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Literature Overview: Girls' Experiences in the Classroom

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I. Concise Overview of the Literature

While there have been impressive increases in the number of women achieving bachelor's and advanced degrees (Bureau of Labor Statistics, 2004), there continues to be a shortage of female students trained in science, technology, engineering, and math (STEM) fields (Herzig, 2004). For instance, women account for 22% of graduate students in engineering fields and 25% of graduate students in computer science (National Science Foundation [NSF], 2007), and women make up only 24.8% of workers in computer and mathematical occupation (e.g. computer scientists, systems analysts, computer software engineers, and statisticians), 33.1% of workers in the chemical and material sciences, 2.6% of aircraft pilots and flight engineers, and 13.5% of workers in architecture and engineering occupations (e.g. civil engineers, architects, industrial engineers, and mechanical engineers) (U.S. Bureau of Labor Statistics, 2008)). Thus, a great "gender gap" continues to exist in STEM fields, and researchers have spent considerable effort attempting to identify both biological and social explanations for such differences. In this review, we examine girls' experiences in the classroom and describe the many ways in which our education system (and societal expectations) may continue to "shortchange" girls (see American Association of University Women [AAUW], 1992).

We begin by describing pre-existing variables (i.e., parents) that substantially shape girls' experiences in the classroom. Then, we focus on the influences that occur within the classroom (i.e., interest levels, confidence levels, peer interactions, teacher interactions, and performance) that differentiate the male and female classroom experience. Although progress is being made, our review shows that classrooms remain gendered and have important implications for inequities in the selection of and perseverance in STEM majors and careers. However, there are actions that promote equality in the classroom, such as creating safe psychological spaces for both female and male students and fostering equity in teachers' verbal and nonverbal classroom behaviors.

Furthermore, we propose that researchers and educators *can* make a difference. First, much of the research in this area is fast becoming outdated so there is a need for researchers to identify current gender inequities and unfolding changes that have occurred over time, as well as reasons for why discrepancies do or do not continue to emerge. Second, educators need to be aware of the ways they may be fostering gender differences in interest levels, confidence levels, peer- and teacher-student interactions, and performance, which ultimately give rise to profound inequities in course selections, choice of majors, and career paths.

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II. Synthesis of Findings

IIa. Precursors that Shape Girls' Experiences in the Classroom. Although there are a host of influences that likely shape girls' and boys' differential experiences before they enter the classroom, we focus on parental influences, which continue to be strong influences on male and female students throughout the educational process (e.g., Halpern et al., 2007; Seymour, 1995). Parents have a tremendous influence (both deliberately and unintentionally) on what will eventually transpire in the classroom as they act as implicit models and reinforce gender normative behaviors (Buchmann & Dalton, 2002; Rosen & Aneshensel, 1978; Bhanot & Javanovic, 2005).

Moreover, parental achievement, parental involvement in children's schooling, and parental expectations for children significantly influence children's confidence and achievement (Bleeker & Jacobs, 2004; Coleman, 1988; Muller, 1998; Eccles, 2005). In terms of specific parental attitudes toward STEM fields, parents tend to view math to be more of a masculine than feminine domain (Nosek, Banaji, & Greenwald, 2002; Lummis & Stevenson, 1990; Tiedemann, 2000a). Parents also tend to buy more math and science-related products for their sons than their daughters (Bleeker, 2003). Other research shows that parents generally have higher expectations of academic achievement for their sons than daughters (Lytton & Romney, 1991; Tennenbaum, 2008), especially in STEM fields (Andre, Whigham, Hendrickson, & Chambers, 1999). In short, parents provide fewer STEM-related experiences and have lower STEM expectations for their daughters than sons.

IIb. Inside the Classroom. The AAUW's report (1992), *How Schools Shortchange Girls*, is one of the largest and most thorough assessments of the experiences that female (and male) students have in the classroom. This report is comprised of findings from hundreds of studies and concluded that female students are disadvantaged relative to male students. In particular, although male and female students begin their formal schooling on an equal-footing, a gender gap—in interest, confidence, peer and teacher interactions, and performance—develops and grows as students progress (AAUW, 1991, 1992).

