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Literature Overview: Gender Differences in Math Performance

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Recent studies show learning experiences among females in science, technology, engineering, and mathematics (STEM) disciplines are impacted by a pattern of socialization that often differs from males despite comparable ability (American Association of University Women [AAUW], 1992; National Association of Educational Progress [NAEP], 2007a; National Educational Longitudinal Survey [NELS], 2004; Seymour & Hewitt, 1997). While both males and females attain relatively equal numbers of bachelor's degrees in math and statistics, females do not attain degrees at equal rates in fields where mathematical preparation and application plays an important role such as science, technology, and engineering (National Science Foundation [NSF], 2008).

While some causal explanations for differences between males and females in math performance are outlined, this overview does not intend to analyze these explanations. The purpose of this report is to highlight statistical trends related to the math performance by gender in K12 and undergraduate education, and to outline how practitioners might use the data provided to inform programmatic initiatives related to female representation in STEM disciplines.

National Trends Associated with Gender Differences in Math Performance among Students at K-12 and Postsecondary Levels

National Education Longitudinal Study of 1988 (NELS). This longitudinal study conducted by the National Center for Education Statistics consists of data collected periodically from 1988 to 2004. Each cohort of participants reported on school experiences when the students were in eighth grade, sophomores, and seniors in high school. Across cohorts, there are few instances of gender differences in math performance, as measured by course taking patterns.

- Over time results reveal seniors, both male and female, are taking more mathematics courses by the time of graduation, including more upper-level courses such as pre-calculus and calculus (refer to Figure 1) (Ingels & Dalton, 2008).

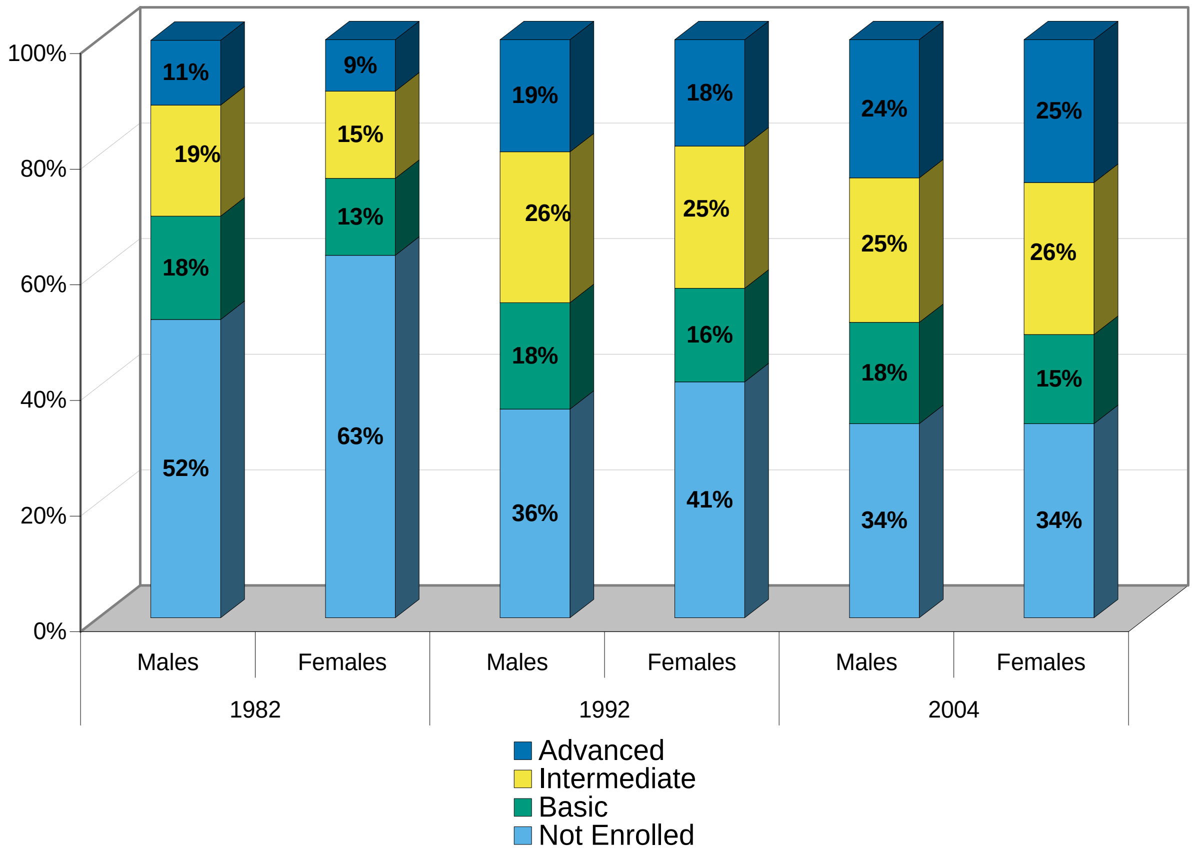

Figure 1: Percentage of High School Seniors Enrolled in Mathematics Courses during Senior Year, by Course Level and Gender, 1982, 1992, 2004

NOTE: "Basic mathematics course" refers to basic, general, or applied mathematics, pre-algebra, algebra I, and geometry. "Intermediate mathematics course" refers to algebra II, algebra III, trigonometry, advanced geometry, statistics, probability, and other intermediate courses such as linear algebra. "Advanced mathematics course" refers to pre-calculus and calculus courses. SOURCE: NELS, 1988, 2004.

- Both males and females maintained growth in advanced-level mathematics courses with both groups more likely to take algebra II, precalculus, or calculus and less likely to finish high school with no math or only low academic math courses such as algebra I/geometry (refer to Figure 2).
- The largest increases for both males and females were in pre-calculus-level course taking (from 5% to 18% for males, and 5% to 20% for females), and the largest decreases were in the proportion taking no math or low academic math courses (from 26% to 6% for males, and 24% to 4% for females).
- No differences were detected between females and males in the combined percentage completing advanced mathematics courses (Dalton, Ingels, Downing, & Bozick, 2007).

