of the individual items that make up the associated scales. A factor analysis may reveal that the multiple variables actually measure one construct. If this prediction is true, then I can continue the analysis using the combined variables as one factor.

In addition to multicollinearity, six other assumptions must be met by the data before I can conduct the necessary regression equations for my analysis (Tabachnick & Fidell, 2001). First, the independent variables must have a linear relationship with the dependent variable math score. For a linear relationship to exist, a graph of the predicted math score versus the residual should demonstrate a random display of points. If the graph shows any systematic patterning, a different analysis or a transformation of the data may be necessary. As required by another assumption, measurement error will be minimized due to the strong reliability and validity of the instruments in this research.

Additionally, the estimated errors, known as the residuals, must meet several assumptions (Tabachnick & Fidell, 2001). First, the residuals should be independent of one another. Since this research employs random sampling and one-time measurement, this assumption should not be violated. Also, the residuals must be normally distributed. Outliers can greatly affect this assumption as well as change the residual line. The errors need to have a mean of zero and a constant variance. This latter requirement, known as homoscedasticity, can be tested with the same graph of predicted value of the dependent variable versus the residual. Homoscedastic data will display equal spread at all predicted values. Transformations of the data may alleviate violations of these assumptions. Also, the data should not contain any influential observations. Residuals that are more than three standard deviations from the mean or have a Cook's distance greater than one are potentially influential (Stevens, 2009). In my investigation, I will decide if any influential points exist. Then, I will re-run the analyses without these data to determine if my conclusions drastically change without the points. Either way, I will note their existence and possible influence. Once these seven assumptions are met, I can continue with my primary analysis of the data.

**Primary Analysis**

Both research questions will be answered using a hierarchical multiple regression analysis. The first model will determine the importance of the three attitudes toward math variables (SCM, PATM, and SVM) on math achievement. The second model will add SRES to this prediction. The following equations will be used, with the different independent variables ($X_{SCM}$, $X_{PATM}$, $X_{SVM}$, and $X_{SRES}$) predicting math achievement scores ($\hat{Y}_{math}$).

Model One: $\hat{Y}_{math} = A + ß_{SCM}X_{SCM} + ß_{PATM}X_{PATM} + ß_{SVM}X_{SVM} + e$

Model Two: $\hat{Y}_{math} = A + ß_{SCM}X_{SCM} + ß_{PATM}X_{PATM} + ß_{SVM}X_{SVM} + ß_{SRES}X_{SRES} + e$

In this research, I am most interested in the predictive ability of SRES on math achievement. Since SCM, PATM, and SVM have already shown associations with achievement (Olson et al., 2008), I want to determine first, if they can be used to predict math scores and second, if SRES adds to this prediction. As such, I have chosen a hierarchical multiple regression equation with SRES added to the full model.

In the first block, the independent variables SCM, PATM, and SVM will be used to predict math achievement scores. A significant F-statistic, one larger than the predicted value at an alpha of .05, will indicate that the three attitudes towards math variables together account for a significant amount of variance in math scores. The multiple coefficient of determination, $R_{reduced}^2$, will indicate how much variance is accounted for by the three independent variables together. I expect that the variables will explain a large amount of variance in math achievement. Additionally, Beta weights will be calculated via SPSS. These numbers will represent how much the predicted value of math scores change for each one unit change in a given variable, holding the others constant (Tabachnick & Fidell, 2001). I expect to find that the variables SCM, PATM, and SVM have large Beta weights, thereby contributing greatly to the prediction of math achievement. I anticipate that this first model significantly will predict math achievement, as per my first hypothesis.

In the second block, the independent variables SCM, PATM, SVM, and SRES will predict math achievement scores. A significant F-statistic will indicate that the four variables together account for a significant amount of variance in math achievement. If the first model does produce a large $R^2$, as I expect, then this block should explain a high amount of variance in the dependent variable as well. This full model will be used to determine the amount of variance that SRES adds to math achievement above what the attitudes to math already do. Again, I will determine the Beta weights of each independent variable, all of which I expect to be large. Using SPSS, I will calculate how much variance ($R_{full}^2$) all four predictor variables account for in the dependent variable. By subtracting $R_{reduced}^2$ from $R_{full}^2$, I will determine the change in variance in math scores ($\Delta R^2$) due to the addition of the variable SRES. A significant $\Delta R^2$ will indicate that sex-role egalitarianism adds to the prediction of math scores above what the three math attitudes variables contribute, thereby supporting my second hypothesis.

Additionally, I will calculate the squared semipartial correlations for each independent variable ($sr_i^2$). This statistic indicates how much variance in the dependent variable each independent variable uniquely contributes. In hierarchical regressions, the squared semipartial correlation indicates the unique variance added by a variable at the time it is entered into the equation (Tabachnick & Fidell, 2001). Using this analysis, I can determine the relative importance of each independent variable. I expect to find that all the variables have significant squared semipartial correlations, but that SRES displays the largest one. I anticipate that SRES is an important contributor to the prediction of math achievement.

# Chapter 4: Discussion

## CONCLUSION

Historically, women have been discouraged from entering mathematical careers (Hill et al., 2010). As such, girls did not value or expect success in math classes in school. Math and related subjects were (and still are) perceived as a male domain (Smith & Hung, 2008). Previous research has shown that perception of sex roles affects both self-concepts and academic achievement (e.g. Burke, 1989; Greene et al., 1999; Rose & Monetmayor, 1994). Gender socialization strongly contributes to an individual's notion of self. Yet no research to date has investigated the association among sex role egalitarianism, math self-confidence, positive affect, valuation, and achievement.

