FACTORING GIRLS INTO THE EQUATION: A STUDY OF 12th GRADE STUDENTS’ INTEREST IN MATHEMATICS AND MATH-RELATED CAREERS

A Thesis

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in

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by

Christina A. Patane

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FACTORY GIRLS INTO THE EQUATION: A STUDY OF 12th GRADE
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Graduate and Professional Studies in Education
Abstract

of

FACTORING GIRLS INTO THE EQUATION: A STUDY OF 12th GRADE
STUDENTS’ INTEREST IN MATHEMATICS AND MATH-RELATED CAREERS

by

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The focus of this research is to determine if there is a difference between male and female 12th grade students’ interest levels in mathematics and math related careers. An additional focus of this research is to explore factors that may contribute to differences in the participating students’ interest levels.

The underrepresentation of women in math-related careers is concerning to both women and the future of these career fields. Considerable research has been done on the factors that may affect female participation in math-related career fields, yet the gender gap in math-related careers persists. Gender stereotypes, teachers’ perceptions of gender, the media, and other influences continue to relay gendered messages to children regarding mathematics. It is important to determine the factors that are keeping women out of math-related career fields and to train future teachers to address these factors. Intervention should be done before a student’s junior year of high school
because this is when students choose which colleges to apply to as well as their future field of study.

________________________________________, Committee Chair
Sherrie Carinci, Ed.D.

________________________________________
Date
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I would like to acknowledge how much my family has done to benefit my education. They forced me to do my homework before I played as a child, pushed me to excel in my classes as a high school and college student, and supported my higher educational pursuits. Without their encouragement and financial support, I do not believe I would be where I am today.

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Finally, I would like to acknowledge my husband, who not only helped transport crates of library books and articles countless times from Fresno to Sacramento, but also checked out library books for me when I had exceeded library limits. In addition, he convinced me to work on my thesis when I didn’t particularly want to. It’s been a long process for me, but it definitely helped to have the support of my husband.
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Chapter 1

INTRODUCTION

With the growing use of technology, math-related careers are becoming increasingly important. The Science, Technology, Engineering, and Mathematics (STEM) field’s lack of growth is concerning to the future of the United States economy and their ability to compete with other nations (American Association of University Women [AAUW], 1991). In addition, success in our society has become increasingly dependent on higher education, requiring students to be successful in high school mathematics as well as some college mathematics. In order to attend a four year university, one must achieve good grades in mathematics classes such as Geometry and Algebra II, receive a sufficient score on the SAT test, which is a test entirely based on English and Mathematics ability, and pass college entrance exams in English and Mathematics. Once at a university, students must fulfill general education requirements including math requirements such as entry level Statistics. If one decides to major in a math-related field such as Engineering, Chemistry, or Computer Science, they must then endure rigorous, high level mathematics courses. In addition, organizations are searching for a way to engage students in mathematics and spark interest in math-related careers to fulfill the increasing demand for workers who are skilled in math.

Unfortunately, student value and interest in future STEM careers is declining. Many people, despite their talent or ability, have no interest in pursuing a STEM career, especially a high level career (Jacobs, 2005). Standing out in the pool of
talented students that shy away from STEM careers are women and minorities (Jacobs, 2005). In order to increase the supply of future STEM employees, it is important to maintain the interest of all potential candidates. Since women make up about half of the nation’s workforce, it is especially important to address the factors excluding so many women from high level STEM careers (AAUW, 1991).

**Statement of the Problem**

High school and college students who have low mathematics abilities or interest levels are excluded from a wide variety of high paying careers. Fennema & Leder (1990) described mathematics as a “‘critical filter’ that successfully inhibits participation in many occupations and in career advancement and change” (p. 2). At the high school level, girls, even those earning A’s in honors mathematics classes, tend to feel they are less successful in math than their male counterparts. The National Mathematics Advisory Panel (2008) determined there is a correlation between success in high school mathematics and college graduation. Students who do complete Algebra II in high school are twice as likely than those who do not to graduate from college (National Mathematics Advisory Panel, 2008). The fact that success in high school mathematics courses is correlated with college graduation emphasizes the importance of creating positive mathematics experiences for high school students. Without these experiences, students are less likely to graduate from college, and consequently less likely to graduate with math-related degrees.

There is also a gender gap in relation to college majors and math-related careers. More specifically, women are less likely to choose a career that requires high
level mathematics (Kiefer & Sekaquaptewa, 2007). Sadker and Silber (2007) pointed out:

At this time, perhaps more so than at any other time in history, people need to be able to use mathematics in the workplace to perform their everyday tasks…It is critical, as more women are entering the workforce worldwide, that they are prepared for the skilled jobs that will be available. (p. 228)

Low levels of self-efficacy and mathematical interest filter women out of high paying, respected careers and math-related college majors. Research on gender and career interest in the mathematics field can lead to better classroom practices, changes in curriculum, and programs that can better benefit girls and women interested in the field of mathematics.

**Purpose of the Study**

The purpose of this study is to determine if there are gender differences in mathematics interest and interest in math-related careers. Another aim of this study is to determine causes, such as self-efficacy, curriculum and teacher bias, and gender stereotypes, for any gender differences that may exist. This study was inspired by this researcher’s own mathematics experiences in high school and college as well as her high school students’ beliefs and experiences about mathematics, their mathematical ability, and their interest levels in mathematics.

**Methodology**

This study represents a population of 12th grade students at a high school in a suburb of Northern California in the Unites States of America. Participants included
12th grade students who did not opt out of the study at the participating school. The study consisted of a survey containing Likert-type questions as well as open ended questions (see Appendix A). Surveys are an important research tool when individuals are being studied and a population is too large to conduct individual interviews and observations (Rubin & Babbie, 1993). High school students are often exposed to peer-pressure, and truthful responses are important to research results. Because of the importance of independent responses and student academic time, confidential surveys were distributed in all 12th grade advocacy classes, or grade level classes in which students receive information on a variety of topics including college preparation, character building, test taking strategies, and other school wide themes.

The surveys require both quantitative and qualitative analysis, also known as mixed methods. Rubin and Babbie (1993) pointed out that mixed research methods aid in filling in gaps or weakness present when using any given single research method. They added that the addition of open-ended questions to quantitative data allows for the further investigation of unexpected findings. In the survey, students were asked to rank their interest levels in mathematics, science, language arts, and social studies as well as careers in the different fields. Quantitative analysis was used to determine gender averages and compare interest levels in mathematics and math-related career fields. Students were also asked to answer open-ended questions regarding mathematics success, self-efficacy, and interest in both mathematics and mathematics-related careers. Mixed methods were used to determine any factors that may contribute to an interest or lack of interest in specific subjects and career fields.
Limitations

Limitations of this study include sample selection, language limitations, and time. The survey was distributed at a public high school in a diverse Northern California school district. It represents population specific to the school sampled, which does not allow for generalizations outside of the population. Results may vary depending on the ethnic make-up of a region. The survey was provided in English only, which may have excluded a population of students who are English language learners as well as students in self-contained special education classes. Although the survey was distributed in advocacy classes in order to remove bias toward any one subject area, this researcher was not able to personally distribute the surveys. Advocacy classes are 40 minute classes, similar to homeroom classes, in which students receive school-wide and college preparatory information. Since advocacy is only a 40 minute class, teachers were asked to distribute the surveys to their own advocacy classes, and time was extremely limited. Due to time restrictions, a short survey was created. The participants may not have had adequate time to respond to the questions to the best of their abilities. In addition, this researcher may have been unable to achieve maximum results due to the students’ right to opt out of participate in the study, therefore limiting the sample size.

Theory

Feminist theory stresses the importance of equity in education. Theorists such as bell hooks, Carol Gilligan, Charlotte Perkins-Gilman, John Dewy, and Paolo Freire advocate for the inclusion and experience of women in education. In addition, social
role theory notes the importance of gender stereotypes, which can influence children’s educational and career choices as they age and conform to societal stereotypes. Current research, as well as postmodernist theory, point out the absence of feminine existence in text books and curriculum (Carinci, 2009). Sadker and Sadker (1994) explain the importance of the absence of women in curriculum by stating, “When girls do not see themselves in the pages of textbooks, when teachers do not point out of confront the omissions, our daughters learn that to be female is to be an absent partner in the development of our nation” (p. 8). The lack of female role models, both in the curriculum and STEM careers, lead many female students to believe there is no place for them in the STEM world. Low self-esteem and perceived value of mathematics continue to aid in excluding women from high level mathematics classes and careers.

Social Role Theory addresses gender differences, specifically men’s and women’s behavior, due to societal expectations. Social role theory explains that children match their ideas and behaviors to societal gender stereotypes (Perry, White, & Perry, 1984; Wilbourne & Kee, 2010). These learned behaviors persist through adulthood. Due to social and economical consequences that parallel conformity to societal expectations, girls and women continue to conform to pre-determined social stereotypes about behavior, interests, and family life. Social role theory provides the pavement for studies regarding gender differences in schools, workplaces, and other social arenas. Girls and women continue to be oppressed in educational and career aspects due to societal expectations.
Social Learning Theory connects children’s participation and perceived usefulness of a subject or task to their parents (Simpkins, Davis-Kean, & Eccles, 2005). Social Learning Theory leans on observational learning, or the fact that children observe and imitate masculine and feminine qualities from their parents. Parents are often the first teachers for their children, and innately pass their beliefs, skills, and knowledge on to their children. Since children learn by observing others, they learn gender appropriate behaviors from their parents, the media, peers, and others in their environment (Simpkins et al., 2005).

Carol Gilligan’s Moral Development Theory describes differences between men and women in terms of morality and compassion for others. Gilligan points out that morality often plays an important part in women’s decisions (Gilligan, 1982). Women tend to consider others’ feelings as well as moral obligations such as taking care of children or other family members before their own personal benefits. Moral Development Theory aids in explaining differences between girls and boys in their self-concept, course selection, and career choice. Since women tend to be concerned with others, such as their school peers and family members throughout life, they may choose not to pursue a math-related career despite their mathematical ability.

John Dewey analyzes the role of societal expectations on constructing identity, thinking, learning, and teaching. He advocates for feminist teaching, or teaching that caters to equity among students. Dewey expresses the importance of personal experience, connections, and democracy in the classroom (Knowles, Holton, & Swanson, 2005). Unfortunately, mathematics textbooks and teachers almost always
highlight male mathematicians. In addition, mathematics classes often consist entirely of direct instruction. The amount of direct instruction in mathematics is more noticeable as the rigor of mathematics courses increases. Personal experience, hands on projects, and real world applications also tend to be missing from the mathematics curriculum.

Charlotte Perkins Gilman discusses women’s economic reliance on men and the limiting role of wife and mother on women (Ceplair, 1991). Women who are expected to devote time as wives and mothers to their family as less likely than their counterparts to consider a demanding, full-time career. Careers in the mathematics field are considered both time consuming and demanding. As a result, many women see entering a math-related career as an end to their expected roles as wives and mothers.

Paulo Freire’s banking system paints a picture of a traditional classroom in which students are expected to bank or deposit information delivered through the direct instruction of the teacher (Freire & Macedo, 2000). The deposited information is memorized for later regurgitation or assessment. Instead, Freire stresses the importance of incorporating student knowledge and experience into the curriculum. Freire adds that students possess valuable knowledge and experiences which other students, and teachers, can benefit from. Current mathematics instruction typically follows this male-centered banking system model. Math curriculum is often delivered through direct instruction and independent practice which generally caters to boys who are trained to think independently and problem solve. On the other hand, girls tend to
benefit small group collaboration and the incorporation of language into the curriculum.

bel hooks (1994) addresses the importance of student involvement in education. hooks argues that students need to be active participants in their education. hooks also states that students must be able to see themselves in the curriculum, noting that minority students are often not pictured or written about in curricular materials. Postmodernism theory adds that the experiences and ideas of minority groups need to be recognized and heard (Carinci, 2002). The experiences of minority groups throughout history are often absent from school curriculum. The absence of women math teachers, mathematicians, and role models in mathematics curriculum aids in creating a lack of perceived usefulness and disconnect between girls and mathematics.