<u>Interests</u>. The interests of male and female students are greatly influenced by what transpires in the classroom. As a whole, STEM classrooms seem to nurture male students' interests and discourage female students' interests in STEM (Gerber & Cheung, 2008). This pattern may begin occurring at a young age, as girls are socialized to engage in cooperative experiences with others (Herzig, 2004); hence, they come to expect and prefer such experiences in the classroom (Abu El-Haj, 2003). Male students, however, tend to engage in interactions and prefer classrooms with a clear hierarchy and an emphasis on specified goals (Abu El-Haj, 2003). STEM classes do not tend to be cooperative; rather, they are more competitive, hierarchical, lecture- and goal-based, independent, negative, and less interactive (Brady & Eisler, 1999; Gerber & Cheung, 2008).

Similarly, interests may also be shaped by learning styles, in which male and female students differ. Girls are more likely than boys to develop what Dweck (1999) calls an *entity approach* to learning, which reflects a belief that individuals possess a set amount of intelligence and cannot rise above this level. This attitude is characterized by the sentiment, "If I don't do well on the test, then I'm just not smart enough, and more effort won't change that." This sentiment is much more detrimental to one's interest (as well as self-efficacy) than, "If I don't do well on the test, then I just didn't work hard enough and I will work harder next time," – a sentiment boys are more likely to express after failure or negative feedback, which reflects an *incremental approach*. The entity approach is less likely to reinforce interests in the face of initial setbacks or failures, something girls may be vulnerable to experiencing in STEM classrooms (see Holland & Eisenhart, 1990). Indeed, Smith (2005) found that women who were reminded of gender stereotypes were more likely to endorse performance-avoidance goals, in which one merely tries to avoid being perceived as incompetent. Research has shown that different preferences for learning environments and styles do influence STEM-related interests. For instance, traditional science pedagogy (more competitive,

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hierarchical, and less interactive) dampened women's (but not men's) interest in STEM and, by the end of the first year, a majority of the female students reported decreased interest and diminished self-confidence in their ability to excel in science (Manis et al., 1989; AAUW, 2000; see also Tobias, 1990).

Girls' interests clearly influence their *participation rates* in STEM classes. While there are few overall gender differences in high school and college course enrollments, female students are still lagging behind male students in certain STEM subdisciplines. For instance, female high school students are now taking more intermediate-level math (i.e., trigonometry, pre-calculus), intermediate biology, and chemistry classes than are male students; however male students continue to take more advanced math (i.e., calculus), physics, and engineering classes (U.S. Department of Education, 2007). Once in college, men are overrepresented in engineering, math, science, and business majors; while women are overrepresented in education and humanities (Gerber & Cheung, 2008; Shauman, 2006). In recent decades, women have become better represented in the sciences but these numbers are somewhat misleading, as women are concentrated in the biological (62.5%) and social sciences (54.1%; psychology 77.8%; NSF, 2007). Sizeable gender gaps remain in technology and engineering majors (NSF, 2007), in which women account for one-quarter of computer science majors and less than 21% of engineering majors.

Although the number of women pursuing STEM majors has increased over the last decade (NSF, 2007), it is important to note that STEM fields continue to lose more female than male students. In a study examining why gender differences exist in STEM majors and also in dropout rates of such majors, Seymour (1995) found that women were more likely to switch from STEM to non-STEM majors because the latter was more intrinsically interesting, better matched their educational desires, and provided better career options and lifestyles. In addition, women who switched had altruistic interests and pursued majors and careers that they felt offered greater opportunity to help others than did STEM careers (see also Miller, Blessing, & Schwartz, 2006).

Confidence. Confidence is often assessed in terms of self-efficacy, which is defined as "people's judgments of their capabilities to organize and execute courses of action required to attain designated types of performances" (Bandura, 1986, p. 391). Self-efficacy beliefs influence the effort students expend, the extent to which students will persevere on tasks, and the choices students make.