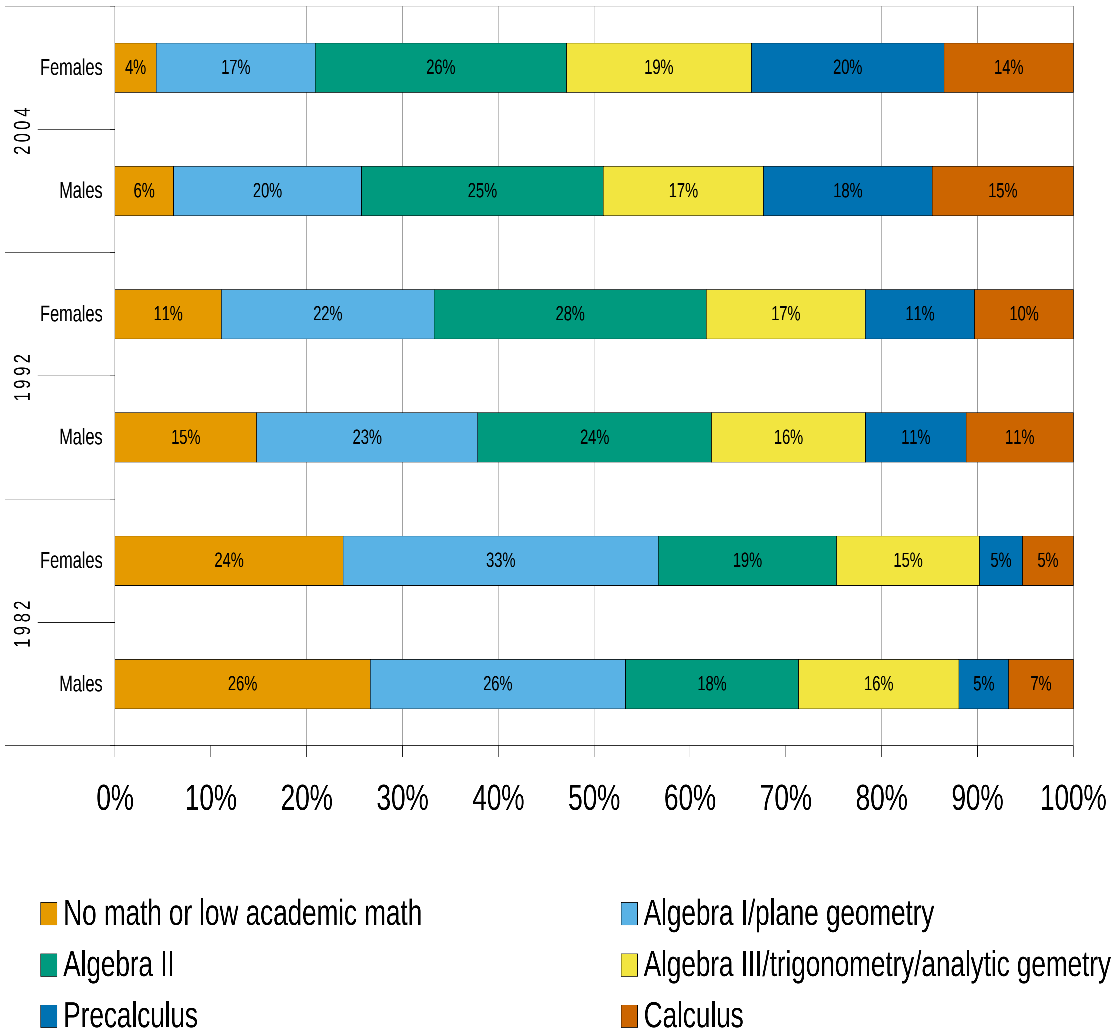

Figure 2: Percentage of High School Graduates Who Completed Different Levels of Mathematics Courses by Gender in 1982, 1992, 2004
SOURCE: NELS, 2004.

- In 2004, high school graduates earned more credits in mathematics than in previous years (refer to Figure 3), with no differences detected in the average math credits earned by gender (Dalton, Ingels, Downing, & Bozick, 2007).

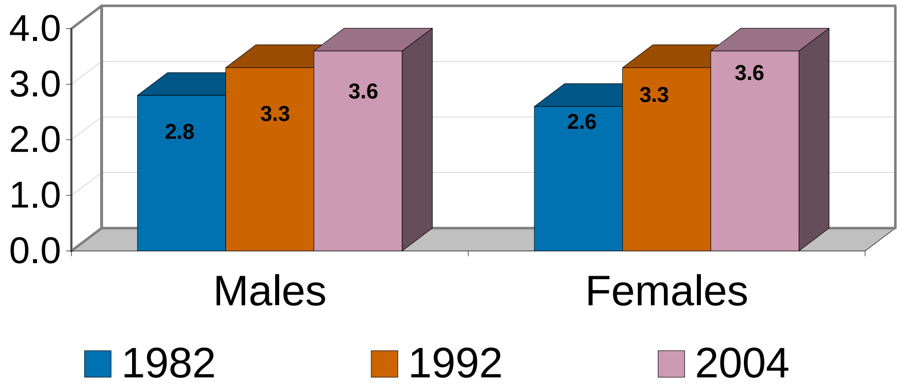

Figure 3: Average Number of Credits Earned in Mathematics by Gender in 1982, 1992, 2004
SOURCE: Dalton, Ingels, Downing, & Bozick, 2007

The Nation's Report Card: Mathematics 2007. The Nation's Report Card is conducted by the NAEP (2007a). Assessments have been conducted among a nationally representative sample since 1969 in several fields including mathematics. Approximately 197,700 students at grade 4 and 153,000 students at grade 8 completed the NAEP mathematics assessment in 2007.

Student scores are reported for the percentage of students at or above three different competency levels: Basic (denoting partial mastery of prerequisite knowledge and skills), Proficient (denoting demonstrated competency over and application of challenging subject matter), and Advanced (denoting superior performance) (NAEP, 2007a):

- Nationally, at grades 4 and 8, the average mathematics scores were higher in 2007 than in all previous assessment years, moving from 213 on average in 1990 to 240 on average in 2007 (refer to Figure 4). Results are reported on a 0-500 point scale.