**Definition of Relevant Terms**

*Advocacy:* is a term used for the purpose of this study and refers to grade level homeroom classrooms in which students receive information about school-related events, standardized tests, citizenship, and other relevant topics.

*Cooperative learning:* type of instruction in which students work with others in a small group to achieve a common goal or task (Sadker & Silber, 2007).

*Gender bias:* preferential inclusion of one group or opinion over another; prejudice view (Sadker & Silber, 2007).

*Gender equity:* treating boys and girls in an equitable manner which sometimes means treating them the same and other times means treating them differently in order to promote equal opportunity (Sadker & Silber, 2007).

Learned helplessness: occurs when someone assigns blame for failure to a lack of ability and gives up easily or shows a decline in problem-solving strategies associated with failure (Meece, Glienke, & Burg, 2006).

Likert scale: type of survey research in which participants are asked whether they strongly agree, agree, disagree, or strongly disagree with a statement (Rubin & Babbie, 1993).

Math anxiety: nervousness or negative attitudes associated with mathematical procedures that can hinder one’s mathematical performance (Ashcraft, 2002; Hopko et al., 2003).

Self-efficacy: the belief that one is capable of executing, or learning to execute, a given task (Wigfield, Barnes, and Eccles, 2006).

Stereotype: notion about an individual based on the social group in which they belong (Ruble, Cohen, & Ruble, 1984).

Stereotype threat: when a minority group does not perform to their ability on a task due to a fear of confirming negative stereotypes about the group (Johns, Schmader, & Martens, 2005; Steele & Aronson, 1995).

Organization of the Thesis

Chapter 1 of this study includes an introduction, purpose of the study, statement of the problem, significance of the study, hypotheses, methodology, definition of relevant terms, limitations of the study, and the organization of the study. Chapter 2 consists of a review of relevant literature including peer-reviewed journal
articles, books, and online documents such as ERIC documents. Chapter 3 describes the methodology used for the study, the population, sample selection, and procedures for collecting and analyzing data. Chapter 4 provides an analysis of the data. Chapter 5 presents a summary of the findings, discussion of the results, conclusions of the study, and recommendations for the future.

**Background of the Researcher**

Christina Patane grew up with only one sibling – a younger brother. Her childhood was spent playing with both stereotypical female toys, such as Barbie, and stereotypical male toys such as Legos and Kenex. As a result of her upbringing, the researcher enjoyed math and science, and despised history which is atypical to gender stereotypes regarding school interest and achievement. The researcher took advanced math courses, including AP Calculus, throughout high school. In college, she majored in Liberal Studies in order to become an elementary school teacher. After her freshman year of college, she grew bored with a lack of challenging mathematics courses, so she sought a solution from college advisors who led her to minor in mathematics.

The first college mathematics course the researcher entered was second semester Calculus. Upon entering, she quickly noticed she was one of two female students in the class taught by a professor who noted many of the students would not succeed. She, like others, thought about dropping the course but decided to attend other Calculus courses in hope of finding one that better suited her. Thankfully, this researcher found another Calculus class and continued on to pursue a minor in
mathematics as well as a single subject mathematics credential, which would allow her to teach mathematics.

This researcher has personally experienced the negative effects that result from stereotypes and inequity in mathematics education. These stereotypes can affect a female’s interest to pursue mathematics professionally. In her own high school math classroom, she has heard female students, even high achieving students, state they are not good at, or interested in, mathematics. While some believe the gender gap in mathematics is closing, this researcher knows it still creates a barrier for girls in math.
Chapter 2

REVIEW OF LITERATURE

History of Women and Mathematics

After a long history of being banned from educational institutes, 19th century women were allowed to attend seminaries where they were taught to be good companions for their husbands, good mothers, and religious leaders for their families (Sadker & Sadker, 1994). These seminaries, though lacking academics, opened the door for the education of women. In addition to offering music, dance, and needlework classes, the seminaries provided women with a basic education in grammar, composition, rhetoric, geography, and arithmetic (Fox, 1989). By following the seminaries lead, Oberlin became the first American college to accept women in 1833. Unfortunately, like the seminaries, Oberlin educated their women to be good housewives and mothers. The women at Oberlin were expected to do the men’s laundry, clean their rooms, offer companionship, and serve them meals (Sadker & Sadker, 1994). Women were finally finding a place in the educational realm, but the thought of them studying mathematics was still far from accepted. In fact, it became popular belief that receiving a higher education would harm one’s ability to bear children (Sadker & Sadker, 1994). Surprisingly, as late as the 1960s, obvious gender discrimination in schools was still considered acceptable, and girls’ career aspirations fell into four limited categories: teacher, secretary, nurse, or mom (Sadker & Sadker, 1994).
With the exception of Hypatia, who is regarded by many as the first female mathematician, female mathematicians do not emerge until the 18th century (Bryden, 2008). Some notable, early, female mathematicians include Sophie Germain, Mary Fairfax Somerville, Sonya Kovalevskaya, and Emmy Noether (Bryden, 2008). These undoubtedly brilliant female mathematicians went to great lengths to receive a mathematics education. They battled parents, popular belief regarding women’s health, and discrimination. Although their success was not easily earned, these famous women mathematicians thrived during a time of oppression and discrimination. Although the education of women has come far since the 19th century, women still battle oppression and gender bias in education (Sadker & Sadker, 1994).

**Gender Stereotypes**

Gender stereotypes begin their effects before a child is even born, and they continue to affect a child throughout his or her entire life. Friends and family members are often puzzled when an expecting parent does not want to know the sex of their baby. After all, the excited parents will need to name their baby and decide on a color to paint the baby’s room. Friends and family members will need to know what color clothes they should purchase, and, of course, everyone needs to know what type of toys should they begin purchasing. Unfortunately, it is difficult to shield a child from exposure to gender stereotypes. Based on one’s gender, a person receives differential treatment from a wide range of people including: teachers, parents, school counselors, friends, society, and the media (Sadker & Sadker, 1994). These influences can encourage, as well as discourage, one from developing nontraditional interests, but
effects generally parallel gender stereotypes (Eccles, 1994). While children are often rewarded by their peers, parents, or teachers for conforming to gender appropriate roles, they also learn about their gender and copy gender appropriate role models without reward and persuasion (Grossman & Grossman, 1994). Gender stereotypes are part of a child’s everyday environment, and in turn, the stereotypes aid in shaping a child’s future decisions and careers.

**Parental Influence on Mathematical Interest and Career Choice**

Parents undoubtedly have a huge influence on their children. In fact, one of the most uniform findings when it comes to studying gender and choice of college major is the significance of parents roles in their children’s gender-related beliefs of ability, class selection, and college major (Bleeker & Jacobs, 2004). Bleeker and Jacobs (2004) cited several studies, including Bender (1994), who shared that students recognize their parents as the strongest influences on their career and academic choices. Parents, in addition to teachers and counselors, can expand a child’s future career options through the exposure they provide in various career fields (Eccles, 1994). Parents can also affect their children’s future career options by offering college funds and encouragement, or sometimes a lack of encouragement, in particular fields which often parallel gender role stereotypes (Eccles, 1994, p. 590).

Parent encouragement has been the focus of many recent studies regarding ability beliefs, or self-efficacy, in mathematics. Cavanagh (2007) found that parent encouragement makes a difference on girls’ interest levels in math and science as well as their academic achievement in the subject areas. Cavanagh (2007) concluded that
fathers’ beliefs specifically are strong predictors of their children’s mathematical interest. Cavanagh (2007) noted, “The more entrenched the father’s gender stereotype, the less likely his daughter is to take an interest in the subject” (p. 3). On the other hand, fathers’ stronger gender stereotypes aid in strengthening boys’ interest levels in math (Cavanagh, 2007). It is important for fathers to encourage their daughters to participate in, enjoy, and excel in mathematics.

In addition to fathers’ beliefs, Linver and Davis-Kean (2005) concluded that mothers’ expectations are important for adolescents since mothers’ higher expectations lead to higher student achievement in seventh grade—which is such an important year in terms of whether or not students continue on to study algebra. Longitudinally, Bleeker and Jacobs (2004) found that mothers’ perceptions of their children’s ability are related to both the self-perceptions as well as future career choices of their children. Mothers who demonstrated higher perceptions about their middle school children’s success in math-related careers had children who also expressed higher math and science self-efficacy two years after graduating from high school. Bleeker and Jacobs (2004) emphasized the importance of parents over teachers by reporting:

Despite the fact that girls have higher teacher ratings than boys, girls report lower self-perceptions of math ability, are less likely to indicate plans to pursue math and science careers than boys, and are ultimately less likely to choose careers in physical science-computing, if their mothers reported low perceptions of their abilities. (p. 107)
Bleeker and Jacobs added that the most important findings from their study were the long-term relationships between mothers’ expectations for their children and their children’s future career paths. Mothers’ expectations of their daughters’ mathematical abilities and future career goals greatly influence their daughters’ future career decisions.

Though Bleeker and Jacobs emphasized the importance of mothers’ perceptions over fathers’, fathers cannot be completely ruled out of the equation. Cavanagh (2007) pointed out, “Fathers are more likely than mothers to encourage gender stereotypes among children, and their tendency to use more demanding scientific language with boys, assuming they can handle it, may reflect that habit” (p. 3). Since children share much of their time and interests with their parents, it is only natural they would be influenced by their parents’ beliefs and experiences.

Interestingly, although mothers’ beliefs about their children’s ability showed a direct correlation with their children’s future beliefs on their abilities, Bleeker and Jacobs (2004) found that mothers’ stereotypical views about math and science were not significantly related to their children’s perceptions or future career choices. However, Jacobs and Bleeker (2004) did note that children’s exposure to mothers who engaged in mathematical activities, children’s participation in math activities with their parents, and owning math and science related toys, led to greater math and science involvement two years later. In addition, mothers were more likely to buy math and science related toys for their boys than girls (Bleeker & Jacobs, 2004). Mothers also tend to encourage boys more than girls to participate in activities relating
to computers, math, and science (Simpkins, Davis-Kean, & Eccles, 2005). Increased exposure to math and science related toys and activities can aid in developing problem-solving and spatial skills, therefore giving boys an early advantage in the fields of math and science.

Even though parents have a prime opportunity to shape their children’s mathematical future for the better, their beliefs and practices can also negatively affect their children. While gender stereotypes regarding mathematics are common, and may be passed from one generation to the next, the direct results of these stereotypes, such as toy purchases and parent involvement in academic activities, are more likely to affect children. Parents typically encourage their boys more than their girls to explore an interest in mathematics (Cavanagh, 2007). They also tend to provide more math-friendly environments for their sons. More specifically, parents tend to purchase math-related toys, books, and games for their sons and support gender stereotypes regarding girls and mathematics (Cavanagh, 2007). When mothers provide math-related toys and are involved in their children’s math activities, their children’s interest in math increases (Jacobs & Bleeker, 2004). Also, boys’ experiences with math-related toys provide them with more opportunities to develop math skills such as spatial skills and problem solving (Jacobs & Bleeker, 2004).