Men have higher levels of STEM-related self-efficacy than do women (e.g., AAUW, 1991; Betz & Hackett, 1983; Pajares & Miller, 1994; Schunk & Pajares, 2002). For example, STEM-related efficacy is positively correlated with math (Hart, 1990) and science performance (Britner & Pajares, 2006). As important, researchers have found that when preparation and confidence levels are taken into account, gender differences in math achievement disappear (Lapan, Boggs, & Morrill, 1989), suggesting that differences are not due to ability.

Other research has shown that first-year undergraduate women majoring in STEM tend to have high levels of STEM-related confidence (often based on good high school GPAs, good SAT scores, and teacher praise) but that their confidence drops shortly after their entry to college. More specifically, women reported feeling "isolated, insecure, intimidated" and questioned "whether they 'belonged' in the sciences at all, and whether they were good enough to continue" (Seymour, 1995; p. 458). Even when male and female students achieve similarly in STEM-related fields (e.g., course grades), males tend to report higher confidence than females (e.g., Watt, 2006; see also Pajares, 2005 for a review).

Peer Interactions. Peers also have a dramatic influence on the classroom experiences of girls and boys. Children's math grades, for instance, are correlated with the verbal and math skills of the children in their peer groups (Kurdek & Sinclair, 2000). Although it is difficult to isolate the peers' effect on student achievement from other confounding variables (i.e., neighborhood, school system), research has attempted to do this by examining students' perceptions of peers' attitudes toward academic performance and college plans (see Buchmann & Dalton, 2002). These studies show that, indeed, peers do substantially influence

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achievement (see also Hanushek, Kain, Markman, & Rivkin, 2003). It is important to note that gender segregation is another outcome of peer influence. As early as preschool, students tend to segregate themselves by gender and this effect becomes more pronounced during elementary and middle school (Maccoby, 2002). Such segregation may influence and reinforce gender differences in achievement and aspirations. In fact, a number of studies have shown that peers play an import role in shaping students' educational aspirations (see Buchmann & Dalton, 2002).

Peers continue to affect students' classroom experiences in college courses. Male peers believe that female students who enter STEM fields could only be attractive *or* smart; male students thought pretty girls could not be good at STEM and many reported that they found girls who did well in STEM to be unattractive (Seymour, 1995). Furthermore, women reported that many of their male STEM peers only responded to them with sexual interest and in many cases, this interest involved sexually suggestive, unwanted remarks (Seymour, 1995). Moreover, female STEM students reported that their male peers did not include them in study groups, men felt threatened when women scored well, and men continued to believe that women could not excel in math. These findings indicate that one of the reasons why science enrichment programs and all-women educations are particularly helpful for girls because they provide girls a science-supportive peer network (Stake & Nickens, 2005).

<u>Teacher Interactions</u>. Teachers influence students in both overt and subtle ways, through expectations that they hold for students; through the guidance, role modeling, and future possibilities they provide to students; and through verbal and nonverbal teacher/student exchanges. Although it seems unlikely that female students are being told, "You just don't have a future in mathematics," or "Science is really for boys," teachers may be signaling this to students in less overt ways. For instance, they impart on students the traits and behaviors they believe are gender appropriate (Irvine, 1986), hold and act consistently with their expectations that some students will not perform as well as others (Rosenthal & Jacobson, 1968), and provide guidance about available and suitable options for male and female students (Spelke & Grace, 2006). Jussim and Eccles (1992) conducted a particularly profound display of teachers' influence by conducting a longitudinal study on 6th-grade math teachers' expectations about their students' performance. Consistent with the self-fulfilling prophecy (see Rosenthal & Jacobson, 1968; Jussim & Harber, 2005), teachers' expectations predicted student achievement, even after controlling for prior achievement and motivation. Such expectations, even in preschool teachers, have been shown to reliably predict SAT test-taking 14 years later (Alvidrez & Weinstein, 1999).