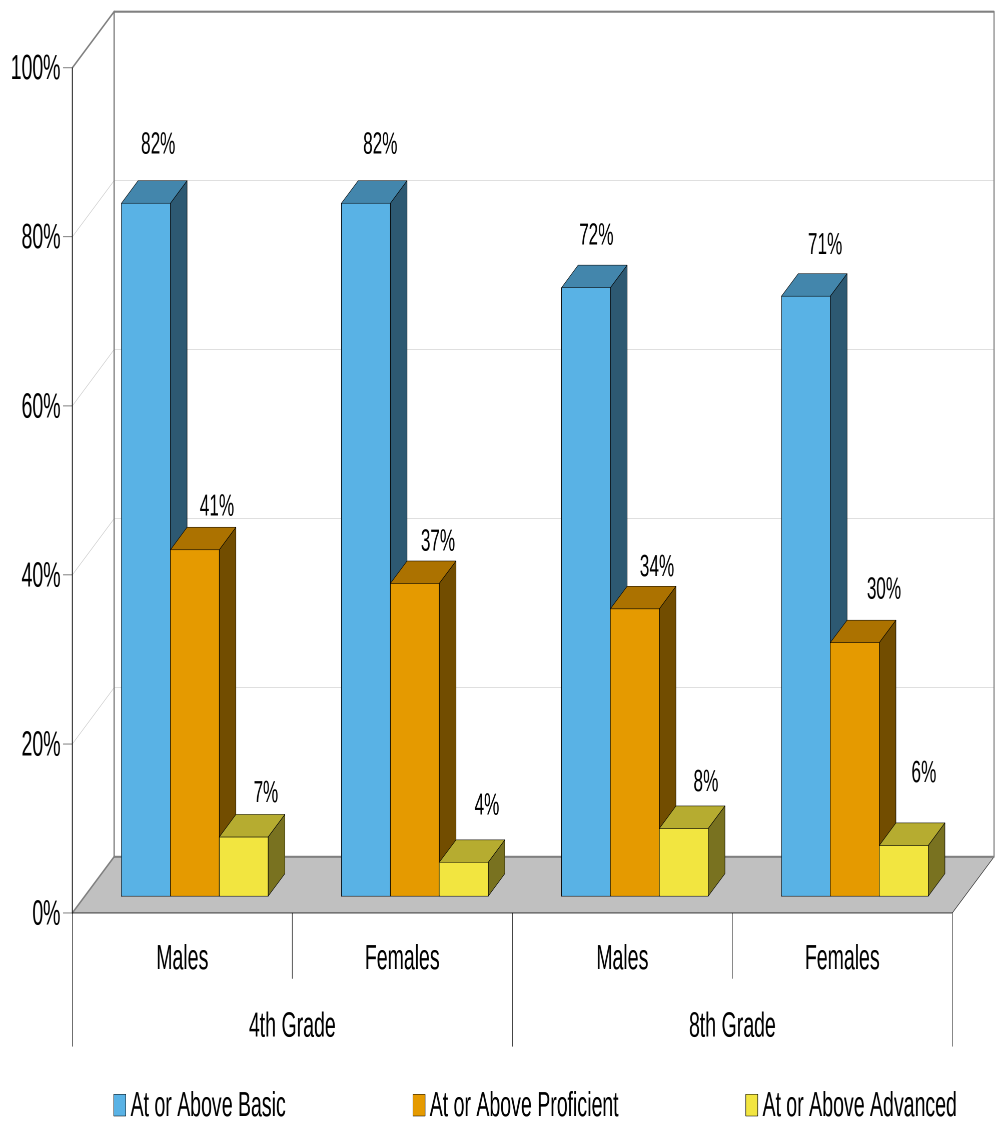

Figure 4: 2007 Math Performance Levels by Gender and Grade Level
Source: NAEP, 2007a

Looking at 2007 math performance by gender reveals (refer to Table 1):

- Among fourth-graders, males outscored their female peers by 2 points in 2007. Examining differences by content area reveals males scored higher on average than females in all the mathematics content areas (numbers and operations, measurement, data analysis and probability, algebra) with the exception of geometry in which female students scored higher.
- Among eighth graders, males also outscored their female peers by 2 points in 2007, a gap similar to those seen in prior years. With the exception of geometry and data analysis/probability, male students scored higher on average than female students in all mathematics content areas.

Grade Level	Gender	1996	2000	2007
4th Grade	Males	224	227	241
	Females	223	224	239
8th Grade	Males	271	274	282
	Females	269	272	280

Table 1: Trend in Average NAEP Math Scale Scores by Gender, 1996, 2000, 2007

Data collected from the NAEP was combined with the 2005 High School Transcript Study (HSTS), which examines transcripts collected from about 640 public schools and 80 private schools. Results reveal that (refer to Figure 5):

- Overall GPAs in mathematics have increased since 1990. Female graduates' GPAs overall and in mathematics were higher than male graduates' during each year the HSTS was conducted.
- In 2005, among those who took higher-level mathematics courses, male graduates had higher NAEP scores than female (NAEP, 2007b; Shettle, Roey, Mordica, Perkins, Nord et al., 2007).

