Why So Few?

Women in Science, Technology, Engineering, and Mathematics

AAUW
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<table>
<thead>
<tr>
<th>Section</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>Foreword</td>
<td>ix</td>
</tr>
<tr>
<td>Acknowledgments</td>
<td>x</td>
</tr>
<tr>
<td>About the Authors</td>
<td>xii</td>
</tr>
<tr>
<td>Executive Summary</td>
<td>xiii</td>
</tr>
<tr>
<td>Chapter 1. Women and Girls in Science, Technology, Engineering, and Mathematics</td>
<td>1</td>
</tr>
<tr>
<td>Chapter 2. Beliefs about Intelligence</td>
<td>29</td>
</tr>
<tr>
<td>Chapter 3. Stereotypes</td>
<td>37</td>
</tr>
<tr>
<td>Chapter 4. Self-Assessment</td>
<td>43</td>
</tr>
<tr>
<td>Chapter 5. Spatial Skills</td>
<td>51</td>
</tr>
<tr>
<td>Chapter 6. The College Student Experience</td>
<td>57</td>
</tr>
<tr>
<td>Chapter 7. University and College Faculty</td>
<td>67</td>
</tr>
<tr>
<td>Chapter 8. Implicit Bias</td>
<td>73</td>
</tr>
<tr>
<td>Chapter 9. Workplace Bias</td>
<td>81</td>
</tr>
<tr>
<td>Chapter 10. Recommendations</td>
<td>89</td>
</tr>
<tr>
<td>Bibliography</td>
<td>97</td>
</tr>
</tbody>
</table>
Table of Figures

Figure 1. High School Credits Earned in Mathematics and Science, by Gender, 1990–2005 4

Figure 2. Grade Point Average in High School Mathematics and Science (Combined), by Gender, 1990–2005 4

Figure 3. Students Taking Advanced Placement Tests in Mathematics and Science, by Gender, 2009 6

Figure 4. Average Scores on Advanced Placement Tests in Mathematics and Science Subjects, by Gender, 2009 7

Figure 5. Intent of First-Year College Students to Major in STEM Fields, by Race-Ethnicity and Gender, 2006 8

Figure 6. Bachelor’s Degrees Earned by Women in Selected Fields, 1966–2006 9

Figure 7. Bachelor’s Degrees Earned in Selected Science and Engineering Fields, by Gender, 2007 10

Figure 8. Bachelor’s Degrees Earned by Underrepresented Racial-Ethnic Groups in Selected STEM Fields, by Gender, 2007 11

Figure 9. Doctorates Earned by Women in Selected STEM Fields, 1966–2006 12

Figure 10. Women in Selected STEM Occupations, 2008 14

Figure 11. Women in Selected STEM Occupations, 1960–2000 15

Figure 12a. Workers with Doctorates in the Computer and Information Sciences Workforce, by Gender and Employment Status, 2006 16

Figure 12b. Workers with Doctorates in the Biological, Agricultural, and Environmental Life Science Workforce, by Gender and Employment Status, 2006 16
Figure 13. Female STEM Faculty in Four-Year Educational Institutions, by Discipline and Tenure Status, 2006

Figure 14. A Fixed versus a Growth Mindset

Figure 15. Performance on a Challenging Math Test, by Stereotype Threat Condition and Gender

Figure 16. Self-Assessment of Ability, by Gender

Figure 17. Students’ Standards for Their Own Performance, by Gender

Figure 18. Sample Question from the Purdue Spatial Visualization Test: Rotations (PSVT:R)

Figure 19. Process for Improving Recruitment and Retention of Women in Computer Science

Figure 20. Instructions for an Implicit Association Test on Gender and Science

Figure 21. Competence and Likability for Women and Men in “Male” Professions
AAUW is proud to have been selected by the National Science Foundation to conduct this study of women’s underrepresentation in science, technology, engineering, and mathematics. Since 1881, AAUW has encouraged women to study and work in these areas through fellowships and grants, research, programming, and advocacy. From local science camps and conferences to our groundbreaking research reports, AAUW has a long history of breaking through barriers for women and girls.

Women have made tremendous progress in education and the workplace during the past 50 years. Even in historically male fields such as business, law, and medicine, women have made impressive gains. In scientific areas, however, women’s educational gains have been less dramatic, and their progress in the workplace still slower. In an era when women are increasingly prominent in medicine, law, and business, why are so few women becoming scientists and engineers?

This study tackles this puzzling question and presents a picture of what we know—and what is still to be understood—about girls and women in scientific fields. The report focuses on practical ways that families, schools, and communities can create an environment of encouragement that can disrupt negative stereotypes about women’s capacity in these demanding fields. By supporting the development of girls’ confidence in their ability to learn math and science, we help motivate interest in these fields. Women’s educational progress should be celebrated, yet more work is needed to ensure that women and girls have full access to educational and employment opportunities in science, technology, engineering, and mathematics.

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Executive Summary
The number of women in science and engineering is growing, yet men continue to outnumber women, especially at the upper levels of these professions. In elementary, middle, and high school, girls and boys take math and science courses in roughly equal numbers, and about as many girls as boys leave high school prepared to pursue science and engineering majors in college. Yet fewer women than men pursue these majors. Among first-year college students, women are much less likely than men to say that they intend to major in science, technology, engineering, or math (STEM). By graduation, men outnumber women in nearly every science and engineering field, and in some, such as physics, engineering, and computer science, the difference is dramatic, with women earning only 20 percent of bachelor’s degrees. Women’s representation in science and engineering declines further at the graduate level and yet again in the transition to the workplace.

Drawing on a large and diverse body of research, this report presents eight recent research findings that provide evidence that social and environmental factors contribute to the underrepresentation of women in science and engineering. The rapid increase in the number of girls achieving very high scores on mathematics tests once thought to measure innate ability suggests that cultural factors are at work. Thirty years ago there were 13 boys for every girl who scored above 700 on the SAT math exam at age 13; today that ratio has shrunk to about 3:1. This increase in the number of girls identified as “mathematically gifted” suggests that education can and does make a difference at the highest levels of mathematical achievement. While biological gender differences, yet to be well understood, may play a role, they clearly are not the whole story.

**Girls’ Achievements and Interest in Math and Science Are Shaped by the Environment around Them**

This report demonstrates the effects of societal beliefs and the learning environment on girls’ achievements and interest in science and math. One finding shows that when teachers and parents tell girls that their intelligence can expand with experience and learning, girls do better on math tests and are more likely to say they want to continue to study math in the future. That is, believing in the potential for intellectual growth, in and of itself, improves outcomes. This is true for all students, but it is particularly helpful for girls in mathematics, where negative stereotypes persist about their abilities. By creating a “growth mindset” environment, teachers and parents can encourage girls’ achievement and interest in math and science.

Does the stereotype that boys are better than girls in math and science still affect girls today? Research profiled in this report shows that negative stereotypes about girls’ abilities in math can indeed measurably lower girls’ test performance. Researchers also believe that stereotypes
can lower girls’ aspirations for science and engineering careers over time. When test adminis-
trators tell students that girls and boys are equally capable in math, however, the difference in
performance essentially disappears, illustrating that changes in the learning environment can
improve girls’ achievement in math.

The issue of self-assessment, or how we view our own abilities, is another area where cultural
factors have been found to limit girls’ interest in mathematics and mathematically challeng-
ing careers. Research profiled in the report finds that girls assess their mathematical abilities
lower than do boys with similar mathematical achievements. At the same time, girls hold
themselves to a higher standard than boys do in subjects like math, believing that they have
to be exceptional to succeed in “male” fields. One result of girls’ lower self-assessment of their
math ability—even in the face of good grades and test scores—and their higher standards for
performance is that fewer girls than boys aspire to STEM careers. By emphasizing that girls
and boys achieve equally well in math and science, parents and teachers can encourage girls to
assess their skills more accurately.

One of the largest gender differences in cognitive abilities is found in the area of spatial skills,
with boys and men consistently outperforming girls and women. Spatial skills are considered
by many people to be important for success in engineering and other scientific fields. Research
highlighted in this report, however, documents that individuals’ spatial skills consistently
improve dramatically in a short time with a simple training course. If girls grow up in an
environment that enhances their success in science and math with spatial skills training, they
are more likely to develop their skills as well as their confidence and consider a future in a
STEM field.

At Colleges and Universities, Little Changes Can Make a Big
Difference in Attracting and Retaining Women in STEM

The foundation for a STEM career is laid early in life, but scientists and engineers are made
in colleges and universities. Research profiled in this report demonstrates that small improve-
ments by physics and computer science departments, such as providing a broader overview of
the field in introductory courses, can add up to big gains in female student recruitment and
retention. Likewise, colleges and universities can attract more female science and engineering
faculty if they improve departmental culture to promote the integration of female faculty.
Research described in this report provides evidence that women are less satisfied with the
academic workplace and more likely to leave it earlier in their careers than their male
counterparts are. College and university administrators can recruit and retain more women by
implementing mentoring programs and effective work-life policies for all faculty members.
Bias, Often Unconscious, Limits Women’s Progress in Scientific and Engineering Fields

Most people associate science and math fields with “male” and humanities and arts fields with “female,” according to research examined in this report. Implicit bias is common, even among individuals who actively reject these stereotypes. This bias not only affects individuals’ attitudes toward others but may also influence girls’ and women’s likelihood of cultivating their own interest in math and science. Taking the implicit bias test at https://implicit.harvard.edu can help people identify and understand their biases so that they can work to compensate for them.

Not only are people more likely to associate math and science with men than with women, people often hold negative opinions of women in “masculine” positions, like scientists or engineers. Research profiled in this report shows that people judge women to be less competent than men in “male” jobs unless they are clearly successful in their work. When a woman is clearly competent in a “masculine” job, she is considered to be less likable. Because both likability and competence are needed for success in the workplace, women in STEM fields can find themselves in a double bind. If women and men in science and engineering know that this bias exists, they can work to interrupt the unconscious thought processes that lead to it. It may also help women specifically to know that if they encounter social disapproval in their role as a computer scientist or physicist, it is likely not personal and there are ways to counteract it.