Today, boys and girls participate and succeed equally in math classes (Lindberg et al., 2010; National Assessment of Educational Progress, *n.d* ). Yet despite this similarity, girls report lower self-concepts related to math than boys (Bleeker & Jacobs, 2004; Frome & Eccles, 1998). In addition, graduate schools and occupations are still segregated by sex (National Science Foundation, 2010). Sex role ideology and the perception of math as a masculine domain may account for this discrepancy. Girls socialized not to value math may choose not to participate or persist in related classes. They may not expend as much effort in math classes that they do take, or may experience negative affect related to the subject. As such, girls who do not value math may have lower math achievement scores than those who do. Alternatively, girls with lower math success may learn to value that subject less; they may report more negative affect toward math. Those with a more traditional view of sex roles may proscribe to the idea that they are less able mathematically. This reduced self-confidence, affect, and valuing of math may account for differences in achievement, post-secondary education, and employment.

## IMPLICATIONS

If I do achieve my expected results, then the regression equation can be used to predict which girls are most likely to score poorly on math assessments. These students can be targeted for different interventions and additional tutoring to help them succeed in math. Adults can expose the students to findings (e.g. Else-Quest et al., 2010; Lindberg et al., 2010) that show that boys and girls do not differ in math ability. The children can learn about or meet women in science, technology, engineering, and mathematics (STEM) careers. Parents can be educated to encourage their daughters in these areas. If the girls at risk for failing receive targeted interventions early in their education, they may learn to develop their math skills better. Additionally, if subsequent research reveals a causal relation between the independent variables and math achievement, teachers, parents, and other socializers can increase girls' self-concepts, affect, valuation, and expectancies of success in this domain. These interventions may increase students' valuation of math, which may lead to greater gains in math achievement. Eventually, if girls learn to value and expect success, they may ultimately choose a more prestigious and lucrative career, one in the mathematical domain.

## LIMITATIONS AND FUTURE RESEARCH

This study will have some limitations. Many of the studies conducted previously within the United States used primarily European American participants (e.g. Casey et al., 2001; Eccles et al., 1993; Frome & Eccles, 1998; Kenny-Benson, Pomerantz, Ryan, & Patrick, 2006), so my assumption that the findings generalize to a more diverse population may be unfounded. Researchers need to conduct more studies on other racial and ethnic groups to determine if the results hold true for other populations.

Also, I could not find an adequate instrument to measure adolescents' sex role ideology, either globally or within the educational domain. As such, I had to use one normed on adults rather than middle school students. The SRES measures traditional and nontraditional attitudes, but it does not give information on a participant's masculinity or femininity. I chose this measure because it fit well with many of the international studies (e.g. Baker & Jones, 1993; Else-Quest et al., 2010; Guiso et al., 2008) that looked at how math scores related to women's role in society. However, other research (e.g. Burke, 1989; Pajares & Valiante, 2001; Rose & Montemayor, 1994; Sappington, et al., 1996) has used levels of masculinity and femininity rather than sex role ideology. Future research should consider both of these variables.

Additionally, regression analyses are correlational in nature. Even if SCM, PATM, SVM, and SRES do significantly predict math achievement, they may not necessarily cause it. Future studies should attempt to determine if these variables are causally linked. For instance, researchers could experimentally increase SCM, PATM, and SVM and measure any relative increase in math scores. The current research is an important first step in determining the importance of self-confidence, positive affect, valuation, and egalitarian attitudes on math achievement.

# Appendix: Student Questionnaire

Adapted from U.S. Department of Education (2007)

## Mathematics in School

How much do you agree with these statements about learning mathematics?

*Fill in one oval for each line.*

| | Agree a lot ↓ | Agree a little ↓ | Disagree a little ↓ | Disagree a lot ↓ |
|---|---|---|---|---|
| a) I usually do well in mathematics. [SCM] ................................ | O | O | O | O |
| b) Mathematics is more difficult for me than for many of my classmates. [SCM] ...................................................... | O | O | O | O |
| c) I enjoy learning mathematics. [PATM] .................................... | O | O | O | O |
| d) Mathematics is not one of my strengths. [SCM] ...................... | O | O | O | O |
| e) I learn things quickly in mathematics. [SCM] ........................... | O | O | O | O |
| f) Mathematics is boring. [PATM] ............................................... | O | O | O | O |
| g) I like mathematics. [PATM] ..................................................... | O | O | O | O |

*SCM: Index of Students' Self-Confidence in Learning Mathematics*
*PATM: Index of Students' Positive Affect Toward Mathematics*
*SVM: Index of Students' Valuing Mathematics*

## Mathematics in School

How much do you agree with these statements about learning mathematics?

*Fill in one oval for each line.*

| | Agree a lot ↓ | Agree a little ↓ | Disagree a little ↓ | Disagree a lot ↓ |
|---|---|---|---|---|
| a) I think learning mathematics will help me in my daily life. [SVM] ........................................................................ | O | O | O | O |
| b) I need mathematics to learn other school subjects. [SVM] ...... | O | O | O | O |
| c) I need to do well in mathematics to get into the university or college of my choice. [SVM] ...................................... | O | O | O | O |
| d) I need to do well in mathematics to get the job I want. [SVM]........................................................................ | O | O | O | O |

*SCM: Index of Students' Self-Confidence in Learning Mathematics*
*PATM: Index of Students' Positive Affect Toward Mathematics*
*SVM: Index of Students' Valuing Mathematics*

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