Because of their greater experience with and exposure to math, parents may believe that boys are simply better than girls at math and would be more successful in future math careers. Parent’s attitudes drive their actions, and Simpkins et al. (2005) summarize, “…parents’ behaviors are powerful predictors of children’s participation
in computer, math, and science activities” (p. 14). Providing opportunities and exposure to career paths, purchasing toys and tutors, being involved in school activities, and other factors can greatly affect a child’s desire to pursue certain school courses and career paths. In addition to encouragement for younger children, Simpkins et al. (2005) also express the importance of modeling for older children. Since children often imitate their parents, modeling can be another powerful way to combat gender stereotypes within one’s family. There are many ways in which parents knowingly and subconsciously affect a student’s mathematical interest and ability.

**Teacher Influence on Females’ Interest in Math**

Teachers, though generally well-intentioned, typically receive little gender equity training. As a result, teachers often perpetuate gender stereotypes regarding mathematics. Girls more often than boys are affected by their perceptions of their teachers’ beliefs (Sadker & Silber, 2007). One way in which teachers commonly relay gender stereotypes to their students is by encouraging boys and expecting more of them than their female counterparts. For example, Sadker & Silber (2007) stated that teachers typically criticize boys more often for underperformance while complimenting girls on the neatness of their work instead of academic quality. Teachers also tend to give boys more prompts and encouragement to discover the answers themselves while often giving girls the answers (Sadker & Silber, 2007). Teachers also tend to respond more to boys’ requests for help and discuss concepts and ideas more with boys (Sadker & Silber, 2007). Some additional ways in which teachers can cheat girls out of a quality mathematics education include: initiating more
interactions with boys than girls, giving boys more praise, more criticism, and more remediation, and being more accepting of boys’ answers than girls’ (Meece et al., 2006; Sadker & Silber, 2007). Boys demand more teacher interaction than girls and, consequently, typically dominate the classroom environment (Sadker & Silber, 2007).

Differential treatment is not the only way teachers can pass on gender stereotypes. Teachers and other adults typically model gender specific behaviors and communicate expectations for gender conformity with children. Children then copy the modeled behaviors and conform to adult expectations (Grossman & Grossman, 1994). They often receive a reward or praise for participating in gender appropriate behaviors while they’re punished by their peers and adults for atypical gender behaviors. Grossman and Grossman (1994) add:

In some situations, children will not only copy adult behavior, they will also change their attitudes, self-concept, and choice of academic subjects to conform to their parents’ and teachers’ gender expectations, even when objective evidence would lead them to think differently about themselves and select other subjects. (p. 66)

So even though a student may receive A’s in mathematics, they are more apt to change their beliefs and choice to continue on to higher level mathematics courses in response to teacher beliefs and expectations. Teachers’ actions, beliefs, responses to student work, and modeling can all affect how a student feels about their work and ability in mathematics. It is important for teachers to make a conscious effort to encourage girls to capitalize on their mathematical abilities.
Self-Concept, Confidence, and High School Achievement in Math

Although the National Assessment of Educational Progress (NAEP) reports that fourth grade girls outperform boys, it also shows that in eighth and 12th grade this lead fades as girls start to develop negative attitudes towards mathematics (Geist, 2010). The lead that girls tend to possess early in elementary school seems to fade quickly by the time they leave elementary school. Frenzel, Pekrun, and Goetz (2007) found that in fifth grade, despite demonstrating similar ability levels, girls display less enjoyment and pride in addition to more anxiety and shame than boys in mathematics. Many believe that the negative emotions expressed by girls regarding math stem from gender stereotypes that cause girls to be lower achievers in math than their male counterparts. In a 2008 study conducted by Kurtz-Costes, Rowley, Harris-Britt, and Woods, girls expressed lower self-confidence in math and science than boys. In addition, they found that adult stereotypes regarding gender and mathematics increased the boys’ confidence (Kurtz-Costes et al., 2008).

One area in which girls tend to underperform, possibly due to negative beliefs and anxiety, is on standardized tests such as the Scholastic Aptitude Test (SAT). The SAT test causes a great deal of pressure on high school students because of its high stakes implications. If a student does not perform well on the SAT test, effects can include getting rejected from desired colleges, loss of self-esteem, academic underachievement, and even the elimination of certain career paths. Males outperform females on both the math and verbal sections of the SAT test, and the greatest gap in scores is among high-scoring students (AAUW, 1998). Some argue that women
underperform on mathematical tests party because they possess anxiety about their performance and believe it might confirm gender stereotypes (Johns et al., 2005). This fear of confirming gender stereotypes is known as stereotype threat. Johns et al. (2005) added stereotype threat can also lead to a lack of interest or motivation in stereotype-relevant domains like math and science. In a 2005 study, Johns et al. found women scored lowered than men when they simply thought they were taking a diagnostic math test. Surprisingly, women who learned about stereotype threat, and the anxiety it may cause, did not share the same underperformance on the test. They concluded that explaining stereotype threat to individuals might combat the negative effects that stereotypes actually have on women (Johns et al., 2005).

Unfortunately, the SAT test is not the only high stakes test affecting girls’ perceptions of math. Due to recent legislature, the increased emphasis on high stakes testing like the California Standardized Testing and Reporting (STAR) test in public education is driving classroom instruction. Some students are beginning to associate mathematics with memorization and boring drills that don’t have a place in their real life. Geist (2010) argued:

Instead of helping children develop fluency at computation and become more efficient at problem solving, these policies have produced students that rely more on remote memorization and have increased the level of anxiety in young children by making mathematics a high risk activity. (p. 25)

Teachers need to incorporate everyday experiences back into the mathematics curriculum to make it more accessible and relevant to students’ lives and experiences.
Anxiety and stereotype threat can cause problems in areas other than high stakes testing. Sadker & Silber (2007) cited Fennema (1974) who found that 6th grade girls’ confidence levels in math could predict 12th grade achievement. Fennema also argued this is partially due to the fact that by the end of 6th or 7th grade, the decision to take Algebra and continue on an advanced path in mathematics must be made. Self-efficacy, often referred to as confidence, is the feeling that one is capable of a given task. It is logical to determine that students who enjoy mathematics, feel they are capable of succeeding in math, and believe it is relevant to their future will choose to take more advanced math courses than their counterparts. Linver and Davis-Kean (2005) argue that, “High school boys and girls enroll in different advanced courses depending on their different expectations for success in math, as well as the value they place on competence in math” (p. 50). In addition, they point out that students who have higher mathematics self-concept, or self-efficacy, may decide to take higher level math courses which broaden their future career options (Linver & Davis-Kean, 2005). Students who possess a lower self-efficacy in mathematics, regardless of achievement, will in turn be excluded from many future career paths.

High level mathematics courses, which often refer to courses higher than Algebra II, are prerequisites for math-related college majors and high paying math-related careers. Without these courses, students are excluded from a variety of high paying math-related careers such as engineering and computer technology. From there, ability tracking plays a role in high school course selection. Linver and Davis-Kean (2005) state, “As important as parents are in helping adolescents make choices
regarding course selection in high school, school policies such as ability tracking also play a large role in the range of options available to students” (p. 51). In addition, they argue there is a correlation between girls’ self-concept and the ability group they are placed in for mathematics (Linver & Davis Kean, 2005). Therefore, girls who are tracked into lower ability groups in mathematics can develop a lower self-concept in math and decide to discontinue their higher mathematics education.

**Mathematical Interest and Perceived Value (Usefulness)**

Although schools, principals, and district employees make decisions that affect students, students ultimately make their own educational decisions. Students decide which higher level courses to take and how much effort they will put into their course selections. The lack of female enrollment in higher level math courses and math-related college majors has often been linked to the following factors: self-efficacy, interest, perceived usefulness, tracking, and gender stereotypes exhibited by parents, teachers, and the media.

In fourth grade, male and female students equally report they like math, understand math, and believe it is useful, but by 12th grade, this equality is shattered (NCES, 2000). In 12th grade, males are more likely than females to report they enjoy math, understand it, and still believe it is useful (NCES, 2000, p. 54). Female interest levels in math, self-efficacy, and perceived usefulness evaporate at some point during middle and high school.

Interest and academic achievement are not linked at the lower secondary level, but interest becomes an important factor in future course selection (Köller, Baumert,
Researchers have strived to find reasons for the lack of female interest that exists in high level mathematics courses. Some explain that math is simply too difficult, too boring, too lecture based, and the curriculum is too male-centered. More specifically, the curriculum consists of male role models and word problems about sports and additional stereotypical male activities, and many secondary math teachers are male. Female students tend to do better when they identify with positive female role models or read about them (Rivardo, Rhodes, Camaione, & Legg, 2011). In addition, the instructional strategies used to support the curriculum tend to be male centered. A typical math class includes direct instruction on the lesson and independent practice on problems relating to the lesson. However, female students tend to excel in collaborative activities as well as oral and written assignments (Sadker & Silber, 2007). Typical mathematics classes do not cater to female students.

Another deterring factor for girls who are interested in math is the perceived usefulness of mathematics. Many students believe there are only a handful of math-related career options including becoming an engineer, mathematician, statistician, accountant, or mathematics teacher. More importantly, students often believe there is an even more limited amount of options for females who excel in mathematics. Female students often choose to focus their studies in areas other than mathematics because it seems it is not valuable to their personal future. In order to pursue a career in a math-related field, one must first have knowledge of math-related careers.
Providing knowledge of the variety of math-related careers is a key factor in attracting more women to these careers.

**Decline in Mathematical Interest**

Research shows that after adolescence, girls often express less interest in mathematics than they did in elementary school (Sadker & Sadker, 1994, Sadker & Silber, 2007). Instead, girls tend to express interest in and enroll in courses related to language arts and social studies while boys typically continue expressing interest in math and science (Francis, 2000; Tenenbaum, 2009). An AAUW study reported that from elementary school to high school, there is a huge decline in girls’ mathematics self-concept, or belief in ability (AAUW, 1992). From fourth grade to 12th grade, there is a decline in the enjoyment, understanding, and perceived value of mathematics (NCES, 2000). Some of the factors that may contribute to this decline in interest and self-concept include: math anxiety, or anxiety due to mathematical problems and operations, perceived usefulness or value, gender stereotypes, and teachers’ differential treatment (Sadker & Silber, 2007). Mathematics is widely regarded as a male domain, and after adolescence, girls often conform to the mathematics gender stereotypes.

**Females’ Career Choices and Social Expectations**

Gender stereotypes, or beliefs regarding appropriate activities for males and females, aid in individuals’ feelings about their abilities to work in certain career fields (Bleecker & Jacobs, 2004). In McKenna and Ferrero’s 1991 study (cited by Rudasill & Callahan, 2010), they discovered, “Boys’ and girls’ attitudes toward careers were
strongly sex-typed. Boys and girls stated they preferred jobs traditional for the sex with boys particularly viewing nontraditional occupations less favorably than traditional ones” (p. 302). Rudasill and Callahan (2010) also stated that eighth graders were more interested, and possessed higher self-efficacy, in careers they thought contained more members of their own gender.

Besides mathematical self-concept and the beliefs of one’s parents and teachers, future family plans hold some girls back from pursuing careers in the STEM field. Many women are afraid that if they pursue mathematics careers, they must reject their femininity (Kiefer & Sekaquaptew, 2007). The fear of losing their gender identity is in part due to a lack of feminine role models in both the mathematics curriculum and math-related careers. Kiefer and Sekaquaptewa (2007) studied a group of 63 female, first year calculus students. Kiefer and Sekaquaptewa (2007) found that gender stereotypes, along with how much one identifies with their female gender, affect women’s math performance and their interest in math-related careers. Kiefer and Sekaquaptewa (2007) added that women’s beliefs in traditional gender stereotypes can affect performance in math as well as the desire to pursue math-related careers. They further argued that gender stereotypes about mathematical ability in addition to gender identification, or the extent at which a girls identifies with her female gender, aid in limiting women’s math performance and their interest in math-related careers.