The striking disparity between the numbers of men and women in science, technology, engineering, and mathematics has often been considered as evidence of biologically driven gender differences in abilities and interests. The classical formulation of this idea is that men “naturally” excel in mathematically demanding disciplines, whereas women “naturally” excel in fields using language skills. Recent gains in girls’ mathematical achievement, however, demonstrate the importance of culture and learning environments in the cultivation of abilities and interests. To diversify the STEM fields we must take a hard look at the stereotypes and biases that still pervade our culture. Encouraging more girls and women to enter these vital fields will require careful attention to the environment in our classrooms and workplaces and throughout our culture.
Chapter 1.
Women and Girls in Science, Technology, Engineering, and Mathematics
Science, technology, engineering, and mathematics (STEM) are widely regarded as critical to the national economy. Concern about America’s ability to be competitive in the global economy has led to a number of calls to action to strengthen the pipeline into these fields (National Academy of Sciences, Committee on Science, Engineering & Public Policy, 2007; U.S. Government Accountability Office, 2006; U.S. Department of Education, 2006). Expanding and developing the STEM workforce is a critical issue for government, industry leaders, and educators. Despite the tremendous gains that girls and women have made in education and the workforce during the past 50 years, progress has been uneven, and certain scientific and engineering disciplines remain overwhelmingly male. This report addresses why there are still so few women in certain scientific and engineering fields and provides recommendations to increase the number of women in these fields.

The National Science Foundation estimates that about five million people work directly in science, engineering, and technology—just over 4 percent of the workforce.¹ This relatively small group of workers is considered to be critical to economic innovation and productivity. Workers in science and engineering fields tend to be well paid and enjoy better job security than do other workers. Workforce projections for 2018 by the U.S. Department of Labor show that nine of the 10 fastest-growing occupations that require at least a bachelor’s degree will require significant scientific or mathematical training. Many science and engineering occupations are predicted to grow faster than the average rate for all occupations, and

Definition of Science, Technology, Engineering, and Mathematics (STEM)

STEM is defined in many ways (for example, see U.S. government definitions at http://nces.ed.gov/pubs2009/2009161.pdf). In this report the term “STEM” refers to the physical, biological, and agricultural sciences; computer and information sciences; engineering and engineering technologies; and mathematics. The social and behavioral sciences, such as psychology and economics, are not included, nor are health workers, such as doctors and nurses. College and university STEM faculty are included when possible, but high school teachers in STEM subjects are not. While all of these workers are part of the larger scientific and engineering workforce, their exclusion is based on the availability of data. In this report the terms “STEM,” “science, technology, engineering, and mathematics,” and “scientific and engineering fields” are used interchangeably.

¹Defined by occupation, the United States science and engineering workforce totaled between 4.3 and 5.8 million people in 2006. Those in science and engineering occupations who had bachelor’s degrees were estimated at between 4.3 and 5.0 million. The National Science Foundation includes social scientists but not medical professionals in these estimates (National Science Board, 2010). Estimates of the size of the scientific, engineering, and technological workforce are produced using different criteria by several U.S. government agencies including the Census Bureau, the National Science Foundation, and the Bureau of Labor Statistics. Defined more broadly, the size of the STEM workforce has been estimated to exceed 21 million people.
some of the largest increases will be in engineering- and computer-related fields—fields in which women currently hold one-quarter or fewer positions (Lacey & Wright, 2009; National Science Board, 2010).

Attracting and retaining more women in the STEM workforce will maximize innovation, creativity, and competitiveness. Scientists and engineers are working to solve some of the most vexing challenges of our time—finding cures for diseases like cancer and malaria, tackling global warming, providing people with clean drinking water, developing renewable energy sources, and understanding the origins of the universe. Engineers design many of the things we use daily—buildings, bridges, computers, cars, wheelchairs, and X-ray machines. When women are not involved in the design of these products, needs and desires unique to women may be overlooked. For example, “some early voice-recognition systems were calibrated to typical male voices. As a result, women’s voices were literally unheard. ... Similar cases are found in many other industries. For instance, a predominantly male group of engineers tailored the first generation of automotive airbags to adult male bodies, resulting in avoidable deaths for women and children” (Margolis & Fisher, 2002, pp. 2–3). With a more diverse workforce, scientific and technological products, services, and solutions are likely to be better designed and more likely to represent all users.

The opportunity to pursue a career in science, technology, engineering, and mathematics is also a matter of pay equity. Occupational segregation accounts for the majority of the wage gap (AAUW Educational Foundation, 2007), and although women still earn less than men earn in science and engineering fields, as they do on average in the overall workforce, women in science and engineering tend to earn more than women earn in other sectors of the workforce. According to a July 2009 survey, the average starting salary for someone with a bachelor’s degree in mechanical engineering, for example, was just over $59,000. By comparison, the average starting salary for an individual with a bachelor’s degree in economics was just under $50,000 (National Association of Colleges and Employers, 2009).

**Preparation of Girls for STEM Fields**

Math skills are considered essential to success in STEM fields. Historically, boys have outperformed girls in math, but in the past few decades the gender gap has narrowed, and today girls are doing as well as boys in math on average (Hyde et al., 2008). Girls are earning high school math and science credits at the same rate as boys and are earning slightly higher grades in these classes (U.S. Department of Education, National Center for Education Statistics, 2007) (see figures 1 and 2).
Figure 1. High School Credits Earned in Mathematics and Science, by Gender, 1990-2005


Figure 2. Grade Point Average in High School Mathematics and Science (Combined), by Gender, 1990-2005

On high-stakes math tests, however, boys continue to outscore girls, albeit by a small margin. A small gender gap persists on the mathematics section of the SAT and the ACT examinations (Halpern, Benbow, et al., 2007; AAUW, 2008). Fewer girls than boys take advanced placement (AP) exams in STEM-related subjects such as calculus, physics, computer science, and chemistry (see figure 3), and girls who take STEM AP exams earn lower scores than boys earn on average (see figure 4). Research on “stereotype threat,” profiled in chapter 3, sheds light on the power of stereotypes to undermine girls’ math test performance and may help explain the puzzle of girls’ strong classroom performance and relatively weaker performance on high-stakes tests such as these.

One notable gain is girls’ increased representation in the ranks of the highest achievers in mathematics. Among students with very high scores on math tests, boys continue to outnum- ber girls (Lubinski & Benbow, 1992, 2006; Hedges & Nowell, 1995); however, the proportion of girls among the highest math achievers has greatly increased during the past few decades. The Study of Mathematically Precocious Youth identifies seventh and eighth graders who score greater than 700 on the SAT math section (the top 0.01 percent or 1 in 10,000 stu- dents). Since the early 1980s the ratio of boys to girls in this extremely select group has dra- matically declined from 13:1 (Benbow & Stanley, 1983) to around 3:1 in recent years (Brody & Mills, 2005; Halpern, Benbow, et al., 2007).

Students from historically disadvantaged groups such as African American and Hispanic students, both female and male, are less likely to have access to advanced courses in math and science in high school, which negatively affects their ability to enter and successfully complete STEM majors in college (May & Chubin, 2003; Frizell & Nave, 2008; Tyson et al., 2007; Perna et al., 2009). In 2005, 31 percent of Asian American and 16 percent of white high school graduates completed calculus, compared with 6 percent and 7 percent of African American and Hispanic high school graduates, respectively. Additionally, one-quarter of Asian American and one-tenth of white high school graduates took either the AP or International Baccalaureate exam in calculus, compared with just 3.2 percent of African American and 5.6 percent of Hispanic graduates (National Science Board, 2008). Yet even among under-represented racial-ethnic groups, a growing number of girls are leaving high school well pre- pared in math and science and capable of pursuing STEM majors in college.

**WOMEN IN STEM IN COLLEGES AND UNIVERSITIES**

The transition between high school and college is a critical moment when many young women turn away from a STEM career path. Although women are the majority of college students, they are far less likely than their male peers to plan to major in a STEM field (see figure 5).
Figure 3. Students Taking Advanced Placement Tests in Mathematics and Science, by Gender, 2009

Why So Few?

Almost one-third of all male freshmen (29 percent), compared with only 15 percent of all female freshmen, planned to major in a STEM field in 2006 (National Science Foundation, 2009b). The gender disparity in plans to major is even more significant when the biological sciences are not included. Just over one-fifth of male freshmen planned to major in engineering, computer science, or the physical sciences, compared with only about 5 percent of female freshmen (ibid.).

Women who enter STEM majors in college tend to be well qualified. Female and male first-year STEM majors are equally likely to have taken and earned high grades in the prerequisite math and science classes in high school and to have confidence in their math and science abilities (Brainard & Carlin, 1998; U.S. Department of Education, National Center for Education Statistics, 2000; Vogt et al., 2007). Nevertheless, many of these academically capable women

Figure 4. Average Scores on Advanced Placement Tests in Mathematics and Science Subjects, by Gender, 2009

Figure 5. Intent of First-Year College Students to Major in STEM Fields, by Race-Ethnicity and Gender, 2006

leave STEM majors early in their college careers, as do many of their male peers (Seymour & Hewitt, 1997). For example, in engineering the national rate of retention from entry into the major to graduation is just under 60 percent for women and men (Ohland et al., 2008). Although the overall retention of female undergraduates in STEM is similar to the retention rate for men and has improved over time (U.S. Department of Education, National Center for Education Statistics, 2000; Xie & Shauman, 2003), understanding why women leave STEM majors is still an important area of research. Women make up a smaller number of STEM students from the start, so the loss of women from these majors is of special concern. Chapter 6 profiles the work of researchers Barbara Whitten, Jane Margolis, and Allan Fisher, showing the role of departmental culture in attracting and retaining female computer science and physics majors.