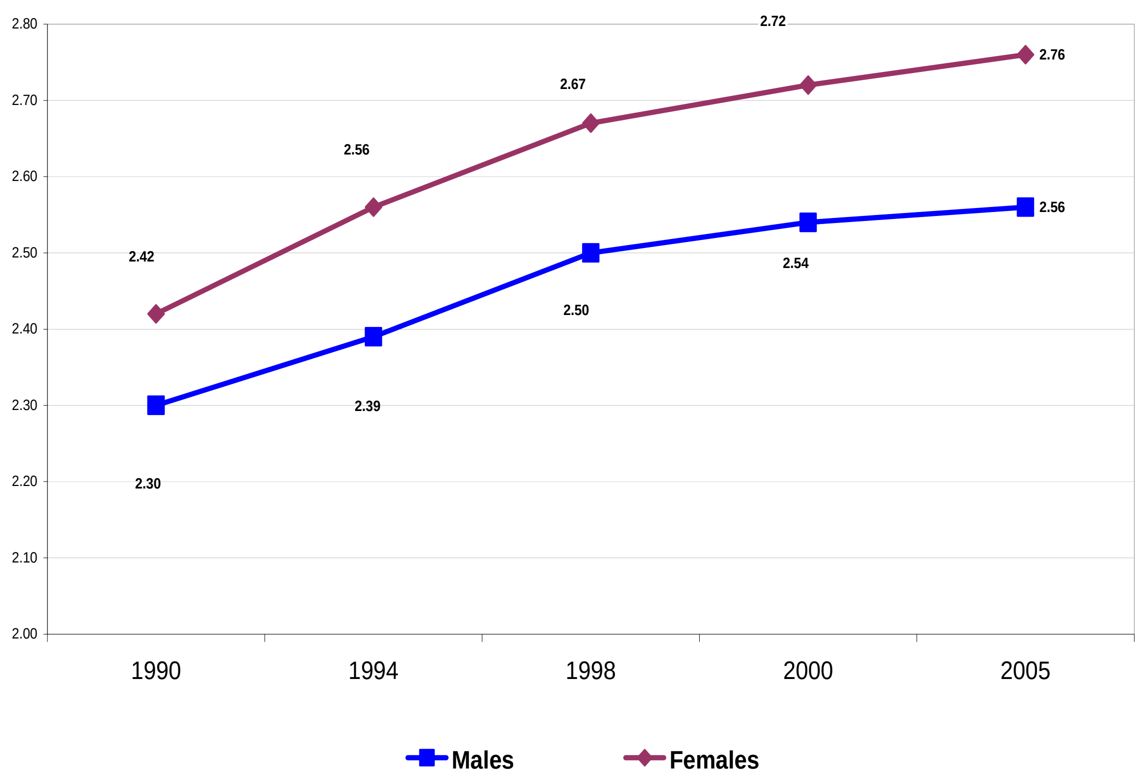

Figure 5: Mathematics GPA by Gender, 1990-2005

Trends in International Mathematics and Science Study (TIMSS) is conducted by the International Association for the Evaluation of Educational Achievement (IEA). The assessment provides data on the mathematics and science performance of U.S. students and compares their performance to that of students in over 35 other countries. TIMSS data has been collected in 1995, 1999, 2003, and 2007, with only eighth graders included in the 1999 study (Mullis, Martin, & Foy, 2008). The TIMSS scale was established to have a mean of 500 and is used for comparative purposes (Mullis, Martin, Fierros, Goldberg, & Stemler, 2000). Over time trends reveal:

- Overall math performance has increased among both U.S. males and females' in fourth and eighth grade, with higher average scores in 2007 than in subsequent years (Figure 6 and Figure 7).
- Among U.S. fourth-graders, males outperformed females in each of the four years of administration (Figure 6).
    - In 2007 males performed 6 score points on average than females. This difference in the overall score is attributed to higher performance on one content area: males outscored females 528 to 520, on average, in *number*. There were no measurable sex differences detected in the average scores in either the *geometric shapes and measures* domain or the *data display* domain.
    - In 2003 males performed significantly higher than females, which differs from 1995 when no measurable difference was detected.
    - In 1995 males tended to outperform females in average percent correct in *measurement, estimation*, and *number sense*.

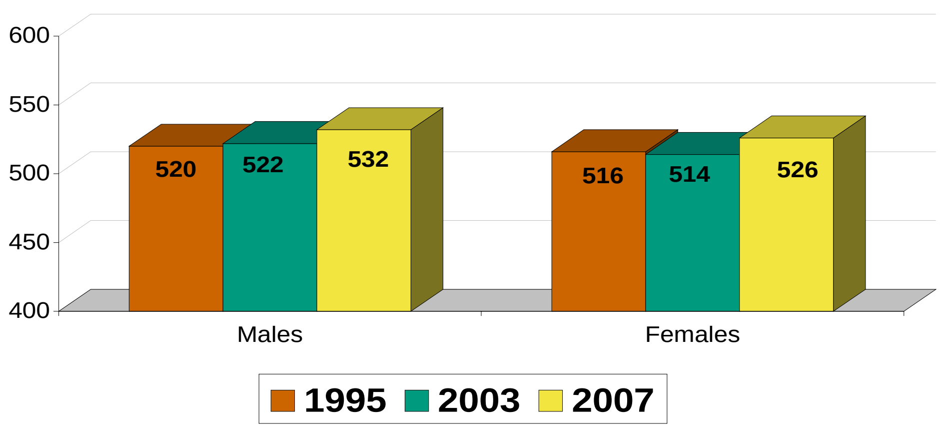

Figure 6: Comparison of TIMSS 2003 and TIMSS 1995 Fourth Grade Score Results by Gender

- Among U.S. eighth-graders, male and female performance has reached similar levels over the four years of administration (Figure 7).
    - In 2007 there was no measurable difference in the average mathematics scores of males and females. While differences were not significant, males outperformed females in three of four mathematics content domains: *number* (515 v. 506), *geometry* (483 v. 477), and *data and chance* (535 v. 527).

- o In 2003 eighth-grade males performed significantly higher on average overall than females.
- o In 1999 males performed higher overall than females, due in part to the significantly higher performance of males in *measurement.*