The stereotypical family, although not necessarily most common family structure, includes a father who works to provide for the children and a mother who stays devoted to the household chores and children. Eccles (1994) explained that men
who believe their success as a parent is due to their career may be more career-driven and encourage their children to be competitive. Women who define their success as a parent in relation to their involvement with their children may decrease their commitment to their career goals. Eccles (1994) added men rated family and occupation of equal importance as opposed to women who rated family as more important than occupation. Naturally, in an effort to fulfill gender roles, women are often found either leaving their careers altogether to take care of their children or choosing careers that may better cater to family responsibilities. VanLeuvan (2004) states other researchers found that women described the STEM field as a detriment to future family responsibilities. Females are typically more concerned than their male counterparts about balancing a family and a career (Reis & Callahan, 1994). Van Leuvan continued to add that in attempt to balance career and family responsibilities, many women choose careers in the health profession or teaching because they believe they can balance their work and family responsibilities. In order to be the head of a family, one must work flexible hours around their children’s schedules and have a transportation and day care system in effect. As a result, women often believe that if they want to have children, they need to be the primary caretaker who works around their child’s schedule.

**Current Status of Women in Education**

Women now dominate college campuses by both outnumbering male students and typically earning higher grades across all majors (AAUW, 2007). Between 2007 and 2008, women earned about 57% of all bachelor’s degrees; however, females only
earned about 17% of bachelor’s degrees in engineering and 18% of bachelor’s degrees in computer science and support services (U.S. Department of Education, 2010). Some of the fields in which women earn more than 50% of the bachelor’s degrees include: health-related sciences, education, and biological or life sciences (NCES, 2000). In short, women tend to work in lower-paying service fields such as the social sciences, health services, and education (AAUW, 1998). While it’s safe to say that women are successful in terms of college enrollment and completion, they continue to fall short of men in completing degrees in engineering and computer science—two high paying, math-related career fields.

**Concerns due to the Lack of Gender Equity in Math-Related Careers**

With the exception of physics, female students are just as likely as male students to take rigorous high school mathematics and science courses (Meece et al., 2006). Even though the gender divide in high school mathematics has decreased, there is still a desperate need for women in engineering and computer science (Reynolds & Conaway, 2003). High school mathematics courses can be associated with more than just high school graduation requirements. Kennedy and Schumacher (2005) emphasized the importance of taking high school mathematics courses by pointing out that the correlation between high school courses and college majors in math and science. They added the fact that completing a college degree was directly related to the mathematics courses students took in high school (Kennedy & Schumacher, 2005). This relation means that the stereotypes affecting girls in high school mathematics courses can limit much more than future math and science careers. The stereotypes
can, in fact, hold girls back from graduating from college. Since high school mathematics courses can predict more than just success in math, it is important to inspire girls to pursue mathematics before they enter high school.

In addition to the importance to women, the lack of a growing field in Science, Technology, Engineering, and Mathematics (STEM) is limiting the U.S. economy and their ability to parallel other nations (AAUW, 2010). In an increasingly technological society, the demand for individuals who are literate in mathematics and computer science naturally increases. In spite of the increased female participation in advanced high school courses, women are less likely than men to pursue a college degree in science or engineering (AAUW, 2010; VanLeuvan, 2004). More specifically, there is still a significant gender gap in the fields of college engineering and computer science (Meece et al., 2006). Patricia VanLeuvan (2004) added, “Women who do pursue STEM careers most often choose fields in the biological sciences where they represent 40% of the workforce, with smaller percentages found in mathematics or computer science (13%), the physical sciences (22%), and engineering (9%)” (p. 248).

Unfortunately, the gender differences regarding STEM career interest begins much earlier than college graduation. Boys from eighth grade to high school were twice as likely as girls to prefer a future career in the STEM field (VanLeuvan, 2009). If women continue to be excluded from careers involving math and science, the pool of able workers will be unnecessarily limited. It is essential that schools and teachers begin encouraging women to participate in STEM classes and careers.
Although more women now than ever are leaving the home to join the workforce, they are being filtered from the most prestigious, high-paying careers. In 2008, the U.S. Census Bureau concluded women in the United States earn 77.9% of men’s earnings, and in all of the 50 states women’s median earnings were less than men’s. In addition, the U.S. Census Bureau (2009) reported on average, women still earn 77 cents for every dollar men make. Eccles (1994) stated:

Despite recent efforts to increase the participation of women in advanced educational training and high status professional fields, women and men are still concentrated in different occupations and educational programs, and women are still underrepresented in many high status occupational fields—particularly those associated with physical science, engineering, and applied mathematics. (p. 585)

The exclusion of women in mathematics-related careers such as engineering and computer science limits much more than U.S.’s technological advancement; it places a limit on the income produced by women which could be in turn, reinvested in the U.S. economy.

**Conclusion**

There are many factors that have been known to contribute to a gender gap in mathematical interest and confidence. Some of the factors include: gender stereotypes, parents, teachers, anxiety, perceived value, and society norms. Sometime before or during adolescence, female interest and confidence in mathematics fades. In order to
increase female participation in STEM careers, high school students’ interest and confidence in mathematics must be addressed.
Chapter 3

METHODOLOGY

The purpose of this study is to determine if there are gender differences in mathematics interest and interest in math-related careers. Another aim of this study is to determine causes for any lack of interest in mathematics and math-related careers that may exist. Ninety-six 12th grade students in a suburban, Northern California high school participated in this study. The students answered a short survey consisting of Likert-type questions as well as open ended questions in their 40 minute advocacy, or grade level homeroom class (see Appendix A).

Study Design and Data Collection

This study was designed to determine and analyze gender differences relating to mathematics interest and interest in future career paths. As a result of the different types of questions students included in the survey, mixed methods, or both qualitative and quantitative methods, were used in this study. Quantitative methods were used to analyze the Likert-type survey questions while qualitative methods were used to analyze the short response questions.

Quantitative research typically uses numerical data to determine relationships (Ridenour & Newman, 2008). This researcher used quantitative analysis to determine if there was a relationship between gender and interest in the four core academic areas: language arts, social studies, mathematics, and science. Quantitative analysis was also used to determine if there was a relationship between gender and career interest in the core subject areas.
Though quantitative analysis provides sound, numerical data, it is important to broaden the possible findings of a study by allowing participants to share their answers and feelings without limiting their answers to perceived notions. Rubin and Babbie (1993) addressed the importance of using multiple methods in stating:

As a general guideline, it is always best to use a variety of techniques in the study of any topic. Because each of the methods has its weaknesses, the use of several methods can help fill in any gaps; and if the different, independent approaches to the topic all yield the same conclusions, that can constitute a form of replication. (p. 331)

Using a multiple method approach aids in justifying the results and validity of a study. Multiple method approaches can also help to fill in missing links after the use of one approach.

As well as strengthening weaknesses of a single approach, Bouma and Atkinson (1995) add, “…an open approach allows the researcher to investigate unexpected topics which may only become apparent after an investigation has begun” (p. 207). Using qualitative data aids in the discovery of new, relevant outcomes. Studies should not always be bound by preexisting notions and research. Since qualitative research is often used to understand meaning, this researcher used qualitative analysis to investigate possible reasons for an interest, or lack of interest, in mathematics and STEM careers (Ridenour & Newman, 2008).

Six open-ended questions were included in the student survey. A thematic approach was used to analyze the qualitative data from the open-ended responses. In
thematic analysis, student responses are coded, or placed into categories based on common themes (Bouma & Atkinson, 1995; Ridenour & Newman, 2008). Sometimes the categories are determined by the researcher, and other times, the categories are determined by participant responses (Ridenour & Newman, 2008). Categorizing and coding open-ended data allows the researcher to accurately analyze open-ended responses.

Convenience sampling was used to obtain participants for this study. Convenience sampling is a sampling method in which participants are chosen because they are easily accessible (Jones & Kottler, 2006). Cluster sampling was also used. In cluster sampling, participants are part of “…a naturally occurring group of people—for example, a classroom, a school, or a club” (Jones & Kottler, 2006, p. 62). The population of this study consisted of 12th grade students at a Northern California suburban, public high school.

**Research Question**

This study addressed the following questions to 12th grade high school students: “Are there gender differences in mathematics interest? What factors contribute to an interest, or lack of interest, in mathematics? Are there gender differences in the interest levels of 12th grade students in math-related careers?” In summary, the aim of the study was to discover and analyze any gender differences that exist among 12th grade students regarding mathematics and math-related careers.
Research Instruments

Surveys are beneficial when a population is too large to interview (Rubin & Babbie, 1993). Because of the students’ time constraints during school, as well as the researcher’s time constraints, a survey was used in order to receive responses from as many 12th grade students as possible (see Appendix A). The survey was developed by the researcher using feedback and insight from professors in the discipline. Likert-type questions were used in order to gather accurate, qualitative data. Students were arbitrarily numbered, and names were removed to ensure the confidentiality of the students and school. Numerical ratings were averaged by gender to compare responses by gender. Short responses were analyzed for common themes, also known as thematic analysis, and notable findings.

Participants

The school selected for this study is a new school in a Northern California suburb. Because it is a new school, attendance boundaries had not been determined at the time of the study. Students at this school are ethnically and socially diverse with the majority of the students being Caucasian, African American, and Hispanic, and approximately one-third of the students being socioeconomically disadvantaged (see Table 1).
Table 1

*Participants*

<table>
<thead>
<tr>
<th>Race/Ethnicity</th>
<th>Number of Female Participants</th>
<th>Percentage of Female Participants</th>
<th>Number of Male Participants</th>
<th>Percentage of Male Participants</th>
</tr>
</thead>
<tbody>
<tr>
<td>Caucasian/White</td>
<td>13</td>
<td>28.89</td>
<td>11</td>
<td>21.57</td>
</tr>
<tr>
<td>African American</td>
<td>8</td>
<td>17.78</td>
<td>6</td>
<td>11.76</td>
</tr>
<tr>
<td>Hispanic/Mexican/Puerto Rican</td>
<td>4</td>
<td>8.89</td>
<td>11</td>
<td>21.57</td>
</tr>
<tr>
<td>Mixed Ethnicity</td>
<td>7</td>
<td>15.56</td>
<td>6</td>
<td>11.76</td>
</tr>
<tr>
<td>Asian/Filipino</td>
<td>4</td>
<td>8.89</td>
<td>5</td>
<td>9.80</td>
</tr>
<tr>
<td>Indian</td>
<td>2</td>
<td>4.44</td>
<td>2</td>
<td>3.92</td>
</tr>
<tr>
<td>Afghan</td>
<td>0</td>
<td>0</td>
<td>2</td>
<td>3.92</td>
</tr>
<tr>
<td>Muslim</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>1.96</td>
</tr>
<tr>
<td>Pakistani</td>
<td>1</td>
<td>2.22</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Declined to State</td>
<td>6</td>
<td>13.33</td>
<td>7</td>
<td>13.74</td>
</tr>
<tr>
<td>Total</td>
<td>45</td>
<td>100</td>
<td>51</td>
<td>100</td>
</tr>
</tbody>
</table>
A letter from the principal was obtained to demonstrate consent for the research study. Opt out forms were distributed to the affected 12th grade students. Students who did not wish to participate, or parents who did not wish for them to participate, were then allowed to formally opt out of the research study. Ninety-six students in all opted to participate. Participants included 45 females and 51 males. The population of students targeted was 12th grade because this is the year in which students must decide if they wish to continue their education in college or join the workforce. At this time, the students must also weigh college options in relation to their interest in college majors and career fields. By 12th grade, students are forced to make preliminary decisions about their college and career paths. At this time, they have already been accepted to colleges, and have accepted or declined these offers. Convenience sampling and cluster sampling were used to create a population for this study. False names will be used for any notable findings in order to preserve the confidentiality of the participants and school.