Despite the still relatively small percentages of women majoring in some STEM fields, the overall proportion of STEM bachelor’s degrees awarded to women has increased dramatically during the past four decades, although women’s representation varies by field.

In 2006, women earned the majority of bachelor’s degrees in biology, one-half of bachelor’s degrees in chemistry, and nearly one-half in math. Women earned a much smaller proportion

![Figure 6. Bachelor’s Degrees Earned by Women in Selected Fields, 1966–2006](image)

Figure 7. Bachelor’s Degrees Earned in Selected Science and Engineering Fields, by Gender, 2007

of bachelor’s degrees awarded in physics, engineering, and computer science. In fact, as figure 6 shows, women’s representation in computer science is actually declining—a stark reminder that women’s progress cannot be taken for granted. In the mid-1980s women earned slightly more than one-third (36 percent) of the bachelor’s degrees in computer science; by 2006 that number had dropped to 20 percent.

The size of the STEM disciplines, and, therefore, the number of degrees awarded, varies dramatically. As figure 7 shows, women earned 48,001 biological science degrees in 2007, compared with only 7,944 computer science degrees, 2,109 electrical engineering degrees, and 1,024 physics degrees. In comparison, men earned 31,347 biological science degrees, 34,652 computer science degrees, 16,438 electrical engineering degrees, and 3,846 physics degrees.

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**Figure 8. Bachelor’s Degrees Earned by Underrepresented Racial-Ethnic Groups in Selected STEM Fields, by Gender, 2007**

Note: Racial-ethnic groups include U.S. citizens and permanent residents only. Data based on degree-granting institutions eligible to participate in Title IV federal financial aid programs.

Trends in bachelor’s degrees earned by women from underrepresented racial-ethnic groups (African American, Hispanic, and Native American/Alaskan Native) generally mirror the overall pattern; however, in some cases the gender gap in degrees earned by African American and Hispanic women and men is much smaller or even reversed (see figure 8). For example, African American women earned 57 percent of physical science degrees awarded to African Americans in 2007; still, the overall number of African American women earning physical science bachelor’s degrees was less than 600.

Women’s representation among doctoral degree recipients in STEM fields also has improved in the last 40 years (see figure 9). In 1966, women earned about one-eighth of the doctorates in the biological and agricultural sciences, 6 percent of the doctorates in chemistry and mathematics, and 3 percent or less of the doctorates in earth, atmospheric, and ocean sciences; physics; engineering; and computer science. Forty years later, in 2006, women earned almost one-half of the doctorates in the biological and agricultural sciences; around one-third of the doctorates in earth, atmospheric, and ocean sciences, chemistry, and math; and approximately one-fifth of the doctorates in computer science, engineering, and physics.

**Figure 9. Doctorates Earned by Women in Selected STEM Fields, 1966–2006**

Why So Few?

In general the number of doctoral degrees in STEM disciplines earned by women from underrepresented racial-ethnic backgrounds also increased during the past four decades but still remains a small proportion of the total. For example, in 2007, African American women earned 2.2 percent of the doctorates awarded in the biological sciences and less than 2 percent of those awarded in engineering, computer sciences, the physical sciences, and mathematics and statistics. The proportions were similar for Hispanic women and even smaller for Native American women (National Science Foundation, 2009b). Although women have clearly made great progress in earning doctorates in STEM fields, at the doctoral level women remain underrepresented in every STEM field except biology.

Title IX and Gender Equity in STEM

Title IX of the Education Amendments of 1972 prohibits sex discrimination in education programs and activities that receive federal financial assistance. The law states, “No person in the United States shall, on the basis of sex, be excluded from participation in, be denied the benefits of, or be subjected to discrimination under any educational program or activity receiving federal financial assistance” (20 U.S. Code § 1681). Title IX covers nearly all colleges and universities. To ensure compliance with the law, Title IX regulations require institutions that receive any form of federal education funding to evaluate their current policies and practices and adopt and publish grievance procedures and a policy against sex discrimination.

When Congress enacted Title IX, the law was intended to help women achieve equal access to all aspects of education at all levels. During the last 37 years, however, Title IX has been applied mostly to sports. Recent efforts by Congress have brought attention to how Title IX could be used to improve the climate for and representation of women in STEM fields.

Critics argue that women do not face discrimination in STEM fields but rather that women are less interested than men in certain STEM fields and that enforcement of Title IX could lead to a quota system in the sciences (Tierney, 2008; Munro, 2009). Title IX requires neither quotas nor proportionality, and it cannot address gender gaps in participation due to personal choices; however, Title IX reviews can help identify institutional policies and practices that negatively, and in some cases inadvertently, affect personal choices in gender-specific ways (Pieronek, 2005). Simply put, Title IX can help create a climate where women and men of similar talent who want to be scientists or engineers have equal opportunity to do so.

A report by the U.S. Government Accountability Office (2004) focused on Title IX in STEM disciplines and concluded that federal agencies need to do more to ensure that colleges and universities receiving federal funds comply with Title IX. In response to these findings, federal agencies, including NASA and the Department of Energy in conjunction with the Department of Education and the Department of Justice, have begun to conduct Title IX compliance reviews more regularly (Pieronek, 2009).
WOMEN IN THE STEM WORKFORCE

Consistent with the increased representation of women among STEM degree recipients, women’s representation in the STEM workforce has also improved significantly in recent decades; yet, as figure 10 shows, women are still underrepresented in many STEM professions.

In fields such as the biological sciences, women have had a sizeable presence as far back as 1960, when women made up about 27 percent of biologists. Forty years later, in 2000, women made up about 44 percent of the field. On the other end of the spectrum, women made up a mere 1 percent of engineers in 1960 and only about 11 percent of engineers by 2000 (see figure 11). This is an impressive increase, but women still make up only a small minority of working engineers. Overall, progress has been made, but women remain vastly outnumbered in many STEM fields, especially engineering and physics.

![Figure 10. Women in Selected STEM Occupations, 2008](image)

*Note:* Occupations are self-reported.
Among workers who hold doctorates, men represent a clear majority in all STEM fields. Figures 12a and 12b show that men far outnumber women, even in the biological sciences.

In the academic workforce, women’s representation varies by discipline as well as tenure status. Forty percent of the full-time faculty in degree-granting colleges and universities in the United States in 2005 were women; however, women’s representation in STEM disciplines was significantly lower. Women made up less than one-quarter of the faculty in computer and information sciences (22 percent), math (19 percent), the physical sciences (18 percent), and engineering (12 percent). In the life sciences, an area in which many people assume that women have achieved parity, women made up only one-third (34 percent) of the faculty. In all cases women were better represented in lower faculty ranks than in higher ranks among STEM faculty in four-year colleges and universities (Di Fabio et al., 2008).

The situation is even more severe for women from underrepresented racial-ethnic backgrounds. Of the more than 7,000 computer-science doctoral faculty in 2006, only 60 were
Figure 12a. Workers with Doctorates in the Computer and Information Sciences Workforce, by Gender and Employment Status, 2006

Note: The number of female unemployed workers was not available due to small sample size.
Source: National Science Foundation, Division of Science Resources Statistics, 2009, Characteristics of doctoral scientists and engineers in the United States: 2006 (Detailed Statistical Tables) (NSF 09-317) (Arlington, VA), Authors' analysis of Table 2.

Figure 12b. Workers with Doctorates in the Biological, Agricultural, and Environmental Life Science Workforce, by Gender and Employment Status, 2006

Note: The percentages do not equal 100 due to rounding.
Source: National Science Foundation, Division of Science Resources Statistics, 2009, Characteristics of doctoral scientists and engineers in the United States: 2006 (Detailed Statistical Tables) (NSF 09-317) (Arlington, VA), Authors' analysis of Table 2.
African American women; numbers for Hispanic and Native American women were too low to report. African American women also made up less than 1 percent of the 17,150 postsecondary teachers in engineering. Even in the biological sciences the number of African American and Hispanic female faculty was low. Of the nearly 25,000 postsecondary teachers in the biological sciences, 380 were African American women and 300 were Hispanic women (ibid.).

Women’s representation among tenured faculty is lower than one would expect based on the supply of female science and engineering doctoral degree recipients in recent decades (Kulis et al., 2002). The path from elementary school to a STEM career has often been compared to a pipeline. This metaphor suggests that as the number of girls who study STEM subjects in elementary, middle, and secondary school increases (more girls go into the pipeline), the number of women who become scientists and engineers will also increase (more women come out of the pipeline), and gender disparities in representation will disappear. This has not happened at the expected rate, especially at the tenured faculty level in science and engineering. If we compare the percentage of tenured female faculty in 2006 with the percentage of STEM doctorates awarded to women in 1996 (allowing 10 years for an individual to start an academic job and earn tenure), in most STEM fields the drop-off is pronounced. For example, women earned 12 percent of the doctorates in engineering in 1996 but were only 7 percent of the tenured faculty in engineering in 2006. Even in fields like biology, where women now receive about one-half of doctorates and received 42 percent in 1996, women made up less than one-quarter of tenured faculty and only 34 percent of tenure-track faculty in 2006 (National Science Foundation, 2008, 2009a). Women make up larger percentages of the lower-paying, nontenured STEM faculty positions (see figure 13).

Several studies have found a gender difference in hiring in STEM academic disciplines (Bentley & Adamson, 2003; Nelson & Rogers, n.d.; Ginther & Kahn, 2006). Although recent research found that when women do apply for STEM faculty positions at major research universities they are more likely than men to be hired, smaller percentages of qualified women apply for these positions in the first place (National Research Council, 2009). Improving women’s position among STEM faculty will apparently require more than simply increasing the pool of female STEM degree holders (Valian, 1998; Kulis et al., 2002).