Although not unanimous (e.g., Boersma, Gay, Jones, Morrison, & Remick, 1981; Brady & Eisler, 1999), the most commonly reported teacher-student interaction bias is that male students receive more attention than do female students. In fact, a recent meta-analysis, based on 32 studies conducted between 1970 and 2000, assessed sex differences in student-teacher interactions (Jones & Dindia, 2004) and similarly concluded that teachers interact more with male students than with female students. This preference toward male students over female students has been acknowledged consistently across kindergarten (e.g., AAUW, 1992), elementary school (e.g., Irvine, 1986; Merrett & Wheldall, 1992), and high school (e.g., Duffy, Warren, & Walsh, 2001). Similarly, Hall and Sandler (1982) concluded that teachers call on and allow male students to respond to questions more frequently than female students, and they interrupt male students less frequently than female students (see also Sadker & Sadker, 1986). Thus, Hall and Sandler (1982) coined the phrase "chilly climate" to describe how female students likely perceive the classroom.

Jones and Dindia (2004) also indicated that teachers have more negative but not more positive interactions with male students compared to female students: Teachers reprimand and critique male students more than female students but do not praise male students more than female students. Duffy et al. (2001) further explored the disparity in negativity that teachers exhibit toward male and female students. In particular, teachers seem to have fewer *acceptance-intellectual* interactions (e.g., teacher indicates student's response is correct but challenges his or her thinking) and fewer *criticism-intellectual* interactions

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(e.g., teacher negatively evaluates student's response) with female than male students. Such teachers may be exhibiting benevolent sexism—sexist attitudes that view women stereotypically and in restricted roles (Glick & Fiske, 1996). That is, teachers may be "protecting" female students by not challenging their ideas or critiquing their work, and believing that they are fragile and should be protected. Accordingly, Irvine (1986) found that although lower-elementary male and female students received comparable academic feedback, upper-elementary girls received significantly less academic feedback than did boys. As a result, female students might not be as well-prepared for course exams or given the same degree of demanding assignments as male students. Thus, although such teachers most likely believe that this benevolence benefits female students, it may ultimately impair their performance. If this trend—benevolent sexism—continues through middle and high school, it is no wonder that competent females expect to fail more in STEM and have lower STEM self-efficacy than do competent males (AAUW, 1992).

Performance. When it comes to STEM-related fields, female students are vulnerable to experiencing *stereotype threat*, which occurs when individuals are faced with situations in which they risk being personally reduced to a stereotype targeting their group (Davies, Spencer, & Steele, 2005; Steele & Aronson, 1995). The added burden of stereotype threat can undermine an individual's performance and aspirations in any stereotype-relevant domain. For example, female students are vulnerable to stereotype threat in domains where stereotypes allege a sex-based inability (e.g., math test). When girls experience stereotype threat in STEM-related fields, they may react to them a number of ways, ranging from avoiding the domain (i.e., spending less time on STEM-related homework) to *disidentification,* permanently withdrawing from the domain and no longer considering it a basis of self-evaluation or self-esteem (i.e., choosing a non-STEM major or career; Major, Spencer, Schmader, Wolfe, & Crocker, 1998). In short, stereotype threat and disidentification processes are possible reasons why women are less likely than men to choose STEM-related careers (e.g., see Davies & Spencer, 2005).

Researchers have argued that stereotype threat may be one reason that girls' class performance is not always reflected in high-stakes testing performance (e.g., Davies & Spencer, 2005; Spencer, Steele, & Quinn, 1999). Female students tend to receive equal or better grades across all classes throughout their academic careers, than do male students (AAUW, 1998; Gallagher & Kaufman, 2005). According to the National Assessment of Educational Progress (NAEP) Report of 2005 (Grigg Lauko, & Brockway, 2006), while male and female students in grades 4 and 12 perform at "basic" levels (as compared with "proficient" and "advanced") within performance levels, male students score slightly higher than female students, a gap that has been consistent over time with the NAEP test. Scores on national and standardized tests (Advanced Placement, SAT, ACT), among the most important determinants of future success, display the largest gender differences of any assessment tool. In high school and beyond, male and female students score similarly on high-stakes verbal tests (see Hyde, 2005); however, when it comes to math, male students consistently score higher on the math sections of the PSAT and the SAT, the quantitative section of the GRE, and the AP calculus exam (Feingold, 1988; Gallagher & Kaufman, 2005). Gender disparities exist for the AP exams as well. Relative to male students, female students are more likely to take AP tests in all subjects areas except math, science, and computer science.