**Setting**

Students from seven sections of regular 12th grade advocacy classes participated in this study. At this particular school, advocacy classes are 40 minute classes similar to homeroom classes at other schools, in which non-subject specific information is delivered. Typical curriculum for advocacy class at this school consisted of school wide policies and information, citizenship lessons, college preparatory lessons and assessments, and homework help. Regular advocacy classes
do not include 12th grade students who are enrolled in elective advocacy classes such as yearbook or journalism, which are not grade specific.

**Procedure**

The researcher obtained principal approval to conduct this study. The opt out consent method was used for participants in order to increase the number of participants and gain a larger, more representative sample of the population (see Appendix B). Students participated in the study by completing a survey in their regular, 40 minute advocacy class. Students were allowed the entire 40 minute class period to complete the survey individually. The participants were in their normal advocacy classes, so their routines and environment were uninterrupted. Advocacy teachers were able to distribute the surveys to their own students. The teachers were instructed to only clarify directions in order to remove bias from the environment.

Quantitative analysis was used to examine results in the Liket-type questions. For the open ended questions, student responses were tallied. The responses were then grouped according to common themes. Student quotes were also examined for notable findings.

**Summary**

This study consisted of mixed methods in order to increase the possibility for valuable results and notable findings. The Likert-type questions yield quantitative data regarding interest levels in mathematics and math-related careers while the short-response questions offer qualitative date including information regarding specific
career interests and factors that contribute to their interest in different subject areas.

The students freely participated in this study to avoid blank or false responses.
Chapter 4

FINDINGS

This study included data collected from 96 high school seniors. The aim of the study was to determine if a gender gap persists in high school mathematics students. Another aim of this study was to determine any factors that may contribute to females’ lack of interest in mathematics. In order to achieve greater results, a two part survey was completed. The first part of the survey consisted of four Likert scale questions, and the second part contained six open ended questions.

Quantitative Results

Questions 1-4, the Likert scale questions, addressed interest levels, confidence levels, and student grades in the four core school subjects: language arts, social studies, mathematics, and science. Means were used to determine differences between male and female student responses.

Question # 1: Rank your interest in the following subject areas: language arts, social studies, mathematics, science. (see Table 2)

1 = not interested 2 = somewhat interested 3 = interested 4 = very interested
Table 2

*Student Interest in Language Arts, Social Studies, Mathematics, and Science*

<table>
<thead>
<tr>
<th>Subject</th>
<th>Female Mean Interest</th>
<th>Male Mean Interest</th>
</tr>
</thead>
<tbody>
<tr>
<td>Language Arts</td>
<td>3.022222</td>
<td>2.117647</td>
</tr>
<tr>
<td>Social Studies</td>
<td>2.795455</td>
<td>2.568627</td>
</tr>
<tr>
<td>Mathematics</td>
<td>1.977273</td>
<td>2.529412</td>
</tr>
<tr>
<td>Science</td>
<td>2.272727</td>
<td>2.333333</td>
</tr>
</tbody>
</table>

*Figure 1. Student Interest in Language Arts, Social Studies, Mathematics, and Science.*

On average, the subject in which female students were the least interested was mathematics. The average female interest level for mathematics was only 1.977273 which meant most female students were “not interested” or “somewhat interested” in mathematics. The highest average interest level for female students was in language arts. Female interest in language arts was the only average to exceed a rank of 3,
meaning most female students were “interested” in the subject area. The subject in which males were least interested on average was language arts. On average, the subject in which males were the most interested in was social studies. Mathematics was the only subject area in which the mean interest level was less than 2 for either gender. This low interest level occurred only in the female population, while on average, male students reported they were “somewhat interested” or “interested” in mathematics. The greatest gender disparities in interest levels occurred in language arts and mathematics.

**Question # 2: Rank your interest in careers related to the following subject areas:**

- language arts (Journalist, Author, English Teacher, etc.)
- social studies (Historian, History teacher, etc.)
- mathematics (Teacher, Engineer, Accountant, Statistician, etc.)
- science (Doctor, Nurse, Chemist, Biologist, Science teacher, etc.) (see Table 3)

1 = not interested  2 = somewhat interested  3 = interested  4 = very interested
Table 3

*Student Interest in Careers Relating to Core Subjects*

<table>
<thead>
<tr>
<th>Subject</th>
<th>Female Mean Interest</th>
<th>Male Mean Interest</th>
</tr>
</thead>
<tbody>
<tr>
<td>Language Arts</td>
<td>2.511111</td>
<td>1.647059</td>
</tr>
<tr>
<td>Social Studies</td>
<td>1.931818</td>
<td>1.764706</td>
</tr>
<tr>
<td>Mathematics</td>
<td>1.590909</td>
<td>2.333333</td>
</tr>
<tr>
<td>Science</td>
<td>2.454545</td>
<td>2.235294</td>
</tr>
</tbody>
</table>

*Figure 2. Student Interest in Careers Relating to Core Subjects.*

On average, female students were least interested in careers involving mathematics. The mean female interest level for careers involving mathematics was only 1.590909, which was the lowest interest level for any career area. On average, female students were most interested in a career involving language arts, but this was closely followed by interest in science careers. Males, on average, expressed the least
interest in careers involving language arts and the highest interest in careers relating to mathematics.

**Question # 3: How confident do you feel in your abilities in the following subject areas?** (see Table 4)

1 = not interested  2 = somewhat interested  3 = interested  4 = very interested

Table 4

*Student Confidence in Core Subjects*

<table>
<thead>
<tr>
<th>Subject</th>
<th>Female Mean Confidence</th>
<th>Male Mean Confidence</th>
</tr>
</thead>
<tbody>
<tr>
<td>Language Arts</td>
<td>3.318182</td>
<td>2.901961</td>
</tr>
<tr>
<td>Social Studies</td>
<td>2.977273</td>
<td>3.117647</td>
</tr>
<tr>
<td>Mathematics</td>
<td>2.377778</td>
<td>2.941177</td>
</tr>
<tr>
<td>Science</td>
<td>2.659091</td>
<td>2.705882</td>
</tr>
</tbody>
</table>

*Figure 3. Student Confidence in Core Subjects.*
On average, females were the least confident in their mathematical abilities and most confident in their language arts abilities. Males were on average least confident in their science abilities and most confident in their social studies abilities.

**Question # 4: What grades do you typically earn in the following subject areas: Language Arts, Social Studies, Mathematics, Science?** (see Table 5 and Table 6)

Table 5

*Grades Earned*

<table>
<thead>
<tr>
<th>Grade</th>
<th>Language Arts</th>
<th>Social Studies</th>
<th>Mathematics</th>
<th>Science</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Female</td>
<td>Male</td>
<td>Female</td>
<td>Male</td>
</tr>
<tr>
<td>A</td>
<td>28</td>
<td>19</td>
<td>26</td>
<td>17</td>
</tr>
<tr>
<td>B</td>
<td>11</td>
<td>15</td>
<td>11</td>
<td>26</td>
</tr>
<tr>
<td>C</td>
<td>6</td>
<td>13</td>
<td>6</td>
<td>3</td>
</tr>
<tr>
<td>D</td>
<td>0</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>F</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>A/B</td>
<td>0</td>
<td>1</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>B/C</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>C/D</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>

| 45 | 51 | 45 | 51 | 45 | 51 | 45 | 51 |
Table 6

Grades Earned by Percent

<table>
<thead>
<tr>
<th>Grade</th>
<th>Language Arts</th>
<th>Social Studies</th>
<th>Mathematics</th>
<th>Science</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Female</td>
<td>Male</td>
<td>Female</td>
<td>Male</td>
</tr>
<tr>
<td>A</td>
<td>62.22</td>
<td>37.25</td>
<td>57.78</td>
<td>33.33</td>
</tr>
<tr>
<td>B</td>
<td>24.44</td>
<td>29.41</td>
<td>24.44</td>
<td>50.98</td>
</tr>
<tr>
<td>C</td>
<td>13.34</td>
<td>25.50</td>
<td>13.34</td>
<td>5.89</td>
</tr>
<tr>
<td>D</td>
<td>0</td>
<td>1.96</td>
<td>2.22</td>
<td>1.96</td>
</tr>
<tr>
<td>F</td>
<td>0</td>
<td>1.96</td>
<td>0</td>
<td>1.96</td>
</tr>
<tr>
<td>A/B</td>
<td>0</td>
<td>1.96</td>
<td>2.22</td>
<td>3.92</td>
</tr>
<tr>
<td>B/C</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>1.96</td>
</tr>
<tr>
<td>C/D</td>
<td>0</td>
<td>1.96</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>

In mathematics, 13/45 (28.9%) of the female students reported they typically get A’s while 17/51 (33.3%) male students reported they usually earn A’s. 13/45 (28.9%) female students said they usually earn B’s in mathematics compared to 18/51(35.3%) male students. 16/45 (35.6%) female students reported they earn C’s in mathematics compared to 12/51 (23.5%) male students. 2/45 (4.44%) female students stated they typically earn D’s in mathematics, while 1/51 (1.96%) male students said they earn D’s in mathematics. None of the female students reported they typically earn F’s in mathematics, and only one out of the 51 male students stated he typically earns F in mathematics.
Open Ended Responses

Six open ended questions (question numbers 5 - 10) were included in the student survey. The students were directed to answer the questions with as much description as possible. Ninety-six surveys were included in the study: 45 female student surveys and 51 male student surveys. Student responses were tallied for frequencies, and a table was constructed. Then, the responses were analyzed, noting themes in student responses.

Question # 5: Are there any subjects you used to be interested in, but no longer are? If so, what subject and why? (see Table 7)

Table 7
Decline in Student Interest

The six most common student responses are listed in the below.

<table>
<thead>
<tr>
<th>Subject</th>
<th>Female Frequency</th>
<th>Male Frequency</th>
<th>Female Percent</th>
<th>Male Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>None</td>
<td>15</td>
<td>26</td>
<td>33.33</td>
<td>50.98</td>
</tr>
<tr>
<td>Mathematics</td>
<td>9</td>
<td>8</td>
<td>20</td>
<td>15.69</td>
</tr>
<tr>
<td>History/Government</td>
<td>6</td>
<td>3</td>
<td>13.33</td>
<td>5.88</td>
</tr>
<tr>
<td>Science</td>
<td>7</td>
<td>2</td>
<td>15.56</td>
<td>3.92</td>
</tr>
<tr>
<td>No Response</td>
<td>3</td>
<td>5</td>
<td>6.67</td>
<td>9.80</td>
</tr>
<tr>
<td>Language Arts</td>
<td>3</td>
<td>1</td>
<td>6.67</td>
<td>1.96</td>
</tr>
</tbody>
</table>

43 45 95.56 88.23
The most common response was that there are no subjects in which the students’ interests had declined. However, the subject in which the highest frequency of students lost interest in was mathematics. Seventeen out of 88 students who answered question #5 said they used to be interested in mathematics, but no longer are. Nine of the 17 students who possessed a decreasing interest in mathematics were female. Four 12th grade female students explained they were no longer interested in mathematics because of its increasing difficulty. One 18 year-old African American student stated she was no longer interested in mathematics because, “It got confusing.” A 17 year-old Hispanic female agreed stating she was no longer interested in math because, “It was starting to be more difficult.” A 17 year-old Caucasian female student added she was not interested in math anymore because, “The lessons became too complex with multiple answers per question.” Another 17 year-old Caucasian female explained, “I used to be interested in math, but as it got more difficult, my interest dropped.”