Cathy Trower and her colleagues at the Collaborative on Academic Careers in Higher Education (COACHE) at Harvard University found that female STEM faculty express lower job satisfaction than do their male peers. Lower satisfaction leads to higher turnover and a loss of talent in science and engineering. Trower’s research, profiled in chapter 7, suggests that the climate of science and engineering departments is closely related to satisfaction of female faculty and that providing effective mentoring and work-life policies can help improve job satisfaction and, hence, the retention of female STEM faculty.
Women working in STEM fields tend to have higher earnings than do other women in the workforce, although a gender pay gap exists in STEM occupations as in other fields. For example, in 2009 the average starting salary for bachelor’s degree recipients in marketing was just over $42,000 a year, and bachelor’s degree recipients in accounting received starting salaries averaging around $48,500 a year. In comparison, starting salaries for bachelor’s degree holders in computer science averaged around $61,500, and average starting salaries were just under $66,000 for individuals holding bachelor’s degrees in chemical engineering (National Association of Colleges and Employers, 2009). As these numbers indicate, many STEM careers can provide women increased earning potential and greater economic security.

Recent studies of scientists, engineers, and technologists in business and the high-tech industry have found that women in these fields have higher attrition rates than do both their male peers and women in other occupations (Hewlett et al., 2008; Simard et al., 2008). The studies highlight midcareer as a critical time for these women. Hewlett et al. (2008) at the Center for Work-Life Policy at Harvard University found that female scientists, engineers, and technologists are fairly well represented at the lower rungs on corporate ladders.
(41 percent). More than half (52 percent), however, quit their jobs by midcareer (about 10 years into their careers). High-tech companies in particular lost 41 percent of their female employees, compared with only 17 percent of their male employees. In engineering, women have higher attrition rates than their male peers have, despite similar levels of stated satisfaction and education. The Society of Women Engineers (2006) conducted a retention study of more than 6,000 individuals who earned an engineering degree between 1985 and 2003. One-quarter of female engineers surveyed were either not employed at all or not employed in engineering or a related field, while only one-tenth of men surveyed had left the engineering field.

**WHY SO FEW?**

Academic research on this topic is prolific, with three themes emerging from the literature. First, the notion that men are mathematically superior and innately better suited to STEM fields than women are remains a common belief, with a large number of articles addressing cognitive gender differences as an explanation for the small numbers of women in STEM. A second theme revolves around girls' lack of interest in STEM. A third theme involves the STEM workplace, with issues ranging from work-life balance to bias. The remainder of this chapter summarizes and examines these themes and concludes with an introduction to the research projects profiled in chapters 2 through 9.

**Cognitive Sex Differences**

As noted earlier, a difference in average math performance between girls and boys no longer exists in the general school population (Hyde et al., 2008). Nevertheless, the issue of cognitive sex differences, including mathematical ability, remains hotly contested. Lynn and Irwing (2004) found small or no differences in average IQ between the sexes; that is, neither girls nor boys are the “smarter sex.” Other researchers have found, however, that girls and boys tend to have different cognitive strengths and weaknesses. Generally, boys perform better on tasks using spatial orientation and visualization and on certain quantitative tasks that

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2Some research suggests that women and men achieve similar IQ results using different parts of the brain (Haier et al., 2005).

**Methodology**

Using multiple databases, including Web of Science, ProQuest, Social Science Citation Index, and J-Stor, AAUW reviewed hundreds of academic articles written during the past 25 years on the topic of women in science and engineering. Articles from the fields of psychology, sociology, education, economics, neuroscience, and endocrinology were examined. The literature review informed this chapter, and it was used to help identify the eight research findings profiled in chapters 2 through 9. These projects were chosen because they each address an important issue with the potential to influence public understanding. The profiled findings are well respected in the research community, as measured by publication in peer-reviewed journals, number of citations, and other forms of public recognition. These projects were conducted within the past 15 years.
rely on those skills. Girls outperform boys on tests relying on verbal skills, especially writing, as well as some tests involving memory and perceptual speed (Hedges & Nowell, 1995; Kimura, 2002; Halpern, Aronson, et al., 2007).

One of the largest gender gaps in cognitive skills is seen in the area of spatial skills and specifically on measures of mental rotation, with boys consistently outscoring girls (Linn & Petersen, 1985; Voyer et al., 1995). Many people consider spatial skills to be important for success in fields like engineering, although the connection between spatial abilities and success in STEM careers is not definitive (Ceci et al., 2009). Whether or not well-developed spatial skills are necessary for success in science and engineering, research shows that spatial skills can be improved fairly easily with training (Baenninger & Newcombe, 1989; Vasta et al., 1996).

Among the most promising research findings in this field are those of Sheryl Sorby, whose work is profiled in chapter 5. Sorby and Baartmans (2000) and their colleagues designed and implemented a successful course to improve the spatial-visualization skills of first-year engineering students who had poorly developed spatial skills. More than three-quarters of female engineering students who took the course remained in the school of engineering, compared with about one-half of the female students who did not take the course. Poor or underdeveloped spatial skills may deter girls from pursuing math or science courses or careers, but these skills can be improved fairly easily.

**Biology is not destiny**

Ceci et al. (2009) reviewed more than 400 articles exploring the causes of women’s underrepresentation in STEM fields, including biological as well as social factors, and concluded that the research on sex differences in brain structure and hormones is inconclusive. Female and male brains are indeed physically distinct, but how these differences translate into specific cognitive strengths and weaknesses remains unclear. Likewise, evidence for cognitive sex differences based on hormonal exposure is mixed. Ceci et al. found that hormonal exposure, especially in gestation, does have a role in cognitive sex differences. Overall, however, the researchers concluded, “Evidence for a hormonal basis of the dearth of female scientists” is “weaker than the evidence for other factors,” such as gender differences in preferences and sociocultural influences on girls’ performance on gatekeeper tests (p. 224).

Differences in the representation of women in science and math fields cross-culturally and over time also support the role of sociocultural factors for explaining gender gaps in these fields (Andreescu et al., 2008). As discussed earlier, the ratio of boys to girls among children identified as mathematically precocious has decreased dramatically in the last 30 years, far faster than it would take a genetic change to travel through the population. Also, while in the vast majority of countries more boys than girls scored above the 99th percentile in mathema-
tics on the 2003 Program for International Student Assessment, in Iceland and Thailand more girls than boys scored above the 99th percentile (Guiso et al., 2008). Differences between countries and over time illustrate the importance of culture in the development of mathematical skills.

**Scientists and engineers are not necessarily the highest math achievers**

Boys outnumber girls at the very high end of the math test score distribution. Some researchers have suggested that this gender difference accounts for the small number of women in certain STEM fields. This logic has two main flaws. First, as mentioned above, girls have made rapid inroads into the ranks of children identified as “mathematically gifted” in the past 30 years, while women’s representation in mathematically demanding fields such as physics, computer science, and engineering has grown slowly. That is, fewer women pursue STEM careers than would be expected based on the number of girls who earn very high math scores. Second, Weinberger (2005) found that the science and engineering workforce is not populated primarily by the highest-scoring math students, male or female. Less than one-third of college-educated white men in the engineering, math, computer science, and physical science workforce scored higher than 650 on the SAT math exam, and more than one-third had SAT math scores below 550—the math score of the average humanities major. Even though a correlation exists between high school math test scores and later entry into STEM education and careers, very high math scores are not necessarily a prerequisite for success in STEM fields.

**“Just Not Interested”**

Many girls and women report that they are not interested in science and engineering. In a 2009 poll of young people ages 8–17 by the American Society for Quality, 24 percent of boys but only 5 percent of girls said they were interested in an engineering career. Another recent poll found that 74 percent of college-bound boys ages 13–17 said that computer science or computing would be a good college major for them compared with 32 percent of their female peers (WGBH Education Foundation & Association for Computing Machinery, 2009). From early adolescence, girls express less interest in math or science careers than boys do (Lapan et al., 2000; Turner et al., 2008). Even girls and women who excel in mathematics often do not pursue STEM fields. In studies of high mathematics achievers, for example, women are more likely to secure degrees in the humanities, life sciences, and social sciences than in math, computer science, engineering, or the physical sciences; the reverse is true for men (Lubinski & Benbow, 2006).

Interest in an occupation is influenced by many factors, including a belief that one can succeed in that occupation (Eccles [Parsons] et al., 1983; Correll, 2004; Eccles, 2006). The work of
Shelley Correll, profiled in chapter 4, shows that girls assess their mathematical ability lower than do boys with equivalent past mathematical achievement. At the same time, girls hold themselves to a higher standard in subjects like math, where boys are considered to excel. Because of this, girls are less likely to believe that they will succeed in a STEM field and, therefore, are less likely to express interest in a STEM career.

Pajares (2005) found that gender differences in self-confidence in STEM subjects begin in middle school and increase in high school and college, with girls reporting less confidence than boys do in their math and science ability. In part, boys develop greater confidence in STEM through experience developing relevant skills. A number of studies have shown that gender differences in self-confidence disappear when variables such as previous achievement or opportunity to learn are controlled (Lent et al., 1986; Zimmerman & Martinez-Pons, 1990; Cooper & Robinson, 1991; Pajares, 1996, 2005). Students who lack confidence in their math or science skills are less likely to engage in tasks that require those skills and will more quickly give up in the face of difficulty. Girls and women may be especially vulnerable to losing confidence in STEM areas. The research of Carol Dweck, profiled in chapter 2, has implications for improving self-confidence. Dweck's research shows that when a girl believes that she can become smarter and learn what she needs to know in STEM subjects—as opposed to believing that a person is either born with science and math ability or not—she is more likely to succeed in a STEM field.

A belief that one can succeed in a STEM field is important but is not the only factor in establishing interest in a STEM career. Culturally prescribed gender roles also influence occupational interest (Low et al., 2005). A review of child vocational development by Hartung et al. (2005) found that children—and girls especially—develop beliefs that they cannot pursue particular occupations because they perceive them as inappropriate for their gender.