III. Interventions and Recommendations for STEM Educators

Although empirical evidence on the effectiveness (or ineffectiveness) of STEM-related interventions remains limited, we propose a number of interventions that can be implemented to potentially make the classroom a more equitable place for girls. Such interventions include both individual- and school-level actions. We present four individual-level practices (changing expectations for girls, encouraging and nurturing girls in the classroom, fostering equity in teacher and classmate behaviors, and creating safe environments) and four school-level practices (equalizing enrollments, equity training for new teachers, promoting and providing financial help for those eligible to take AP tests, and using more than

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just high-stakes tests for admissions decisions). While this is not an exhaustive list of recommendations, we do believe that these interventions can provide more parity to girls' experiences in the classroom.

Individual-Level Interventions. First, teachers, parents, and other role models must be made aware of the need to have similar expectations of girls and boys and hold themselves accountable to treating them equally. Some of the most profound social psychological research shows the effects that differing expectations for students can have on their achievement levels (Rosenthal & Jacobson, 1968) and if educators hold lower expectations for female students, they do more poorly than their male counterparts (Jussim & Eccles, 1992; Tiedemann, 2000b). Second, girls must be encouraged to enroll in STEM-related courses at the same rates as boys. The AAUW Report (1998) suggests that teachers and other role models should prepare and encourage more girls to enroll in honors and AP level STEM courses—especially in physics, engineering, and computer science, in which the gender gap is especially large.

Third, educators must correct the unfair practices they may be employing in their classrooms. Since teachers may be unaware of their own unfair practices, researchers recommend that teachers participate in equity training, especially before they begin teaching. Such training can be effective as shown by Jones, Evans, Byrd, and Campbell (2000), in which they found equity training that involved videotaping teachers was effective in establishing a more equitable classroom environment eight weeks later. Teachers also seem to welcome such training. As Campbell and Sanders (1997) reported, although most teachers are unaware of how to alleviate gender discrepancies in STEM classes, they are interested in learning how to do so.

Fourth, *identity-safe environments*, or those in which all students feel free from stereotype threat and in which teachers encourage and have high expectations for all students, (Davies et al., 2005), can protect students. Such environments are particularly important in eliminating the vulnerability that female students feel when facing stereotypes concerning their STEM-related performances (Davies et al., 2005). Identity-safe environments ensure that individuals are welcomed, supported, and valued; they challenge the validity and dependency on negative stereotypes that are linked to certain individuals; and they ensure that educators hold high expectations and create fair testing grounds for everyone.

School-Level Interventions. At the school level, we propose that schools adopt certain strategies to improve women's achievement in the classroom. First, as outlined by the AAUW (1998), schools can work to equalize the enrollment of male and female students in all courses, with a particular focus on promoting female students to take chemistry, physics, engineering, and computer science. Additionally, however, schools must make strides to ensure that the pedagogy in such classes is as welcoming and attractive to female as male students. They can do this by making classes more collaborative, less competitive, and less hierarchical. Second, schools can also work toward gender parity by integrating equity training into all pre-service teacher training (Jones et al., 2000). While this intervention is an individual-level one, we also believe it should become a mandatory, school-level initiative as well. Such training would include informing teachers about the overt and subtle nonverbal and verbal ways that they may differentially treat students, and the different styles that male and female students prefer.