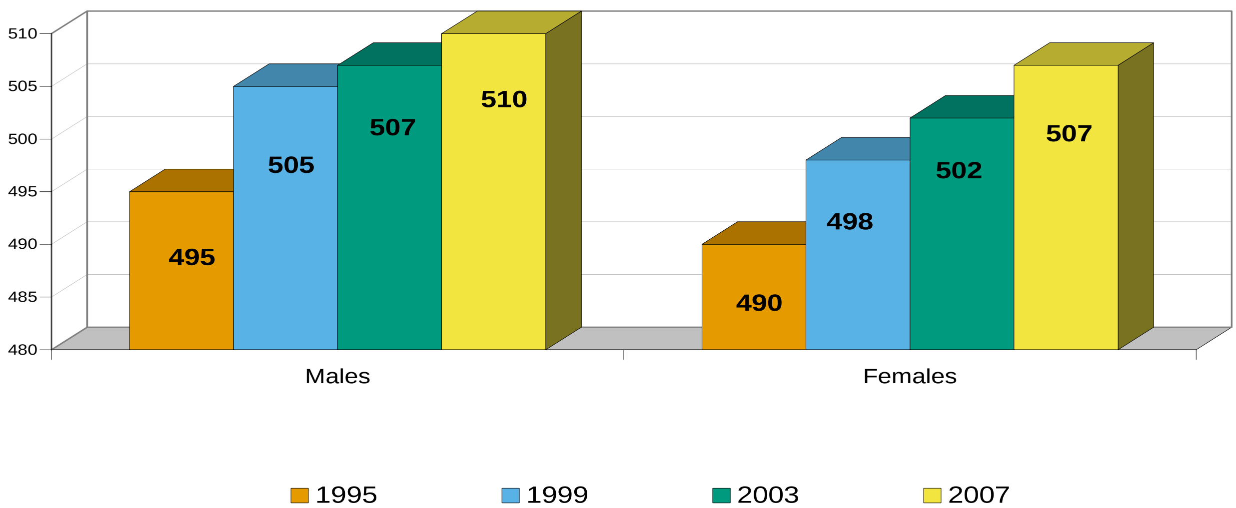

Figure 7: Comparison of TIMSS 2003, 1999, and 1995 Eighth Grade Score Results by Gender

Advanced Placement Program (AP) (College Board, 2007a). The Advanced Placement program of the College Board provides testing for high school students who participate in college level courses to obtain college credit. The tests are graded on a scale of 1 (No Recommendation) to 5 (Extremely Well Qualified), accompanied by a recommendation for approval for college credit. Tests related to mathematics are available in three areas: calculus AB, calculus BC, and statistics. More detailed information about the topics included on these assessments can be found on the College Board's website at: http://www.collegeboard.com/student/testing/ap/about.html

- Roughly equal proportions of male and female high school students take the mathematics tests in calculus AB and statistics, while male students tended to take the calculus BC tests in larger percentages than female students (refer to Figure 8).
- Males tended to score higher on the mathematics subject tests than females (refer to Figure 9).

- A higher percentage of males also received a score of 5 than females in 2007 on mathematical AP tests (refer to Figure 10).

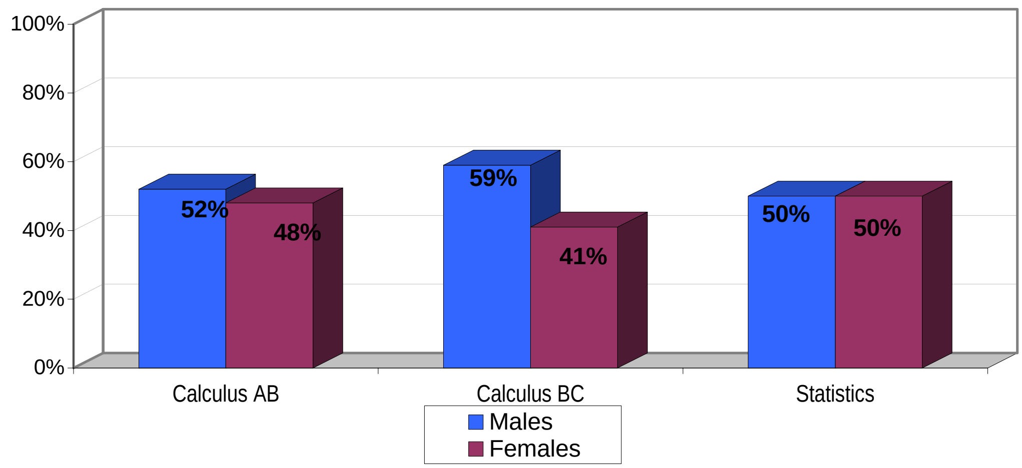

Figure 8: Percentage of AP Math Test Participants by Gender in 2007
Source: College Board, 2007a

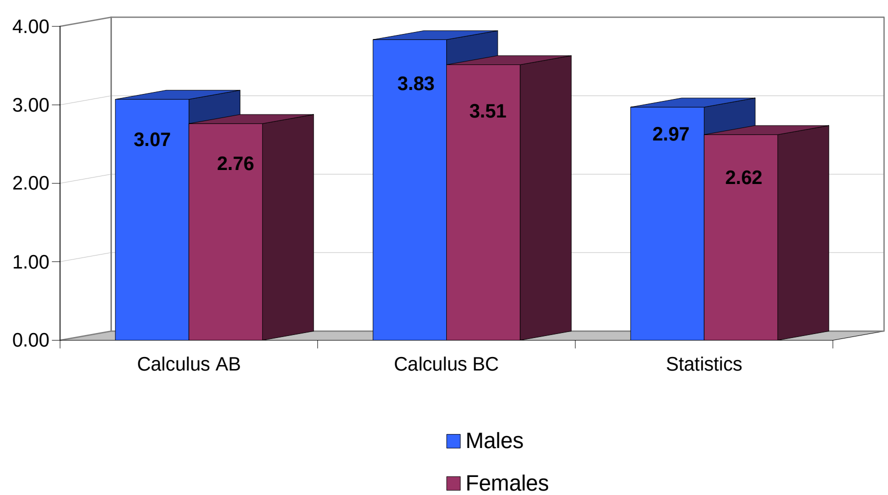

Figure 9: Average AP Math Test Results by Subject and Gender, 2007
Source: College Board, 2007a

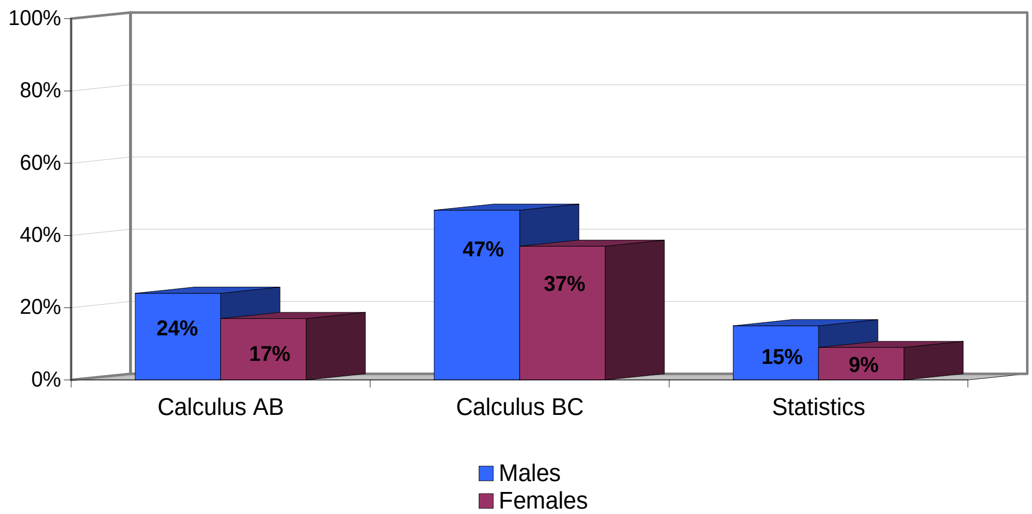

Figure 10: Percentage of AP Math Test Participants Receiving a Score of 5 by Subject and Gender
Source: College Board, 2007a