Jacquelynne Eccles, a leading researcher in the field of occupational choice, has spent the past 30 years developing a model and collecting evidence about career choice. Her work suggests that occupational choice is influenced by a person’s values as well as expectancy for success (Eccles [Parsons] et al., 1983; Eccles, 1994, 2006). Well-documented gender differences exist in the value that women and men place on doing work that contributes to society, with women more likely than men to prefer work with a clear social purpose (Jozeefowicz et al., 1993; Konrad et al., 2000; Margolis et al., 2002; Lubinski & Benbow, 2006; Eccles, 2006). The source of this gender difference is a subject of debate: Some claim that the difference is innate, while others claim that it is a result of gender socialization. Regardless of the origin of the difference, most people do not view STEM occupations as directly benefiting society or individuals (National Academy of Engineering, 2008; Diekman et al., 2009). As a result, STEM careers often do not appeal to women (or men) who value making a social contribution.
Certain STEM subdisciplines with a clearer social purpose, such as biomedical engineering and environmental engineering, have succeeded in attracting higher percentages of women than have other subdisciplines like mechanical or electrical engineering (Gibbons, 2009).

Despite girls’ lower stated interest in science and engineering compared with boys, recent research suggests that there are ways to increase girls’ interest in STEM areas (Turner & Lapan, 2005; Eisenhart, 2008; Plant et al., 2009). Plant et al. (2009) reported an increase in middle school girls’ interest in engineering after the girls were exposed to a 20-minute narrative delivered by a computer-generated female agent describing the lives of female engineers and the benefits of engineering careers. The narrative included positive statements about students’ abilities to meet the demands of engineering careers and counteracted stereotypes of engineering as an antisocial, unusual career for women while emphasizing the people-oriented and socially beneficial aspects of engineering. Another ongoing study and outreach project is focusing on educating high-achieving, mostly minority, high school girls about what scientists and engineers actually do and how they contribute to society. Although the girls knew almost nothing about engineering at the start of the study, of the 66 percent of girls still participating after two years, 80 percent were seriously considering a career in engineering (Eisenhart, 2008). The Engineer Your Life website (www.engineeryourlife.com), a project of the WGBH Educational Foundation and the National Academy of Engineering, has also been shown to increase high school girls’ interest in pursuing engineering as a career. In a survey by Paulsen and Bransfield (2009), 88 percent of 631 girls said that the website made them more interested in engineering as a career, and 76 percent said that it inspired them to take an engineering course in college. Although these studies generally relied on small samples and in a number of cases no long-term follow-up has been done with participants, the results are promising.

Research on interest in science and engineering does not usually consider gender, race, and ethnicity simultaneously. Of course, gender and race do interact to create different cultural roles and expectations for women (and men) from different racial-ethnic backgrounds. Assumptions about the mismatch between women’s interests and STEM often are based on the experiences of white women. In the African American community, for example, many of the characteristics that are considered appropriate for African American women, such as high self-esteem, independence, and assertiveness, can lead to success in STEM fields (Hanson, 2004). Young African American women express more interest in STEM fields than do young white women (Hanson, 2004; Fouad & Walker, 2005). The number of African American women in STEM remains low, however, suggesting that other barriers are important for this community (ibid.).
Workplace Environment, Bias, and Family Responsibilities

As mentioned above, women leave STEM fields at a higher rate than do their male peers (Society of Women Engineers, 2006; Hewlett et al., 2008; Frehill et al., 2009). Workplace environment, bias, and family responsibilities all play a role.

Workplace environment

In the study of STEM professionals in the private sector described earlier, Hewlett et al. (2008) found that many women appear to encounter a series of challenges at midcareer that contribute to their leaving careers in STEM industries. Women cited feelings of isolation, an unsupportive work environment, extreme work schedules, and unclear rules about advancement and success as major factors in their decision to leave. Although women and men in industry and business leave STEM careers at significantly different rates, the situation in academia is somewhat more nuanced. In a recent study on attrition among STEM faculty, Xu (2008) showed that female and male faculty leave at similar rates; however, women are more likely than men to consider changing jobs within academia. Women’s higher turnover intention in academia (which is the best predictor of actual turnover) is mainly due to dissatisfaction with departmental culture, advancement opportunities, faculty leadership, and research support. Goulden et al. (2009) compared men and women in the sciences who are married with children and found that the women were 35 percent less likely to enter a tenure-track position after receiving a doctorate.

Bias

Women in STEM fields can experience bias that negatively influences their progress and participation. Although instances of explicit bias may be decreasing, implicit bias continues to have an adverse effect. Implicit biases may reflect, be stronger than, or in some cases contradict explicitly held beliefs or values. Therefore, even individuals who espouse a belief of gender equity and equality may harbor implicit biases about gender and, hence, negative gender stereotypes about women and girls in science and math (Valian, 1998). Nosek et al. (2002a) found that majorities of both women and men of all racial-ethnic groups hold a strong implicit association of male with science and female with liberal arts. This research is profiled in chapter 8.

Research has also pointed to bias in peer review (Wenneras & Wold, 1997) and hiring (Steinpreis et al., 1999; Trix & Psenka, 2003). For example, Wenneras and Wold found that a female postdoctoral applicant had to be significantly more productive than a male applicant to receive the same peer review score. This meant that she either had to publish at least three more papers in a prestigious science journal or an additional 20 papers in lesser-known specialty journals to be judged as productive as a male applicant. The authors concluded that the
systematic underrating of female applicants could help explain the lower success rate of female scientists in achieving high academic rank compared with their male counterparts.

Trix and Psenka (2003) found systematic differences in letters of recommendation for academic faculty positions for female and male applicants. The researchers concluded that recommenders (the majority of whom were men) rely on accepted gender schema in which, for example, women are not expected to have significant accomplishments in a field like academic medicine. Letters written for women are more likely to refer to their compassion, teaching, and effort as opposed to their achievements, research, and ability, which are the characteristics highlighted for male applicants. While nothing is wrong with being compassionate, trying hard, and being a good teacher, arguably these traits are less valued than achievements, research, and ability for success in academic medicine. The authors concluded, “Recommenders unknowingly used selective categorization and perception, also known as stereotyping, in choosing what features to include in their profiles of the female applicants” (p. 215).

Research profiled in chapter 9 shows that when women are acknowledged as successful in arenas that are considered male in character, women are less well liked and more personally derogated than are equivalently successful men. Being disliked can affect career outcomes, leading to lower evaluations and less access to organizational rewards. These results suggest that gender stereotypes can prompt bias in evaluative judgments of women in male-dominated environments, even when these women have proved themselves to be successful and demonstrated their competence (Heilman et al., 2004).

Biases do change. Today the fields viewed as stereotypically male have narrowed considerably compared with even 30 years ago. Life and health sciences are seen as more appropriate for women, while the physical or hard sciences and engineering fields are still considered masculine domains (Farenga & Joyce, 1999).

Family responsibilities

Many people think that women leave STEM academic careers because they cannot balance work and family responsibilities (Mason et al., 2009; Xie & Shauman, 2003); however, research evidence by Xu (2008) points to a more nuanced relationship between family responsibilities and academic STEM careers. Research shows that being single is a good predictor that a woman will be hired for a tenure-track job and promoted. Research also shows, however, that marriage is a good predictor for both women and men of being hired as an assistant professor (Xie & Shauman, 2003; Ginther & Kahn, 2006). Married women in STEM appear to have a disadvantage compared with married men in relation to tenure and promotion decisions only if the married women have children (Xie & Shauman, 2003).
So while marriage does not appear to hurt women, having young children does affect their chances for advancement. Having young children in the home may affect women's productivity since child-care responsibilities fall disproportionately on women (Stack, 2004).

Some telling statistics point to the difficulties that mothers still face in an academic environment. Mason and Goulden (2002) found that among tenured faculty in the sciences 12 to 14 years after earning a doctorate, 70 percent of the men but only 50 percent of the women had children living in their home. The same study found that among science professors who had babies within the first five years after receiving a doctorate, 77 percent of the men but only 53 percent of the women had achieved tenure 12 to 14 years after earning a doctorate. These disparities were not unique to, and not always worse in, STEM fields. In another Mason and Goulden study (2004), more than twice as many female academics (38 percent) as male academics (18 percent) indicated that they had fewer children than they had wanted.

In business and industry both women and men identify family responsibilities as a possible barrier to advancement, but women are affected differently than men by this “family penalty” (Simard et al., 2008, p. 5). Although both women and men feel that having a family hinders their success at work, women are more likely than men to report foregoing marriage or children and delaying having children. Among women and men with families, women are more likely to report that they are the primary caregiver and have a partner who also works full time. A recent retention study found that most women and men who left engineering said that interest in another career was a reason, but women were far more likely than men to also cite time and family-related issues (Society of Women Engineers, 2006; Frehill et al., 2008). Additionally, women in STEM are more likely to have a partner who is also in STEM and faces a similarly demanding work schedule. In a situation where a “two body problem” exists, the man’s career is often given priority (Hewlett et al., 2008).

**WHERE DO WE GO FROM HERE?**

Multiple factors contribute to the underrepresentation of women and girls in STEM and, therefore, multiple solutions are needed to correct the imbalance. The remainder of this report profiles eight research findings, each of which offers practical ideas for helping girls and women reach their potential in science, technology, engineering, and mathematics. Selected for their relevance to public debate and their scientific credibility, these case studies provide important insights into the question of why so few women study and work in many STEM fields.
These findings provide evidence on the nurture side of the nature-nurture debate, demonstrating that social and environmental factors clearly contribute to the underrepresentation of women in science and engineering. The findings are organized into three areas: social and environmental factors that shape girls’ achievements and interest in math and science; the college environment; and the continuing importance of bias, often operating at an unconscious level, as an obstacle to women’s success in STEM fields.

**Girls’ Achievements and Interest in Math and Science Are Shaped by the Environment around Them**

This report profiles four research projects that demonstrate the effects of societal beliefs and the learning environment on girls’ achievements and interest in science and math. Chapter 2 profiles research showing that when teachers and parents tell girls that their intelligence can expand with experience and learning, girls do better on math tests and are more likely to want to continue to study math.