Third, to equalize the number of male and female students who take math, science, and computer AP exams, more attention must be given to why there are current disparities. Some districts have considered making the tests mandatory for all those enrolled in the courses in an attempt to reach gender parity (see AAUW, 1998). Other districts have considered subsidizing testing costs, again to prevent demographic related differences from emerging (see AAUW, 1998). Fourth and finally, colleges and universities should continue to rely on more than just high-stakes test scores for admission consideration. Such tests may over represent male students' performance and under represent female students' performance in college (Spelke, 2005). Consonant with this idea, some colleges (e.g., Wake Forest University, Smith College) recently have begun to revise their admission policy so that standardized test scores are not required.

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IV. Future Research and Calls to Action

In writing this review, we were struck with the large number of outdated references that continue to be used when addressing girls' experiences in the classroom. Thus, the first call to action that we suggest is for researchers to continue conducting research investigating behaviors in the classroom. With the continuation of strides that women are making in STEM fields, it is essential that future studies monitor progress and identify new challenges that girls (and boys) may face. Additionally, much of the research that we have presented in this review is correlational and not causal. In linking classroom experiences to STEM-related outcomes, more causal and longitudinal research needs to be done on gender differences in *interest* (e.g., "How are interests specifically shaped, nurtured, and changed by parents, teachers, and peers?"), *confidence* (e.g., "What can be done to promote and maintain girls' high levels of STEM-related confidence?"), *peer interactions* (e.g., "How do peers specifically motivate or discourage STEM-related interest and achievement?"), *teacher interactions* (e.g., "What are the specific attitudes and behaviors that transpire in the classroom between teachers and students that lead to STEM-related interest, efficacy and performance?"), and *performance* (e.g., "Exactly how do STEM-related classroom experiences influence STEM-related testing outcomes?").

The AAUW report (1998) makes a number of additional suggestions about future research that we also embrace. First, they suggest that researchers should continue to evaluate assessment procedures to determine the fairest testing practices and those that most accurately reflect students' knowledge. Second, they suggest that researchers continue to explore assessment trends along finer subgroup demographics (see also Buchmann, DiPrete, & McDaniel, 2008). That is, testing data should be disaggregated by gender and divided into categories along SES, race, and ethnicity lines as well as gender. Such research may give a more fine-tuned look at who may or may not be shortchanged in the classroom. Third, and as we mentioned previously, they suggest that researchers should undertake more empirical work that investigates equity in classroom interactions. Researchers can more successfully intervene once they have fully identified and measured classroom disparities. Lastly, they suggest that there is a need for researchers to study why female students are not taking AP exams in math, science, and computer science at the same frequency as are male students.

Buchmann et al. (2008) also reviewed gender inequalities in the classroom, and made two additional suggestions for future research. First, they suggested that researchers take a more interdisciplinary approach to examine inequalities that people of differing genders may experience early in life. They suggest that researchers capitalize on the recent advances in biology, genetics, neuroscience and other fields (Kimura, 1999; Halpern, 2000; Cahill, 2005; Spelke, 2005) to understand more fully the nature-nurture debate regarding early child development. Second, they suggest that researchers identify the educational and pedagogical consequences of different school structures. Single-sex classrooms, schools, and universities have been established in response to the gender differences in performance, but little research concerning their efficacy has been done and draws different conclusions. For instance, some research found that girls perform better in single-sex classrooms (Wong, Lam, & Ho, 2002), whereas other research (Hoxby, 2000; Lavy & Schlosser, 2007) found that both genders perform better in mixed-gender, but female-dominated classrooms.

Today's mere presence of female students – sometimes equal to and often outnumbering male students – is perhaps the most impressive sign of the changing times (see U.S. Census Bureau, 2008). While some gender inequities in the classroom have lessened, other inequities (subtle and overt) continue. Female students appear to be doing well in their coursework and taking classes that will give them the skills necessary to pursue work in STEM-related fields, but still they do not participate in STEM-related careers at the same rates as do men. Like most other social phenomena, awareness of the problem and possible strategies for addressing it are the first steps towards correction. The remediation strategies and recommendations we outlined should put educators and researchers on the right track toward reaching

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equity in classroom experiences, resulting in similar percentages of women and men choosing STEM related majors and professions. It is equally vital that educators foster in their female (and male) students an interest in and a sense of identity with STEM fields.

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