The Scholastic Aptitude Test (SAT). The SAT is a national college admissions examination accepted or required by most four-year colleges that tests verbal and mathematical performance. In 2007, 1,494,531 students took the test. The maximum score in each subject is 800. The SAT also solicits information about mathematics preparation during high school from participants. Trends are not analyzed for statistical differences by gender. For the SAT in 2007:

- Females' average math score was 500 and the average score among males was 533, the national average was 515.
- In terms of preparation in mathematics among college-bound students:
    - Female participants took an average of 3.8 years of mathematics in high school compared to an average of 3.9 for male participants.
    - Both males and females self-reported an average mathematics grade point average of 3.12.
    - 54% of females reported that AP/Honors mathematics courses were the highest level of mathematics achieved compared to 46% of male peers.

ACT (American College Testing Program, 2007). The American College Test (ACT) assessment is a national college admission examination accepted by most U.S. colleges and universities. In 2007, 1,300,599 students took the test. The maximum score in the math content area is 36.

- In 2007 the average ACT score in math for females was 20.4 and for males 21.6.
- During 2007, 38% of females met the college readiness benchmark score in algebra compared to 47% of males. The ACT reports College Readiness Benchmark Scores. A benchmark score is the minimum score needed on an ACT subject-area test to indicate a 50% chance of obtaining a B or

higher or about a 75% chance of obtaining a C or higher in the corresponding credit-bearing college courses, which include English composition, algebra, social science, and biology. These scores were empirically derived based on the actual performance of students in college.

A larger percentage of male students score within the top three distribution categories. In the top two categories, the ratio of males to females is 2:1. As with SAT scores, questions arise as to why females do not achieve high scores in the same proportion as males. One research study by the ACT reports that, when other variables such as high school grade point average, course taking, and student self-perceptions are controlled for race/ethnicity or gender explained only 1% to 2% of the additional variance over and above the other variables considered. These findings can be interpreted to underscore the minimal role that gender plays in explaining math achievement (Noble, Davenport, Schiel, & Pommerich, 1999).

Undergraduate Trends

More women than men pursue a postsecondary degree in the U.S., and roughly equal proportions of females as compared to males earn a bachelor's degree in mathematics or statistics (refer to Table 2). When considering fields in which mathematics performance plays an integral role, such as engineering, there are considerable differences in the number of bachelor's degrees awarded by gender (refer to Table 2).

	1997				2002				2006			
	Females		Males		Females		Males		Females		Males	
	n	%	n	%	n	%	n	%	n	%	n	%
Mathematics and Statistics	5,889	46%	6,834	54%	5,762	47%	6,511	53%	6,878	45%	8,433	55%
Engineering	11,470	18%	50,882	82%	12,687	21%	47,952	79%	13,300	20%	54,821	80%

Table 2: Number of Bachelor's degrees awarded in Mathematics and Engineering by Gender: 1997, 2002, 2006
Source: National Science Foundation, 2008, http://www.nsf.gov/statistics/wmpd/tables/tabc-4.xls.

Meta-Analytic Studies of Gender Differences in Math Performance and Issues Associated with Continued Gender Differences in Math Performance

Recent studies of national trends confirm that females are as likely to enroll in mathematical courses and have higher GPAs than males in math and science but do not always perform as well on standardized mathematical assessments (Hyde, Lindberg, Linn, Ellis, & Williams, 2008). Given the discrepancy between demonstrated ability and interest in mathematics and performance on standardized tests among females, researchers have investigated plausible causes for these differences (Ryan & Ryan, 2005). Plausible causes include: demographic profile of male and female test takers; the construct being studied; male and female differences in experiences in the same classrooms and subsequent interest in mathematics careers; the possibility that females are less confident when solving mathematics; and lower female enrollment in mathematics courses (Hyde, Fennema & Lamon; 1990; Linn & Peterson, 1986). These factors and their influence on the performance of students by gender are discussed in greater detail in the Applying Research to Practice (ARP) resources on *Stereotype Threat* and *Self-Efficacy* available at http://www.engr.psu.edu/awe/. (Singletary et al, 2009; Rittmayer, et al, 2009)

An analysis of national data and independent research studies from the 1960s through 1980s concluded that the gender differences in mathematics achievement depends on several demographic characteristics (Linn & Peterson, 1986). While females outperform males starting at a very young age, that advantage disappears by age 17 (Linn & Peterson, 1986; Mullis et al., 2000). During elementary and middle school, girls have been shown to do better at computation and there were no gender differences for problem solving. By high school, males demonstrated an advantage in problem solving. The magnitude of the difference favoring males increased as the sample became more selective, that is, for college students, students at highly selective colleges or samples of exceptionally mathematically adept students. These findings, combined with advantages in problem-solving found among males, may be most relevant in explaining why females do not pursue engineering degrees at the same rate as males given the exceptionally high mathematical achievement engineering students are expected to demonstrate (Hyde, Fennema & Lamon, 1990).

In terms of attributing gender differences in mathematics to the specific construct being measured (Willingham & Cole, 1997), one meta-analysis reveals that males perform better relative to females on word problems in eighth grade, high school, and college. Higher scores among females are reported on items that deal with direct application of knowledge garnered from classroom instruction while males score higher on items requiring visual spatial skills, problem-solving, and reasoning (Clewell & Campbell, 2002). Internationally and across grades, males tended to perform better than females on test items involving spatial representation, proportionality, measurement, and problems with no immediate formula. In fourth and eighth grades, females outperformed males on items involving reading graphs, computation, and algorithmic problem solving (Mullis et al., 2000).