Chapter 3 examines research showing that negative stereotypes about girls’ abilities in math are still relevant today and can lower girls’ test performance and aspirations for science and engineering careers. When test administrators tell students that girls and boys are equally capable in math, the difference in performance disappears, illustrating the importance of the learning environment for encouraging girls’ achievement and interest in math.

Chapter 4 profiles research on self-assessment, or how we view our own abilities. This research finds that girls assess their mathematical abilities lower than do boys with similar past mathematical achievements. At the same time, girls hold themselves to a higher standard than boys do in subjects like math, believing that they have to be exceptional to succeed in “male” fields. One result of girls’ lower self-assessment of their math ability—even in the face of good grades and test scores—and their higher standard for performance is that fewer girls than boys aspire to STEM careers.

One of the most consistent, and largest, gender differences in cognitive abilities is found in the area of spatial skills, with boys and men consistently outperforming girls and women. Chapter 5 highlights research documenting that individuals’ spatial skills consistently improve dramatically in a short time with a simple training course. If girls are in an environment that enhances their success in science and math with spatial skills training, they are more likely to develop their skills as well as their confidence and consider a future in a STEM field.
At Colleges and Universities, Little Changes Can Make a Big Difference in Attracting and Retaining Women in STEM

As described earlier, many girls graduate from high school well prepared to pursue a STEM career, but few of them major in science or engineering in college. Research profiled in chapter 6 demonstrates how small improvements in the culture of computer science and physics departments, such as changing admissions requirements, presenting a broader overview of the field in introductory courses, and providing a student lounge, can add up to big gains in female student recruitment and retention.

Likewise, colleges and universities can attract more female science and engineering faculty if they improve the integration of female faculty into the departmental culture. Research profiled in chapter 7 provides evidence that women are less satisfied with the academic workplace and more likely to leave it earlier in their careers than their male counterparts are. College and university administrators can recruit and retain more women by implementing mentoring programs and effective work-life policies for all faculty members.

Bias, Often Unconscious, Limits Women’s Progress in Scientific and Engineering Fields

Research profiled in chapter 8 shows that most people continue to associate science and math fields with “male” and humanities and arts fields with “female,” including individuals who actively reject these stereotypes. Implicit bias may influence girls’ likelihood of identifying with and participating in math and science and also contributes to bias in education and the workplace—even among people who support gender equity. Taking the implicit bias test at https://implicit.harvard.edu can help people identify and understand their own implicit biases so that they can work to compensate for them.

Research profiled in chapter 9 shows that people not only associate math and science with “male” but also often hold negative opinions of women in “masculine” positions, like scientists or engineers. This research shows that people judge women to be less competent than men in “male” jobs unless women are clearly successful in their work. When a woman is clearly competent in a “masculine” job, she is considered to be less likable. Because both likability and competence are needed for success in the workplace, women in STEM fields can find themselves in a double bind.

Women have made impressive gains in science and engineering but are still a distinct minority in many science and engineering fields. The following eight research findings, taken together, suggest that creating environments that support girls’ and women’s achievements and interest in science and engineering will encourage more girls and women to pursue careers in these vital fields.
Chapter 2.
Beliefs about Intelligence
So often, when something comes quickly to a student, we say, “Oh, you’re really good at this.” The message there is, “I think you’re smart when you do something that doesn’t require any effort or you haven’t challenged yourself.” Someone said to me recently, “In your culture, struggle is a bad word,” and I thought ... “That’s right.” We talk about it as an unfortunate thing, but when you think about a career in science or math or anything, of course you struggle. That’s the name of the game! If you’re going to discover something new or invent something new, it’s a struggle. So I encourage educators to celebrate that, to say: “Who had a fantastic struggle? Tell me about your struggle!”

—Carol Dweck

Carol Dweck is a social and developmental psychologist at Stanford University. For 40 years she has studied the foundations of motivation. In an interview with AAUW, Dweck described how she first became interested in this topic:

Since graduate school, I've been interested in how students cope with difficulty. Over the years it led me to understand that there were these whole frameworks that students brought to their achievement—that in one case made difficulty a terrible indictment but in the other case made difficulty a more exciting challenge. In one of my very first studies where I was giving failure problems, this little boy rubbed his hands together, smacked his lips, and said, “I love a challenge.” And I thought, “Where is this kid from? Is he from another planet?” Either you cope with failure or you don't cope with failure, but to love it? That was something that was beyond my understanding, and I thought, “I'm going to figure out what this kid knows, and I'm going to bottle it.” Over time I came to understand a framework in which you could relish something that someone else was considering a failure.

Dweck’s research provides evidence that a “growth mindset” (viewing intelligence as a changeable, malleable attribute that can be developed through effort) as opposed to a “fixed mindset” (viewing intelligence as an inborn, uncontrollable trait) is likely to lead to greater persistence in the face of adversity and ultimately success in any realm (Dweck & Leggett, 1988; Blackwell et al., 2007; Dweck, 2006, 2008).

According to Dweck’s research findings, individuals with a fixed mindset are susceptible to a loss of confidence when they encounter challenges, because they believe that if they are truly “smart,” things will come easily to them. If they have to work hard at something, they tend to

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1Carol S. Dweck is the Lewis and Virginia Eaton Professor of Psychology at Stanford University and a leading researcher in the field of student motivation. Her research focuses on theories of intelligence and highlights the critical role of mindsets in students’ achievement. She has held professorships at Columbia and Harvard Universities. Her recent book, *Mindset* (Random House, 2006), has been widely acclaimed and is being translated into 17 languages.
question their abilities and lose confidence, and they are likely to give up because they believe they are “not good” at the task and, because their intelligence is fixed, will never be good at it. Individuals with a growth mindset, on the other hand, show a far greater belief in the power of effort, and in the face of difficulty, their confidence actually grows because they believe they are learning and getting smarter as a result of challenging themselves (see figure 14). Dweck and her colleagues found that students—in both middle school and college—are about equally divided between the two mindsets.

The significance of an individual’s mindset often does not emerge until she or he faces challenges. In a supportive environment such as elementary school, students with a belief in fixed intelligence may do just fine; however, upon encountering the challenges of middle school, differences are likely to emerge between students with a fixed mindset about intelligence and those who believe that intelligence can increase with effort.

Because of this, and because math skills are particularly likely to be viewed as fixed (Williams & King, 1980), Dweck and her colleagues chose to test their theory by assessing the mindset of students entering junior high school and then tracking the students’ math grades for two years. The study included 373 moderately high-achieving seventh graders in four successive entering classes of 67 to 114 students in a New York City public school. One math teacher taught each grade, and the school had no mathematics tracking. The researchers assessed whether each student held a fixed mindset or a growth mindset at the beginning of the study by asking the students to rank their agreement with a number of statements, such as, “You have a certain amount of intelligence, and you really can’t do much to change it” and “You can learn new things, but you can’t really change your basic intelligence.” Nearly two years later, students who endorsed a strong growth mindset were outperforming those who held a fixed mindset, controlling for prior achievement. The researchers concluded that a student’s motivational framework rather than her or his initial achievement determined whether students’ math grades would improve.

In light of this finding the researchers conducted a second study to see if an intervention to teach seventh graders that intelligence is malleable would have any effect on their motivation in the classroom or on their grades. This study included 91 relatively low-achieving seventh graders from a different New York City public school. The students were split into two groups for a 25-minute period once each week for eight weeks. During this time, one-half of the students were taught that intelligence is malleable, and one-half were taught study skills. The students in the intervention group were taught that learning changes the brain and they should think of the brain as a muscle that becomes stronger, developing new connections and strengthening existing ones as someone learns. As a result, the person becomes smarter. The lessons also stressed that mistakes made in the course of learning are necessary and help
Figure 14. A Fixed versus a Growth Mindset

Fixed Mind-set  
Intelligence is static

Growth Mind-set  
Intelligence can be developed

Challenges
- Avoid challenges  
- Lead to a desire to look smart and therefore a tendency to...

Obstacles
- Give up easily  
- Persist in the face of setbacks

Effort
- See effort as fruitless or worse
- See effort as the path to mastery

Criticism
- Ignore useful negative feedback  
- Learn from criticism

Success of Others
- Feel threatened by the success of others
- Find lessons and inspiration in the success of others

As a result, they may plateau early and achieve less than their full potential.  
All this confirms a deterministic view of the world.

As a result, they reach ever-higher levels of achievement.  
All this gives them a greater sense of free will.

Source: Used with permission of Carol S. Dweck.
students learn. The lessons concluded with the message that students are in charge of this process and that being smart is a choice.

The results of this intervention were remarkable. While grades for all students in the experiment were declining on average before the intervention (between spring of sixth grade and fall of seventh grade), as is common in the transition to junior high school, for those students who were taught that intelligence is malleable, the decline in grades was reversed and their average math grades improved within a few months of the intervention. In contrast, the students in the control group continued to experience a decline in grades. This study provides evidence that the learning environment can influence an individual's mindset (fixed or growth).

Dweck's research is particularly relevant to women in STEM, because she and her colleagues have found that for both middle school and college students, a growth mindset protects girls and women from the influence of the stereotype that girls are not as good as boys at math (Good et al., 2003, 2009). If a girl with a fixed mindset encounters a challenging task or experiences a setback in math, she is more likely to believe the stereotype that girls are not as good as boys in math. On the other hand, if a girl believes that doing math is a skill that can be improved with practice, she thinks, in the words of Dweck, “OK, maybe girls haven't done well historically, maybe we weren't encouraged, maybe we didn't believe in ourselves, but these are acquirable skills.” In the face of difficulty, girls with a growth mindset are more likely than girls with a fixed mindset to maintain their confidence and not succumb to stereotypes. A growth mindset, therefore, can be particularly useful to girls in STEM areas because it frees them of the ideas that their individual mathematical ability is fixed and that their ability is lower than that of boys by virtue of their gender. Interestingly, in cultures that produce a large number of math and science graduates, especially women, including South and East Asian cultures, the basis of success is generally attributed less to inherent ability and more to effort (Stevenson & Stigler, 1992).