Some of the female students identified a different reason for their decreasing interest in mathematics—their teachers and grades. A 17 year-old Caucasian female wrote, “I used to be interested in math, but my previous teachers made the subject confusing and boring.” Another Caucasian female student, a high school senior at only 16 years of age, stated, “I used to like math, but I’ve had a series of bad teachers so I haven’t enjoyed it lately.” Finally, a 17 year-old Caucasian student explained, “I used to like math, then I started getting bad grades so now I don’t like it anymore.”
Male students attributed their decreasing interest in mathematics to homework, formulas, difficulty, and enjoyment. A 17 year-old student of mixed ethnicity stated he doesn’t like math anymore “because of homework.” A 17 year-old Caucasian male student explained he lost interest in math “because of the over complication of formulas and lack of actual teaching of them.” A 17 year-old Hispanic male agreed stating he wasn’t interested in mathematics anymore because he “got tired of all the formulas being carried into science.” Another male student said he lost interest in math because, “It (math) just got ridiculous.” Finally, an 18 year-old African American student said he didn’t have an interest in mathematics anymore because, “It’s not as fun.”

The biggest discrepancy between male and female student responses was in science. Seven out of the 43 female students that responded to question # 5 stated they used to be interested in science, but no longer are. Only two male students out of the 45 that responded said the same. A 17 year-old Chinese female explained, “I used to enjoy science but it got more and more calculating with some formulas, so…” Two female students attributed their deceasing interest in science to Chemistry. One female student said, “I used to like science until I met Chemistry. Some of it just doesn’t make sense like it used to.” Another female student added that she was interested in science until she took Chemistry because, “It got confusing.”
Question # 6: What are some of the factors that contribute to your interest in the following subject areas: language arts, social studies, mathematics, science? (see Table 8)

Student responses were only analyzed for factors that contribute to an interest in mathematics. The other subject areas were included in the question to remove student bias. The six most frequent student responses regarding an interest in mathematics are included in the table below.

Table 8

Factors That Contribute to an Interest in Mathematics

<table>
<thead>
<tr>
<th>Factors</th>
<th>Female Frequency</th>
<th>Female Percent</th>
<th>Male Frequency</th>
<th>Male Percent</th>
<th>Combined Frequency</th>
<th>Combined Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>None/Not Interested</td>
<td>11</td>
<td>24.4</td>
<td>8</td>
<td>15.7</td>
<td>19</td>
<td>19.8</td>
</tr>
<tr>
<td>Solving Problems/Reasoning</td>
<td>7</td>
<td>15.6</td>
<td>6</td>
<td>11.8</td>
<td>13</td>
<td>13.5</td>
</tr>
<tr>
<td>Like/Enjoy It</td>
<td>0</td>
<td>0</td>
<td>4</td>
<td>7.8</td>
<td>4</td>
<td>4.2</td>
</tr>
<tr>
<td>Managing Money</td>
<td>2</td>
<td>4.4</td>
<td>2</td>
<td>3.9</td>
<td>4</td>
<td>4.2</td>
</tr>
<tr>
<td>One Solid/Right Answer</td>
<td>3</td>
<td>6.7</td>
<td>0</td>
<td>0</td>
<td>3</td>
<td>3.1</td>
</tr>
<tr>
<td>Real Life Applications</td>
<td>3</td>
<td>6.7</td>
<td>0</td>
<td>0</td>
<td>3</td>
<td>3.1</td>
</tr>
</tbody>
</table>

26 57.8 20 39.2 46 47.9

The factor that most students identified as a contributing factor to their interest in mathematics was the opportunity to solve problems and reason. Seven out of the 45
participating female students said that problem solving or reasoning contributes to their interest in mathematics. While most students simply answered “problem solving,” a 17 year-old female stated, “I enjoy reasoning and thinking in different ways.” In addition, two female students stated that managing money or their bank accounts contributed to their mathematical interest.

The female students identified two more main factors that contribute to their interest in mathematics: the fact that there is only one, solid, or correct, answer in math and real life applications. One female student stated she likes that there is “a certain solid answer to a question.” A 17 year-old Caucasian student answered more specifically by stating, “I like how in math if you do one thing, and do it right, you will always get the right answer, so I kind of like Algebra.” On the other hand, a 17 year-old Filipino female explained, “I actually like stats and things that can be applied to real life.” Another female student added, “It is essential to modern life, but it feels like a chore since you use math daily. It’s dull, mundane.”

Male students, like the female students, noted that problem solving and money management were contributing factors to their interest in mathematics. However, none of the male students stated they like the fact that there is usually only one correct answer in math. In addition, none of the male students cited real life applications as a contributing factor to their mathematical interest. Instead, unlike any female students, four male students said the fact that they like or enjoy mathematics contributes to their interest in it. One 17 year-old African American male stated, “My mind loves numbers.” Another male student referred to mathematics as “intriguing.”
Question # 7: What are some of the factors that contribute to your lack of interest in the following subject areas: language arts, social studies, mathematics, science? (Table 9)

Again, only student responses regarding mathematics were analyzed. The six most common responses are listed in the table below.

Table 9

Factors That Contribute to a Lack of Interest in Mathematics

<table>
<thead>
<tr>
<th>Factors</th>
<th>Female Frequency</th>
<th>Female Percent</th>
<th>Male Frequency</th>
<th>Male Percent</th>
<th>Combined Frequency</th>
<th>Combine Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Difficult/hard</td>
<td>11</td>
<td>24.4</td>
<td>6</td>
<td>11.8</td>
<td>17</td>
<td>17.7</td>
</tr>
<tr>
<td>Too many equations/formulas</td>
<td>7</td>
<td>15.6</td>
<td>4</td>
<td>7.8</td>
<td>10</td>
<td>10.4</td>
</tr>
<tr>
<td>Nothing, I like it.</td>
<td>3</td>
<td>6.7</td>
<td>5</td>
<td>9.8</td>
<td>8</td>
<td>8.3</td>
</tr>
<tr>
<td>Not interesting/boring</td>
<td>1</td>
<td>2.2</td>
<td>2</td>
<td>3.9</td>
<td>3</td>
<td>3.1</td>
</tr>
<tr>
<td>Too much work</td>
<td>1</td>
<td>2.2</td>
<td>2</td>
<td>3.9</td>
<td>3</td>
<td>3.1</td>
</tr>
<tr>
<td>Everything</td>
<td>2</td>
<td>4.4</td>
<td>1</td>
<td>2.0</td>
<td>3</td>
<td>3.1</td>
</tr>
</tbody>
</table>

The majority of female and male students correlated their lack of interest in mathematics with the fact that it is difficult. Eleven out of 45 female students, 24.4%, stated mathematics is difficult compared to only six out of 51 male students, or 11.8%. Another common response was that there are too many equations and formulas in mathematics. One female student described how difficult mathematics is for her by explaining, “It seems to blur together.” A 17 year-old female elaborated by stating,
“Concepts are difficult to understand; they are not concrete.” A 17 year-old female added, “Math requires quick understanding, which many times, it is difficult to grasp right away.

**Question # 8: List as many careers as you can in the science, technology, engineering, and mathematics (STEM) fields.** (see Table 10)

Females listed a mean of 2.18 careers. The 45 female students listed a total of 98 careers. Males listed a mean of 1.45 careers. The 51 male students listed a total of 74 careers. Twenty-six students out of the 96 participants listed 0 careers. The top ten STEM careers listed by students are included in the table below.

Table 10

**Top 10 Careers Listed by Students**

<table>
<thead>
<tr>
<th>Career</th>
<th>Female Frequency</th>
<th>Female Percent</th>
<th>Male Frequency</th>
<th>Male Percent</th>
<th>Combined Frequency</th>
<th>Combined Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Teacher</td>
<td>23</td>
<td>51.11</td>
<td>19</td>
<td>37.25</td>
<td>42</td>
<td>43.75</td>
</tr>
<tr>
<td>Doctor</td>
<td>22</td>
<td>48.89</td>
<td>12</td>
<td>23.53</td>
<td>34</td>
<td>35.42</td>
</tr>
<tr>
<td>Engineer</td>
<td>15</td>
<td>33.33</td>
<td>14</td>
<td>27.45</td>
<td>29</td>
<td>30.21</td>
</tr>
<tr>
<td>Nurse</td>
<td>13</td>
<td>28.89</td>
<td>4</td>
<td>7.84</td>
<td>17</td>
<td>17.71</td>
</tr>
<tr>
<td>Computer Technician/Programmer</td>
<td>10</td>
<td>22.22</td>
<td>8</td>
<td>15.69</td>
<td>18</td>
<td>18.75</td>
</tr>
<tr>
<td>Accountant</td>
<td>9</td>
<td>20</td>
<td>5</td>
<td>9.80</td>
<td>14</td>
<td>14.58</td>
</tr>
<tr>
<td>Scientist</td>
<td>8</td>
<td>17.78</td>
<td>7</td>
<td>13.73</td>
<td>15</td>
<td>15.63</td>
</tr>
<tr>
<td>Architect</td>
<td>5</td>
<td>11.11</td>
<td>5</td>
<td>9.80</td>
<td>10</td>
<td>10.42</td>
</tr>
<tr>
<td>Chemist</td>
<td>5</td>
<td>11.11</td>
<td>8</td>
<td>15.69</td>
<td>13</td>
<td>13.54</td>
</tr>
<tr>
<td>Biologist</td>
<td>3</td>
<td>6.67</td>
<td>5</td>
<td>9.80</td>
<td>8</td>
<td>8.33</td>
</tr>
<tr>
<td>Civil Engineer</td>
<td>4</td>
<td>8.89</td>
<td>6</td>
<td>11.76</td>
<td>10</td>
<td>10.42</td>
</tr>
</tbody>
</table>
Question # 9: Are you interested in a career in science, technology, engineering, or mathematics (STEM)? Why or why not? If so, do you know which career?

Twenty-one out of 45 (46.67%) female students were interested in a STEM career. 29 out of 51 (56.86%) male students were interested in a STEM career. The top two careers listed by females were doctor and nurse. One 17 year-old Caucasian female said she was interested in a STEM career, “…but only being a nurse or doctor. It seems like a good, stable career and I would get to help people.” Another 17 year-old female explained, “Yes, I am interested. I am interested because I enjoy learning about science and I want to pursue a future career either as a nurse practitioner, physician assistant, or doctor.” In addition, a 17 year-old Caucasian female said, “I want to be a registered nurse working with newborn babies and helping people out.” The other careers listed by female students were fairly evenly distributed, with most careers only mentioned by one or two students.

The top three STEM careers male students were interested in were teacher, business, and technology. A 17 year-old African American male stated he was interested in a career in business finance saying, “That’s where the money is at.” A 17 year-old Indian male said he wanted to be “a math teacher or athletic trainer.” An 18 year-old male explained his interest in technology by saying, “I’m excited to see what they’re gonna come out with next.” The other male student responses were fairly evenly distributed, and the remaining careers were only identified by one or two students.
Question # 10: Are there any other specific careers you are currently interested in? If so, which careers and why?

The career in which the most female students were interested was a career in journalism. Five out of 45 female students, approximately 11.1%, expressed an interest in journalism. A 17 year-old African American female explained her interest in journalism by saying, “I’m interested in journalism because I like to write about things of interest or importance.” Another female student said she wanted a career in journalism because she likes “talking to people.” None of the male students shared an interest in journalism. The other careers choices were fairly evenly distributed with most careers only possessing one student who expressed interest.

The career in which the most male students were interested in was business. Six out of fifty-one of the male students, approximately 11.8%, stated they were interested in a career in business. While most male student responses were simply, “Business,” an 18 year-old African American male stated, “I want to become a businessman and own a brand.” Another 18 year-old African American student said he wants to be an “international business financer.” An interest in business was followed by an interest in becoming a mechanic. Four out of the 51 male students, about 7.8%, reported they were interested in becoming a mechanic. A 17 year-old Asian male student said he would like to become a mechanic because he likes “to do hands on things.” He added, “My father is a mechanic.” Similar to the female student responses, the male students were equally interested in the other careers listed, with most careers only having one student who expressed interest.
Notable Findings

Question 5 asked if there were any subjects the students used to be interested in, but no longer are. The most frequent response among both female and male students was mathematics. However, more female than male students stated their interest in science has decreased. Two female students blamed their declining interest in science on chemistry. One female student said, “I used to like science until I met chemistry. Some of it just doesn’t make sense like it used to.” Another female student added that she was interested in science until she took chemistry because, “It got confusing.”