Gender-biased classroom practices, for example calling on females less often for answers during math instruction, may negatively impact females' self-esteem, confidence in mathematical ability, and interest in a career in STEM fields (American Association of University Women, 1992). Classroom climates that empower females and boost confidence in mathematical ability are important given studies that show females have lower expectations for math performance than males starting in elementary school and persisting into middle school (Mullis et al., 2000; Stipek & Granlinski, 1991). These results are underscored by recent analyses of standardized assessments which show that gender differences in math performance are related to the gender equality within a given country. Gaps in performance by gender diminish among more gender-equal countries (Guiso, Monte, Sapienza, &i Zingales, 2008). These results have implications for educational environments that are male-dominated or those that are gender-biased (Donohue, 2008).

Fear of failure may negatively impact female performance in math. Such fear has been shown to lead to females putting less effort into studying math and becoming less engaged in the educational experience. This fear of failure combined with competitive environments that heighten students' perceptions of self-worth proved to be especially damaging to females given the manner in which females internalize failure and attribute it directly to perceived lower ability (Thompson & Dinnel, 2007). The ARP resource on *Stereotype Threat* available at http://www.engr.psu.edu/awe/ discusses this phenomenon in greater detail.

Stereotypes have also been shown to have a significant impact on math performance of females. Females that identified math ability and math professions with males more than females were shown to under-perform on mathematics tests and were less likely to attain a degree in a mathematical field (Ryan & Ryan, 2005). Implicit gender stereotypes held by females may make females less likely to complete a math major in college and create personal and professional conflicts among those who do, making them more likely to leave the field (Kiefer & Sekaquaptewa, 2007). A parent's values of and attitudes about their child's interest in math has also been shown to be related to their child's math performance. If parents hold stereotypes about math being more important for sons more than daughters, this has a significant effect on the child's math achievement and on their career choice. In particular, female interest in math decreased as the father's gender stereotypes increased (Davis-Kean, 2007).

While studies have offered plausible explanations for the differences in math performance and subsequent lack of representation in STEM fields, other studies have underscored the importance of monitoring female enrollment and completion of a challenging mathematics curriculum. Student performance in mathematics is linked to opportunities to enroll in different types of mathematics courses, with more complex skills garnered from completion of increasingly difficult coursework (United States Department of Education, 2007). For instance, thirteen year olds who completed algebra scored higher on national level assessments than peers who completed only pre-algebra or regular mathematics. Additional benefits include an increased likelihood of college enrollment and degree attainment as well as skills and abilities that can be applied to future learning outside of a mathematics classroom (Adelman, 1999, 2006; NSF, 2008; Rose & Betts, 2001). In particular, enrolling in calculus has been shown to increase the likelihood of choosing a mathematics or science major in college (Federman, 2007). Among high school females, taking a series of advanced mathematics courses was related to an increased likelihood of women selecting a major in STEM fields (Trusty, 2002). Despite benefits associated with enrolling in more advanced mathematics coursework, some studies show that by the final year of schooling, males report completing more advanced coursework than females (Mullis et al., 2000).

Synthesis of Findings

Effects of Gender Differences in Math Performance on Individual Performance

National trends reveal an increase in overall math performance, but mixed conclusions with regard to performance by gender on mathematical related assessments among K-12 students (Ingels & Dalton, 2008), with differences in achievement by gender at the K-12 level depending on the subject measured and the assessment tool used (Campbell, Hombo, & Mazzeo, 2000). At the undergraduate level, there is a clear pattern of fewer females pursuing undergraduate degrees in STEM fields that require advanced mathematical skills (National Science Foundation, 2008).

Examining the trends among males and females in math performance at various age levels, in conjunction with the literature related to environmental factors that negatively impact the performance of females in mathematics, sheds light on pipeline issues related to females in STEM related careers. Implications for practitioners related to these trends and successful interventions that can be employed to address gender differences in math performance are outlined.

Implications for Practitioners

- Practitioners should take notice that a variety of environmental factors can make a difference in females' math performance. Popular interventions to raise interest in STEM careers and bolster self-confidence among females in STEM disciplines should be marketed to students as early as middle school rather than waiting until the final years of high school when many females may have already made up their minds to pursue careers in fields other than those that require mathematical application. This includes mentoring programs and programs or initiatives that outline what professionals do and how they accomplish their work in careers that require mathematical application such as engineering (Cunningham, 2007).

- The format and content of the assessment tool being used may influence the magnitude or absence of differences in test scores between males and females. Practitioners should consider alternative means to assess mathematical abilities. Rather than relying solely on standardized, multiple-choice assessments, practitioners should consider performance assessments that also ask students to show and explain how they got to a result. This type of analysis of math performance can help instructors see a students' thought process as well as determine and correct areas of misunderstanding (Education Development Center, 2000).
- A relationship between math performance and students' self-concept and interest in mathematics has been identified (AAUW, 1992). Practitioners should consider related research that shows female students enrolled in fields that require application of mathematical subject matter show a notable drop in academic self-confidence during their first-year in college (Brainard & Carlin,1998; Mullis et al., 2000). Practitioners should consider whether they provide feedback to students that highlight both positive and negative elements of their work. Doing so may help prevent females from internalizing poor performance and bolster their self-concept (Thompson & Dinnel, 2007).
- Stereotypes related to interest in mathematics according to a student's gender may influence teacher's attitudes and behaviors. Based on these stereotypes, teachers may unintentionally create classroom climates that favor males. For instance, teachers may call on females less often, make less eye contact with females during instruction, and give more praise to male students for schoolwork based on the belief that female students are less interested in math subject matter. These behaviors may deter female interest in math careers and in related STEM fields (Sandler, Silverberg, & Hall, 1996). Practitioners should consider whether they give both males and females ample opportunity to participate in classroom activities.
- Practitioners should consider whether classroom environments are collaborative rather than competitive, as competitive environments have been shown to impede the learning of female students (Sandler, Silverberg, & Hall, 1996). Using a variety of pedagogical approaches that include hands-on manipulation and monitoring collaborative learning activities among students so that both males and females have an opportunity to participate in tasks and serve in leadership roles has been shown to benefit the learning of male and female students (Perez, 2000).
- Among undergraduates, stereotypes may exist that STEM fields are better suited to interests and abilities of males. This notion is reinforced given the lack of female role models readily available in STEM disciplines. These factors work together to deter females from pursuing a degree and career in STEM fields (Clewell & Campbell, 2002; Kiefer & Sekaquaptewa, 2007). Providing access to role models through informal and formal mentoring programs may be one way to help expose females to the successful women working in STEM fields. Proactive ways for practitioners to address this are discussed in greater detail in the ARP resource on *Stereotype Threat* available at http://www.engr.psu.edu/awe/.