**A GROWTH MINDSET PROMOTES ACHIEVEMENT IN STEM**

Dweck and others have also found gender gaps favoring boys in math and science performance among junior high and college students with fixed mindsets, while finding no gender gaps among their peers who have a growth mindset (Good et al., 2003; Grant & Dweck, 2003; Dweck, 2006). Dweck and her colleagues conducted a study in 2005 in which one group of adolescents was taught that great math thinkers had a lot of innate ability and natural talent (a fixed-mindset message), while another group was taught that great math thinkers were profoundly interested in and committed to math and worked hard to make their contributions (a growth-mindset message). On a subsequent challenging math test that the
students were told gauged their mathematical ability, the girls who had received the fixed-mindset message, especially when the stereotype of women underperforming in math was brought to their attention, did significantly worse than their male counterparts; however, no gender difference occurred among the students who had received the growth-mindset message, even when the stereotype about girls was mentioned before the test (Good et al., 2009). This research clearly demonstrates that a growth mindset can help girls achieve in math. Dweck explains: “Students are getting this message that things come easily to people who are geniuses, and only if you're a genius do you make these great discoveries. But more and more research is showing that people who made great contributions struggled. And maybe they enjoyed the struggle, but they struggled. The more we can help kids enjoy that effort rather than feel that it’s undermining, the better off they’ll be.”

A GROWTH MINDSET PROMOTES PERSISTENCE IN STEM

Achievement is one thing, but as we’ve seen, girls and women are achieving at the same levels as boys and men in math and science by many measures yet are not persisting to the same degree in many STEM fields. Ongoing research by Dweck and her colleagues has shown that a growth mindset promotes not only higher achievement but increased persistence in STEM fields as well. Good, Rattan, and Dweck (2009) followed several hundred women at an elite university through a semester of a calculus class. Women who reported that their classrooms communicated a fixed mindset and that negative stereotypes were widespread showed an eroding sense that they belonged in math during the semester, and they were less likely to express a desire to take math in the future. Women who said that their classrooms promoted a growth mindset were less susceptible to the negative effects of stereotypes, and they were more likely to intend to continue to take math in the future. At the beginning of the semester, no difference was seen in interest, excitement, sense of belonging, or intention to continue in math, but by the end of the study, girls who were continually exposed to the fixed-mindset message along with the stereotype that girls don’t do well in math lost interest. Dweck and her colleagues are finding similar results in a current study on girls in middle school. Dweck told AAUW, “In all of our research, we’ve seen that in a fixed mindset, if you are hit with negative messages, you are much more likely to succumb and lose interest.” A growth mindset can help maintain a spark of interest.

But how much difference can a growth mindset make? Aren’t some people just born with more ability than others? While Dweck does not deny that there can be “talent differences” among students, she reminds us of the difficulty of measuring individual potential: “I don’t
know how much of talent—even among prodigies—comes from the fact that a person is born with an ability versus the fact that he or she is fascinated with something and passionate about it and does it all the time. I’m not saying anyone can do anything, but I am saying that we don’t know where talent comes from, and we don’t know who’s capable of what.”

**MINDSET MATTERS**

Dweck’s research findings are important for women in STEM, because encountering obstacles and challenging problems is the nature of scientific work. In addition, girls have to cope with the stereotype that they are not as capable as boys in math and science. When girls and women believe they have a fixed amount of intelligence, they are more likely to believe the stereotype, lose confidence, and disengage from STEM as a potential career when they encounter difficulties in their course work. The messages we send girls about the nature of intelligence matter. Eradicating stereotypes is a worthwhile but long-term goal. In the meantime, communicating a growth mindset is a step that educators, parents, and anyone who has contact with girls can take to reduce the effect of stereotypes and increase girls’ and women’s representation in STEM areas. The more girls and women believe that they can learn what they need to be successful in STEM fields (as opposed to being “gifted”), the more likely they are to actually be successful in STEM fields. Dweck’s work demonstrates that girls benefit greatly from shifting their view of mathematics ability from “gift” to “learned skill.”

**RECOMMENDATIONS**

- **Teach children that intellectual skills can be acquired.**
  
  Teach students that the brain is like a muscle that gets stronger and works better the more it is exercised. Teach students that every time they stretch themselves, work hard, and learn something new, their brain forms new connections, and over time they become smarter. Passion, dedication, and self-improvement—not simply innate talent—are the roads to genius and contribution.

- **Praise children for effort.**
  
  Praise children for the process they use to arrive at conclusions. It is especially important to give process feedback to the most able students who have often coasted along, gotten good grades, and been praised for their intelligence. These may be the very students who opt out when the work becomes more difficult.
• **Talented and gifted programs should send the message that they value growth and learning.**

The danger of the “gifted” label is that it conveys the idea that a student has been bestowed with a “gift” of great ability rather than a dynamic attribute that she or he can develop. Talented and gifted programs should send the message that students are in these programs because they are advanced in certain areas and that the purpose of the programs is to challenge students in ways that will help them further develop and bring their abilities to fruition. Consider changing the name of talented and gifted programs to “challenge” programs or “advanced” programs to emphasize more of a growth mindset and less of a fixed mindset.

• **Highlight the struggle.**

Parents and teachers can portray challenges, effort, and mistakes as highly valued. Students with a fixed mindset are threatened by challenges, effort, and mistakes, so they may shy away from challenges, limit their effort, and try to avoid or hide mistakes. Communicate to these students that we value and admire effort, hard work, and learning from mistakes. Teach children the values that are at the heart of scientific and mathematical contributions: love of challenge, love of hard work, and the ability to embrace and learn from our inevitable mistakes. In Dweck’s words, “The message needs to be that we value taking on challenges and learning and growth. Educators should highlight the struggle.”
Chapter 3.
Stereotypes
Girls do every bit as well in their graded work [as] boys [do], but girls lose confidence as they advance through the grades and will start to do more poorly than boys on the timed tests, despite getting good grades. One reason for this loss of confidence is the stereotyping that kids are exposed to—in school and the media and even in the home—that portrays boys as more innately gifted [in math]. Without denying the fact that boys may have some biological advantage, I think that psychology plays a big role here.

—Joshua Aronson

Negative stereotypes about girls’ and women’s abilities in mathematics and science persist despite girls’ and women’s considerable gains in participation and performance in these areas during the last few decades. Two stereotypes are prevalent: girls are not as good as boys in math, and scientific work is better suited to boys and men. As early as elementary school, children are aware of these stereotypes and can express stereotypical beliefs about which science courses are suitable for females and males (Farenga & Joyce, 1999; Ambady et al., 2001). Research profiled in chapter 8 verifies the prevalence of these stereotypes among adults as well (Nosek et al., 2002b). Furthermore, girls and young women have been found to be aware of, and negatively affected by, the stereotypical image of a scientist as a man (Buck et al., 2008). Although largely unspoken, negative stereotypes about women and girls in STEM are very much alive.

A large body of experimental research has found that negative stereotypes affect women’s and girls’ performance and aspirations in math and science through a phenomenon called “stereotype threat.” Even female students who strongly identify with math—who think that they are good at math and being good in math is important to them—are susceptible to its effects (Nguyen & Ryan, 2008). Stereotype threat may help explain the discrepancy between female students’ higher grades in math and science and their lower performance on high-stakes tests in these subjects, such as the SAT-math (SAT-M) and AP calculus exam. Additionally, stereotype threat may also help explain why fewer girls than boys express interest in and aspirations for careers in mathematically demanding fields. Girls may attempt to reduce the likelihood that they will be judged through the lens of negative stereotypes by saying they are not interested and by avoiding these fields.

Joshua Aronson is an associate professor of developmental, social, and educational psychology at New York University. His research focuses on the social and psychological influences on academic achievement, and he is internationally known for his research on stereotype threat and minority student achievement. He was the founding director of the Center for Research on Culture, Development, and Education at New York University. His forthcoming book is titled The Nurture of Intelligence.
This chapter profiles the research on stereotype threat and women in science and math, highlighting the work of social psychologist Joshua Aronson. In the mid-1990s Aronson and his colleagues Claude Steele and Steven Spencer first identified and described the phenomenon of stereotype threat, the threat of being viewed through the lens of a negative stereotype or the fear of doing something that would confirm that stereotype (Steele & Aronson, 1995). Stereotype threat arises in situations where a negative stereotype is relevant to evaluating performance. For example, a female student taking a math test would experience an extra cognitive and emotional burden of worry related to the stereotype that women are not good at math. A reference to this stereotype, however subtle, could adversely affect her test performance. When the burden is removed, however, her performance would improve.

This phenomenon was first identified in experiments examining factors that could explain differences in academic performance among African American and white college students. Aronson and his colleagues observed that existing research did not fully explain the gaps in academic performance between these groups. In addition to considering factors such as home and family variables, school-related variables, and peer influences, Aronson and his colleagues believed that psychological factors at the student level needed to be considered. Their theory focused on the psychological predicament rooted in stereotypical images of certain groups as intellectually inferior. They referred to this phenomenon as stereotype threat and offered it as an important factor—albeit not the sole factor—producing group differences in test performance and academic motivation.

Stereotype threat can be felt as both psychological and physiological responses that result in impaired performance. For example, Blascovich et al. (2001) found that African Americans taking an intelligence test under stereotype threat had higher blood pressure levels than whites did. No difference in blood pressure levels of African Americans and whites occurred in the nontreat situation. Steele and Aronson (1995) found that stereotyped individuals often made more of an effort (attempted the same number of items if not more) than nonthreatened participants did but reread items more often and worked slower with less accuracy.