Questions 9 and 10 asked students what careers, if any, the students were interested in pursuing in the future. As this researcher was tallying and analyzing data, she noticed that five out of the forty-five female students, approximately 11.1%, mentioned they wanted a career in which they could help people compared to only two out of the fifty-one, approximately 3.9%, male students. In addition, five out of fifty-one male students, 9.8%, stated they were interested in a career in which they could earn a lot of money. None of the female students mentioned money in their responses. In addition, one of the female students stated she was interested in a career in cosmetology or culinary arts. She added, “I like hair, makeup, and nails. I’m also interested in culinary arts because I like to cook new things.” Another female student reported that she wanted to pursue a career as a wedding planner. None of the male students expressed an interest in cosmetology, culinary arts, or wedding planning. Finally, one of the male students stated he was interested in a career as a
“businessman.” Approximately 11% of the male students expressed an interest in business compared to zero female students.

**Conclusion**

The study was conducted in order to determine if gender differences in interest in mathematics and math-related careers persist. In addition, the study examined factors that may contribute to an interest and a lack of interest in mathematics for female students. Based on self-reported student data, the study shows there is a difference between female students’ and male students’ interest levels in mathematics and math-related careers. On average, female students report lower interest levels in mathematics and math-related careers. Female students were also less confident in their mathematical abilities. Female students reported that solving problems, enjoying math, managing money, the fact that there is only one correct answer, and real life applications are some of the factors that contribute to their interest in mathematics. They also reported that the difficulty level, number of equations and formulas, boring curriculum, and heavy workload contribute to their lack of interest in mathematics. Finally, a smaller percentage of female students (46.67%) reported they were interested in a STEM career than male students (56.86%).
Chapter 5

DISCUSSION, CONCLUSIONS, LIMITATIONS, AND RECOMMENDATIONS

Introduction

The intent of this study was to determine if gender differences persist in high school students’ interest levels in mathematics and math-related careers. Another goal of the study was to explore factors that may contribute to any gender differences that exist. This study analyzed data from surveys which contained four Likert scale questions and six open-ended questions. The surveys were distributed to 96 12th grade students at a Northern California public school. Forty-five of the 96 students were female, and 51 were male.

Quantitative Data Collection

Interest in the Four Core Subjects: Language Arts, Social Studies, Mathematics, and Science (Question 1)

Female students possessed the highest mean interest level in language arts. The mean female rank in language arts was 3.022 which means on average, the female students were interested in language arts. The subject in which females had the least mean interest in was mathematics. The mean rank for interest in mathematics was 1.977, which means that on average, the female students were either not interested in or only somewhat interested in mathematics. Female students’ interest in language arts and lack of interest in mathematics coincides with the 2000 NCES report which states in 12th grade, boys are more likely than girls to say they like math, understand it, and believe it is important. Francis (2000) also noted that most students believe girls and
boys are equally competent in most subjects—except for the fact that boys are better at mathematics and physical science and girls are better with language. The stereotype regarding math and language arts is consistent with Tenenbaum (2009) who added, “When children feel competent in a domain, they are apt to pursue that domain” (p. 448). The 12th grade female students expressed a greater confidence and therefore interest in language arts and were less confident and interested in mathematics.

Gendered beliefs regarding language arts and mathematics also paralleled the 12th grade male students’ interest levels in mathematics and language arts. On average, male students expressed the most interest in social studies with a mean rank of 2.569. This was followed closely by an interest in mathematics. Male students possessed a mean interest level of 2.529 in mathematics (second to Social Studies by only four hundredths). This means, on average male students were somewhat interested or interested in mathematics. The lowest mean interest rank for male students was in language arts. The mean rank for male students’ interest in language arts was only 2.118 meaning most male students were only somewhat interested in language arts. The male students expressed higher interest levels in mathematics and social studies and lower interest levels in language arts which is again consistent with gender stereotypes relating to gender and subject interest.

Ironically, the overall lowest interest level in any of the four core subjects was female students’ interest in Mathematics. It was the only average interest to fall below a rank of two. Female students also possessed the highest interest level in a core subject. Their average interest level of 3.022 in Language Arts was the only average to
exceed a rank of 3. The male students typically had more equal interest levels among the four core subject areas while the female students possessed more varied interest levels in the different subject areas.

**Career Interest in the Four Core Subject Areas: Language Arts, Social Studies, Mathematics, and Science (Question 2)**

Male and female students possessed opposing interests in careers related to the four subject areas. Female students had the highest average interest in careers related to language arts (2.511). In addition, they had the lowest mean interest in careers related to mathematics (1.591). On the other hand, male students possessed the highest mean interest in careers related to mathematics (2.333) and the lowest mean interest in careers relating to language arts (1.647). The lowest mean interest level for both male and female students was female students’ interest in careers related to mathematics.

The results of this study correspond with Kiefer & Sekaquaptewa (2007) who found that due to stereotypes, female students were less likely than their male counterparts to pursue a career that required high level mathematics. In addition, students often choose to participate in careers that they believe are appropriate for their gender (McKenna & Ferrero, 1991; Rudasill & Callahan, 2010). Because of gender stereotypes regarding career paths, male students are more likely than females to state they are interested in a math-related career.
Confidence in the Four Core Subjects Areas: Language Arts, Social Studies, Mathematics, and Science (Question 3)

On average, female students felt the most confident in their language arts abilities. The mean rank for female students’ confidence in language arts was 3.318, meaning they were confident in their abilities. Female students felt the least confident on average in their mathematics abilities with a mean rank of 2.378, which means they were only somewhat confident in their mathematical abilities. On the other hand, male students reported an average confidence level of 2.941 in mathematics, which was second only to their confidence in social studies (3.118). The findings of this study are consistent with Kurtz-Costes et al. (2008) who found that girls were less confident than boys in their mathematical abilities. They also paralleled Geist (2010) who found that by eighth and 12th grade, girls begin to express negative attitudes about mathematics. Unfortunately, as female students progress in their k-12 education, they begin to feel less confident than their male counterparts in their mathematical abilities (Sadker & Silber, 2007).

Typical Grades Earned in Core Subject Areas (Question 4)

The students were asked to report the grades they typically earned in each of the four core subjects: language arts, social studies, mathematics, and science. A higher percentage of male students stated that they typically earn A’s and B’s in mathematics than female students. One third, or 33.33%, of the male students reported they typically earn A’s in mathematics compared to 28.89% of the female students. In addition, 35.30% of the male students reported they usually earn B’s in mathematics
compared to 28.89% of the female students. The largest discrepancy was in the percentage of students who stated they typically earn C’s in math with 23.53% of the male students reporting they usually earn in C’s compared to 35.56% of the female students. The greater number of female students that reported they typically earn C’s in mathematics can be explained by the lower number of female students that reported they earn A’s and B’s. A higher percentage of female students also reported they typically earn D’s in Mathematics. Only one student stated they typically earn an F in Mathematics, and it was a male student. The mathematics grades used in this study were self-reported by students, and the researcher is unable to access the students’ actual grades to determine if they were inflated or deflated by the students.

Lower mathematics grades can aid in creating lower female interest levels in math. Grossman and Grossman (1994) pointed out that children sometimes alter their attitude, self-concept, and subject enrollment based on their parents’ and teachers’ gender expectations. In addition, male students dominate the classroom in terms of teacher interactions and expectations (Sadker & Silber, 2007). Lower teacher expectations and grades can naturally decrease female student interest and confidence in mathematics.

**Qualitative Data Collection**

**Decline in Interest (Question5)**

The students were asked if there were any subject areas in which they used to be interested in, but no longer are. The top six responses were as follows: none, mathematics, history/government, science, no response, and language arts. The subject
in which the most students had a decline in interest was mathematics. Seventeen out of ninety-six students, nine females and eight males, expressed the fact that they used to be interested in mathematics, but no longer are. The decline in mathematical interest was much higher than in any other subject area for both female and male students.

Four 12th grade female students stated that their decline in mathematical interest was due to its increasing difficulty. A 17 year-old Caucasian female said she was no longer interested in math because, “The lessons became too complex with multiple answers per question.” Another 17 year-old Caucasian female explained, “I used to be more interested in math, but as it got more difficult, my interest dropped.” This is consistent with Sadker & Sadker (1994) and Sadker & Silber (2007). They explained that after adolescence, female students are typically less interested in mathematics than they were in elementary school (Sadker & Sadker, 1994; Sadker & Silber, 2007). The AAUW (1992) also stated that from elementary school to high school, there is a huge decline in girls’ mathematics self-concept. In addition, the NCES (2000) reported that by 12th grade, female students express a decline in the enjoyment, understanding, and perceived value of mathematics. Sometime before 12th grade, female students are losing interest in mathematics as well as their confidence in their mathematical abilities.

Factors that Contribute to Interest in Mathematics (Question 6)

The top five factors that contributed to the students’ interest in mathematics were: solving problems/reasoning, enjoyment, managing money, the fact that there is one correct answer, and real life applications. Interestingly, none of the female
students stated they enjoyed mathematics in comparison to 4/51, or 7.8% of the male students.

The fact that there is only one solid correct answer in mathematics was only noted by female students. One female student explained that she was interested in math because there is “a certain solid answer to a question.” Another female student added, “I like how in math if you do one thing, and do it right, you will always get the right answer, so I kind of like Algebra.” Female interest in Algebra and problems that have one, solid answer is ironic because Algebra is one of the first math courses students take in high school. After Algebra, the difficulty increases and problems become more complex.

In addition, only female students cited real life applications as a contributing factor to their interest in math. A 17 year-old Filipino student admitted, “I actually like stats and things that can be applied to real life.” The NCES (2000) found that by 12th grade, males are more likely than females to enjoy math, understand it, and believe it is useful. An emphasis on statistics and real life applications could potentially increase female student interest in mathematics as well as their perceived value of math.

Factors that Contribute to a Lack of Interest in Mathematics (Question 7)

The top five factors that contributed the students’ lack of interest in mathematics were: it is difficult, there are too many equations and/or formulas, it is not interesting or boring, there is too much work, and everything. Eleven of the 45 female students, or 24.4%, stated mathematics is difficult compared to only 11.8% of the male students. One female student elaborated by saying, “It seems to blur
together.” A 17 year-old female added, “Concepts are difficult to understand; they are not concrete.” Another 17 year-old female explained, “Math requires quick understanding, which many times, it is difficult to grasp right away.” The female students’ emphasis on difficulty is consistent with Kurtz-Costes et al. (2008), who found that girls expressed lower self-confidence in math and science than boys. Despite female achievement in mathematics, many female students report mathematics is difficult for them.

Over 15% of the female students reported that there are too many equations and/or formulas in comparison to 7.8% of the male students. A concern for the number of formulas and equations also ties into female students’ anxiety and concern for difficulty. The other factors listed by students yielded similar percentages among female and male students.