Interventions and Successful Programmatic Initiatives in STEM Disciplines to Address Gender Differences in Math Performance

Successful interventions and initiatives that target females in mathematics are typically captured within programs that address more comprehensive issues related to the under-representation of females in STEM fields (Clewell & Campbell, 2002; Trenor, 2007):

- Using a variety of pedagogical strategies that address different learning styles within instructional environments has been shown to encourage female achievement in mathematics classrooms. For instance, strategies such as collaborative learning, instruction in small-group settings, inquiry-based approaches, and hands-on activities have been shown to be effective in teaching math and science to diverse groups of students, including females (Clewell, Anderson, & Thorpe, 1992). Several tools that explicitly address gender and mathematics in the classroom are available online at http://wge.terc.edu/publications.html
- Schools that devote resources to STEM programs are more likely to see an increase in interest in STEM-related disciplines among females (Clewell & Campbell, 2002). STEM disciplines can be made more attractive to students by providing ample opportunity to learn and apply course work though a variety of in-class as well as out of classroom experiences (Cunningham, 2007).
- School-sponsored math workshops for parents that encourage parents to take an active role in their student's math learning are increasingly popular. The math forums focus on partnering with parents to boost students' confidence and effort in math as a means to increase math achievement (Cavanagh, 2009). School districts may want to consider implementing forums such as these and emphasize how important parental support is in boosting student confidence regardless of a student's gender.
- The Weaving Gender Equity into Math Reform project at the Technical Education Research Center has created a workshop sessions on standardized testing, math, and equity. The materials for conducting the workshops are available online for use by teachers and administrators at http://wge.terc.edu/testingsession.html and http://wge.terc.edu/equitysession.html
- The American Mathematical Society highlights two programs each year. The programs are chosen for their focus on bringing underrepresented groups into some portion of the degree pipeline beginning at the undergraduate level or the program's ability to retain those groups in the pipeline. Programs must be able to document their success in doing so and have replicable models. Programs and contact information are listed at http://www.ams.org/employment/makeadiff.html

Recommendations for Practitioners

Results from national studies can be used in multiple areas to address under-representation of females in STEM fields. Practitioners should note that females enroll in and complete coursework at levels equal to male peers at both the K12 and postsecondary level. In addition, females attain degrees in mathematics at relatively similar rates as their male peers. However, a variety of environmental factors may work to impede female performance on standardized math tests and deter females from pursuing careers in STEM fields.

Stereotypes held by females themselves and by influential people, such as teachers and parents, negatively influence female math performance and future career aspirations as they pertain to STEM disciplines. Practitioners should work directly with female students as well parents to inform them of career opportunities in STEM fields. The fact that females acquire the needed academic preparation at the same rate as their male peers should be highlighted so that females perceive themselves as having the necessary qualifications for success and so that influential individuals are aware that females are prepared for these opportunities (Trenor, 2007). At the same time, to engage female interest in such careers, programs should underscore the collaborative nature with which STEM professionals accomplish work. Classroom settings should be examined for gender-biased practices, especially those that harm the self-concept of females as it pertains to their math ability (Sandler, Silverberg, & Hall, 1996). K-12 practitioners should consider integrating math and science curriculum given the manner in which academic preparation in both fields is needed for attainment of undergraduate degrees.

Research Agenda and Conclusions

This overview provided a review of statistical trends related to math performance by gender and discussed plausible causes for males performing better on standardized math tests. The conclusions drawn point to several areas where additional research is needed to understand better female underperformance on standardized mathematics assessments and their lack of representation in STEM fields. These areas are discussed in this section.

- Review assessments at the national level and employed in classrooms used to measure math performance for gender bias that are at odds with the reported trends associated with female enrollment and related achievement in high school math courses compared to male counterparts (Hyde, Lindberg, Linn, Ellis, & Williams, 2008; Sandler, Silverberg, & Hall, 1996).
- While females enroll in advanced coursework at the same rate as their male counterparts, it is unclear whether females have had the same opportunity to apply math skills needed for success in related areas in areas such as science, engineering, and technology given the underrepresentation of females in these fields. Future studies could examine specifically what math skills are needed for success in science, engineering, and technology and determine whether those skills are being taught to and mastered by females at the same rate as their male counterparts. In addition, males may have more opportunity to master and apply math skills needed for STEM careers given their enrollment in more advanced science courses than female students such as physics. Studies could examine whether this is indeed the case and how this might impact performance on math assessments.
- At this time, it is relatively unclear why females enroll in similar levels of advanced mathematics coursework in high school as their male peers if they do not intend to pursue a career in STEM disciplines. Studies could examine the career goals of female students that enroll in advanced mathematics courses and examine what influences career aspirations.
- Research has primarily examined the formal learning experiences of students such as specific math courses in which students enroll. However, the role of learning experiences such as STEM related field trips, internships, and participation in STEM competitions in math performance by gender could benefit from further study.
- Studies could examine whether teacher preparation plays a role in math performance by gender among students. Examining whether aspiring educators receive adequate preparation in content areas that are being examined through standardized assessments and whether they receive sufficient preparation in pedagogical practices that address different learning styles could provide more detailed information about why differences in performance by gender among students are apparent on standardized assessments.
- Additional information about why undergraduate females enroll in and pursue STEM degrees could be provided by examining trends in student involvement in faculty-led research experiences and participation in out-of-class activities by gender among students enrolled in mathematic degree

programs. These types of activities have been shown to increase student interest and academic success in science fields (Kardash, 2000).

- Research could also more closely examine the career goals of females and how those goals are impacted by perceptions of work-life balance and whether personal and professional goals are attainable in STEM careers.

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