Knowledge of STEM Careers (Question 8)

On average, female students listed more STEM careers than the male students. The top ten STEM careers listed by the students were: teacher, doctor, engineer, nurse, computer technician/programmer, accountant, scientist, architect, chemist, biologist, and civil engineer. Female and male students listed the careers fairly equally with the exception of the careers doctor and nurse. Twenty-two out of 45 (48.89%) female students listed doctor as a STEM career in comparison to 12 out of 51 (23.53%) male students. In addition, 13 out of 45 female students, or 28.89%, listed nurse as a STEM careers in comparison to only four out of fifty-one (7.84%) male students. A much lower number of male students acknowledged nursing as a STEM career which
coincides with Rudasill and Callahan (2010) who noted that boys and girls prefer careers that are traditional for their gender and that boys more strongly looked down upon nontraditional jobs.

**Interest in a STEM Career (Question 9)**

A higher percentage of the male students than female students were interested in a future STEM career. Twenty-one out of 45, or 46.67%, of the female students were interested in a STEM career while 29 out of 51, or 56.86%, of the male students were. The students were then asked which STEM careers they were specifically interested in. The top two responses for female students were a career as doctor or nurse. One 17 year-old Caucasian female said she was interested in a STEM career, “…but only being a nurse or doctor. It seems like a good, stable career and I would get to help people.” Another 17 year-old female student stated she was interested in a STEM career because she “enjoys learning about science” and wants to “pursue a future career either as a nurse practitioner, physician assistant, or doctor.” A 17 year-old Caucasian female added, “I want to be a registered nurse working with newborn babies and helping people out.”

The top three responses for male students were a career in teaching, business, or technology. The rest of the responses were fairly evenly distributed with most careers having only one student who possessed interest. Interestingly, the student responses were consistent with research from the AAUW (1998) which stated that females are typically channeled into service careers while males typically exceed females in business, engineering, and technology. VanLeuvan (2009) adds females
who do choose STEM careers typically choose fields in the biological sciences instead of careers in mathematics, computer science, physical sciences, and engineering. The only exception was the high number of male students who expressed an interest in teaching. This was however in regard to teaching math and science specifically.

Other Future Career Interest (Question 10)

When asked if there were any other careers in which the students were interested in pursuing, the responses were extremely varied. Most careers only had one student that possessed interest in it. There were only a few common themes among student responses. The career in which the most female students expressed interest in was a career in journalism. An African American female explained her desire to pursue journalism by explaining, “I’m interested in journalism because I like to write about things of importance or interest.” The female students’ interest in a career in journalism naturally follows from their higher average interest level and confidence in language arts (survey questions 1-3).

In opposition, no male students stated they were interested in a career in journalism. The only career paths that held the interest of more than two male students were a career in business and a career as a mechanic. Most of the male students who expressed an interest in business did not explain their choice in detail; however one male student did say he was interested in becoming a “businessman” so he could “own his own brand.” Another male student said he specifically wanted to be “an international business financer.” An increased interest in business and lack of interest
in journalism naturally follows from higher male interest levels in mathematics and lower male interest levels in language arts.

**Notable Findings**

When answering question 5, two female students said they used to be interested in science, but their interest declined after taking Chemistry. One female student stated, “I used to be interested in science until I met Chemistry. Some of it just doesn’t make sense like it used to.” The other female student added that she was interested in science until she took Chemistry because, “It got confusing…” This is interesting because Chemistry and Physics are known for their integration of mathematics. High school students take Chemistry before Physics, so it is the first science course in which most students must use a great deal of mathematics.

In answering questions nine and ten, 11.1% of the female students mentioned they wanted to pursue a career in which they could “help people.” Only 3.9% of the male students shared the same response. A desire to work in a service profession is consistent with research from the AAUW (1998) which noted that females are typically channeled into service careers while males exceed females in business, engineering, and technology. In addition, five out of 51 male students, 9.8%, expressed an interest in earning a lot of money while none of the female students mentioned money. A 17 year-old male student said he was interested in a STEM career “if it makes good money.” Another male student stated he was interested in business finance because, “That’s where they money is at.” Many believe that in a stereotypical family, the male is responsible for providing monetary support while the
female is responsible for taking care of the family. Eccles (1994) pointed out that men consider their family and occupation as equally important and women rank their family as more important than their career. A male emphasis on their career and earning money could be partially due to the stereotype that they should be monetary providers for their family.

One of the female students said she was interested in a career in cosmetology or culinary arts. She wrote, “I like hair, make up, and nails. I’m also interested in culinary arts because I like to cook new things.” An interest in appearance and cooking is reminiscent of the 1800s-1900s when women were expected to cook, clean, and look beautiful for their husbands (Fox, 1989; Sadker & Sadker 1994). Another female student said she wanted to be a wedding planner. None of the male students stated they were interested in hair, make up, nails, culinary arts, or planning weddings.

Finally, in addition to the higher number of male students that expressed an interest in business, one student in particular wrote that he wanted to be a “businessman.” The title “businessman” assumes that a career in business is strictly for men. This researcher strived to find a less gendered term for businessman and unsatisfyingly decided upon “business person.” The fact that a person who works in business is often referred to as a “businessman” is interesting since approximately 11% of the male students were interested in business compared to zero female students.
Limitations

This study possessed several limitations. Data was collected from 96 high school seniors. All of the participants attended the same high school. Because of the specific demographics of the sample population, it is not possible to generalize conclusions for a larger population of students, for example California high school seniors.

The students were asked to fill out the survey in their forty minute advocacy class. By the time class attendance and other matters were completed, the students most likely had about thirty minutes to complete the survey. This means the students were not allowed much time to think about their responses. This may have contributed to the large amount of questions that the students left incomplete. Senior burn out, or a lack of motivation to perform to the best of one’s ability due to fatigue, may have also played a part in the lack of responses to open ended questions. In addition, this researcher could not be present in all of the classes when the surveys were distributed. This researcher relied on the students’ normal advocacy teachers to distribute surveys and clarify questions.

Recommendations for Further Study

While this study was originally intended to include high school seniors from various high schools, a lack of time and access to schools limited the student population to one Northern California high school. A future study could include schools from different regions in Northern California. This would allow for greater generalizations and conclusions.
This researcher was only granted access to one high school. Future research could include distributing the same survey to upper elementary students, middle school students, and high school students. Ideally, the surveys would be distributed to students in fourth, fifth, seventh, eighth, 11th, and 12th grade. Distributing surveys to students in different grade levels would allow the researcher to determine if interest in Mathematics and math-related careers increase, stay consistent, or decline from elementary school to high school. Adding 11th grade students to the population alone could improve survey results since senior burn out may have affected survey responses. Many senior students chose to leave responses blank or write ”N/A.” In addition, a longitudinal study could be conducted following the same population of students from elementary through high school.

Finally, this research could be conducted through the use of interviews in place of, or in addition, to surveys. Interviews would allow the researcher to gain longer, more specific answers to open-ended questions. It could also reduce the number of blank responses.

**Conclusion of Study**

The quantitative data confirmed that in this population of students, female students were less interested on average in mathematics and math-related careers than their male counterparts. On average, the subject in which the female students were the least interested in was mathematics. In addition, female students were also typically least interested in a career in mathematics compared to careers in the other three core subject areas. Female students were also typically less confident in their mathematical
ability than their male counterparts. Not to mention, on average, more male students reported they usually earn A’s and B’s in mathematics while more females reported they typically earn C’s and D’s. These gender discrepancies demonstrate the fact that in this population of high school seniors, a gender division persists regarding mathematics.

When the students were asked if there were any subjects they used to be interested in but no longer are, responses were similar regardless of gender. The subject area in which the most students lost interest was mathematics. The top five factors that contributed to an interest in mathematics were: solving problems/reasoning, enjoyment, managing money, the fact that there is one correct answer, and real life applications. In attempt to increase student interest in mathematics, classroom teachers can place more of an emphasis on problem solving, money, and real life applications. The top five factors that contributed to a lack of interest in mathematics were: it is difficult, there are too many equations and/or formulas, it is not interesting or boring, there is too much work, and everything. In an attempt to make mathematics more interesting, teachers can also provide formulas or equations for tests, instead of forcing students to memorize formulas, and require less homework, also known as “drill and kill,” from the students.

Both female and male students were able to name STEM careers, however more male students than female students were interested in pursuing a future STEM career. The STEM careers in which the female students expressed the most interest in included doctor and nurse. On the other hand, the STEM careers the male students
expressed the most interest in were teacher, business, and technology. The students were then asked if there were any other careers they were interested in. The career in which the most female students expressed in was a career in journalism. The career in which the male students expressed the most interest in was a career in business. In short, the male students expressed a greater interest in math-related careers than the female students.

**Final Thoughts**

Female students are still slipping through the cracks when it comes to mathematics education. Teachers, principals, and other educational employees need to continue to search for ways to increase female interest in mathematics and math-related careers. Gender and mathematical interest as well as career interest is an area of study that needs to continue to be addressed by researchers. Current teacher preparation programs include little, or no gender equity training (AAUW, 1998). Teacher preparation programs should include gender equitable practices in the classroom including, but not limited to, equitable mathematics instruction. In addition, mathematics teacher preparation programs need to provide effective tools to increase student interest. Some of these tools include: an emphasis on problem solving or reasoning, managing money, real life applications, providing formulas for tests, and only requiring enough work for mastery instead of overworking the students with practice problems. There is still much research and work that must be done to bridge the gender gap in mathematics and math-related careers.
APPENDIX A

Student Survey
Gender: Male / Female
Age:
Race/Ethnicity:

Directions: Please circle or write your answers to the following statements and questions.

1= not interested  2 = somewhat interested  3 = interested  4 = very interested

1. Rank your interest in the following subject areas.

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<th>Subject Area</th>
<th>1</th>
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<td>Mathematics</td>
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<td>Science</td>
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2. Rank your interest in careers related to the following subject areas.

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3. How confident do you feel in your abilities in the following subject areas?

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<tr>
<th>Subject Area</th>
<th>1 = not confident</th>
<th>2 = somewhat confident</th>
<th>3 = confident</th>
<th>4 = very confident</th>
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<td>Language Arts</td>
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4. What grades do you typically earn in the following subject areas?

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<th>Subject Area</th>
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<th>C</th>
<th>D</th>
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<td>Language Arts</td>
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Please answer the following questions with as much description as possible.

5. Are there any subjects you used to be interested in, but no longer are? If so, what subjects and why?

6. What are some of the factors that contribute to your interest in the following subject areas?
   - Language Arts:
   - Social Studies:
   - Mathematics:
   - Science:

7. What are some of the factors that contribute to your lack of interest in the following subject areas?
   - Language Arts:
   - Social Studies:
   - Mathematics:
   - Science:

8. List as many careers as you can in the science, technology, engineering, and mathematics fields.

9. Are you interested in a career in science, technology, engineering, or mathematics? Why or why not? If so, do you know which career?

10. Are there any other specific careers you are currently interested in? If so, which careers and why?
APPENDIX B

Opt Out Form
CONSENT LETTER

Survey of Student Interest Levels in School Subject Areas and Related Career Interests

Opt Out Form for Participation in a Research Study

My name is Christina Patane, and I am a graduate student in the Masters of Arts in Education at California State University, Sacramento. Your child is being asked to participate in a study regarding their interest levels in different school subjects and careers related to these subject areas. The student’s participation involves a survey in which they will be asked to rank their interest levels in the subject areas and explain possible factors for these interest levels.

Your child’s participation is completely voluntary. You may opt out at any time if your student is uncomfortable for any reason with no negative consequences. The survey answers are only useful to me, so their names will not be disclosed to anyone else. Your child’s participation is greatly appreciated. If this form is not returned, you are giving me consent to have your child participate in my research. Thank you.

Put an X in the appropriate space provided.

____ I do not wish to have my child participate in this study.

____ I give you permission to have my child, ________________________, participate in the study. ________________________ Students’ name

_____________________________ _________________________
Parent Signature Date

If you have questions about the study please contact me by

phone (XXX)XXX-XXXX or by email christinapatane@hotmail.com.
REFERENCES