In one of the earliest experiments looking specifically at women, Spencer et al. (1999) recruited 30 female and 24 male first-year University of Michigan psychology students with strong math backgrounds and similar math abilities as measured by grades and test scores. All students strongly identified with math. The students were divided into two groups, and the researchers administered a math test on computers using items from the math section of the Graduate Record Exam. One group was told that men performed better than women on the test (the threat condition), and the other group was told that there were no gender differences in test performance (the nontreat condition). Spencer et al. believed that if stereotype threat could explain gender differences in performance, then presenting the test as
free of gender bias would remove the stereotype threat, and women would perform as well as men. If, however, gender differences in performance were due to sex-linked ability differences in math, women would perform worse than men even when the stereotype threat had been lifted. They found that women performed significantly worse than men in the threat situation and that the gender difference almost disappeared in the nonthreat condition (see figure 15).

In the ensuing decade more than 300 studies have been published that support this finding. The results of these experiments show that stereotype threat is often the default situation in testing environments. The threat can be easily induced by asking students to indicate their gender before a test or simply having a larger ratio of men to women in a testing situation (Inzlicht & Ben-Zeev, 2000). Research consistently finds that stereotype threat adversely affects women's math performance to a modest degree (Nguyen & Ryan, 2008) and may account for as much as 20 points on the math portion of the SAT (Walton & Spencer, 2009). While 20 points on a test with a total possible score of 800 may seem small, in 2008 the
average male score on the SAT math exam was 30 points higher than the average female score, so eliminating stereotype threat could eliminate two-thirds of the gender gap on the SAT-M.

Aronson’s research also has shown that high-achieving and motivated women in the pipeline to STEM majors and careers are susceptible to stereotype threat. Aronson conducted a field experiment at a large public university in the southwest to investigate stereotype threat among students in a high-level calculus course that is a pipeline to future careers in science. The results showed no difference in performance between female and male STEM majors when they were told that a difficult math test was a diagnosis of their ability (threat condition); however, when the threat was removed by telling the students that women and men performed equally well on the test, the women performed significantly better than the men (Good et al., 2008).

Stereotype threat also has implications beyond test performance. In an interview with AAUW, Aronson suggested that one reason girls lose confidence as they advance in school stems from “the stereotyping that students are exposed to in school, the media, and even at home that portrays boys as more innately gifted and math as a gift rather than a developed skill. Without denying that biological factors may play a role in some math domains, psychology also plays a big role.” Additionally, a repeated or long-term threat can eventually undermine aspirations in the area of interest through a process called “disidentification.” Aronson describes disidentification as a defense to avoid the risk of being judged by a stereotype. Faced with a stereotype that girls are not good at math, for example, an individual might respond by claiming, “I don’t care about math; it’s not who I am.” In extreme cases, rather than repeatedly confronting a negative stereotype, girls and women might avoid the stereotype by avoiding math and science altogether.

Fortunately, Aronson and others have shown that stereotype threat can be alleviated by teaching students about it (Johns et al., 2005), reassuring students that tests are fair (Good et al., 2003), and exposing students to female role models in math and science (McIntyre et al., 2003, 2005). Another promising approach draws on the work of Carol Dweck, profiled in the previous chapter. Encouraging students to think of their math abilities as expandable can lift stereotype threat and have a significant positive effect on students’ grades and test scores (Aronson et al., 2002; Good et al., 2003). In the interview with AAUW, Aronson stressed that “exposing students to role models who can help students see their struggles as a normal part of the learning process rather than as a signal of low ability” can boost the test scores of both minority students and girls.
**RECOMMENDATIONS**

- **Encourage students to have a more flexible or growth mindset about intelligence.**

  Interventions designed to help students adopt a malleable mindset about intelligence and thus reduce their vulnerability to stereotype threat positively affect their academic performance.

- **Expose girls to successful female role models in math and science.**

  Exposing girls to successful female role models can help counter negative stereotypes because girls see that people like them can be successful and stereotype threat can be managed and overcome.

- **Teach students and teachers about stereotype threat.**

  Research with college students shows that acknowledging and explicitly teaching students about stereotype threat can result in better performance. Teachers and college faculty are best suited to do this and, therefore, need to be educated about stereotype threat.
Chapter 4.
Self-Assessment
Boys do not pursue mathematical activities at a higher rate than girls do because they are better at mathematics. They do so, at least partially, because they think they are better.

—Shelley Correll

Fewer girls than boys say they are interested in science or engineering careers (American Society for Quality, 2009; WGBH, 2009). The work of Shelley Correll, a sociologist at Stanford University, sheds light on how girls’ and women’s seemingly voluntary decisions to avoid STEM careers are influenced by the cultural belief that science and math are male domains. Correll’s research focuses on self-assessment and its consequences for interest in math and science. She found that among students with equivalent past achievement in math, boys assessed their mathematical ability higher than girls did. Controlling for actual ability, the higher students assessed their mathematical ability, the greater the odds were that they would enroll in a high school calculus course and choose a college major in science, math, or engineering. Correll found that boys were more likely than their equally accomplished female peers to enroll in calculus not because boys were better at math but because they believed that they were better at math. When mathematical self-assessment levels were controlled, the previous higher enrollment of boys in calculus disappeared and the gender gap in college major choice was reduced (Correll, 2001). In a follow-up study Correll (2004) verified in a laboratory experiment that when cultural beliefs about male superiority exist in any area, even a fictitious one, girls assess their abilities in that area lower, judge themselves by a higher standard, and express less of a desire to pursue a career in that area than boys do.

Undoubtedly, many factors influence an individual’s career choice, but at a minimum, individuals must believe they have the ability to succeed in a given career to develop preferences for that career. If girls do not believe they have the ability to become a scientist or engineer, they will choose to be something else. Correll’s research findings suggest that helping girls understand that girls and boys are equally capable in STEM areas will increase girls’ self-assessment of their math and science skills, which, in turn, will increase girls’ aspirations for careers in STEM fields.

Correll first became interested in the differences between boys’ and girls’ assessments of their science and math abilities when she taught high school chemistry for a few years before attending graduate school. She noticed that no matter how poorly the boys in her chemistry

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5Shelley Correll is an associate professor of sociology at Stanford University. Her research examines how cultural beliefs about gender influence educational and career paths. In addition to her work on self-assessment described in this chapter, her most recent project considers how stereotypical beliefs associated with motherhood influence the workplace evaluations, pay, and hiring of women who give evidence of being a mother.
classes did, they continued to think that they were very good at chemistry; however, no matter how well the girls performed, it was difficult for Correll to convince them that they actually had some scientific ability. Once in graduate school Correll focused on how gender stereotypes attached to different skills or tasks influence how girls and boys understand their abilities independent of test scores or grades and how these gender differences in self-assessments contribute to gender differences in career choice.

STEREOTYPES AND SELF-ASSESSMENTS

How do stereotypes affect self-assessments? Correll explains that we use stereotypes as “cognitive crutches” in situations in which we do not know how to judge our performance. Research shows that even individuals who do not personally endorse beliefs that men are better than women at math are likely to be aware that these beliefs exist in the culture and expect that others will treat them according to these beliefs. This expectation, or what we think “most people” believe, has been shown to influence judgments (Foschi, 1996; Steele, 1997; Lovaglia et al., 1998). If a girl believes that most people, especially those in her immediate environment, think boys are better than girls at math, that thought is going to affect her, even if she doesn’t believe it herself. Even if no one really believes that boys are better at math, the fact that a girl thinks they believe it is what matters. This is the reason that the 2005 comments of Larry Summers—the former Harvard president who famously doubted that women are capable of succeeding at the highest levels of science and engineering—were so damaging. Because he spoke from such a powerful position, his remarks gave credibility to the stereotype that women may lack the aptitude to succeed in STEM fields.

Correll published a study in 2001 that looked at the correlation between students’ math achievement and self-assessment of their math ability by gender and the influence that self-assessment has on persistence on a path to a STEM career. This study analyzed the National Educational Longitudinal Study of 1988 (NELS-88), a national dataset of more than 16,000 high school students. The first NELS-88 survey was conducted in 1988 when the students were in the eighth grade. A subsample of the original students was again surveyed in 1990, 1992, and 1994, when most were sophomores, seniors, and two years beyond high school, respectively.

Correll identified three items on the survey as indicators of mathematical self-assessment: “Mathematics is one of my best subjects,” “I have always done well in math,” and “I get good marks in math.” Students were asked to agree or disagree, on a six-point scale, with these statements during their sophomore year of high school. Student mathematical achievement was approximated through past math test scores and average math grades that students received in high school. Correll’s analysis showed that high school boys were more likely
than their female counterparts of equal past mathematical performance to believe that they were competent at mathematics. Interestingly, the effect was reversed when the students assessed their verbal ability: female students made significantly higher self-assessments of verbal ability, controlling for actual verbal performance. This suggests that stereotypes about gender influence students’ perceptions of their abilities in particular fields: boys do not assess their task competence higher than girls do in every area, just in the areas considered to be masculine domains.

Most important for understanding how gender differences in self-assessment influence women’s underrepresentation in science and engineering, Correll’s research found that higher mathematical self-assessment among students of equal abilities increased students’ odds of enrolling in high school calculus and choosing a quantitative college major. In her sample, she found that boys were 1.2 times more likely than their equally capable female counterparts to enroll in calculus. Correll found this difference to be due to differences in self-assessment. When girls and boys assessed themselves as equally mathematically competent, the gender difference disappeared, and girls and boys were equally likely to enroll in calculus. Likewise, 4 percent of female students compared with 12 percent of male students in Correll’s sample chose a college major in engineering, mathematics, or the physical sciences. Although controlling for mathematical self-assessment did not eliminate this gender difference in college major choice, it did reduce the difference. Together these findings suggest that cultural beliefs about the appropriateness of one career choice over another can influence self-assessment and partially account for the disproportionately high numbers of men in the quantitative professions, over and above measures of actual ability (Correll, 2001).

Interestingly, Correll found that young women who enrolled in high school calculus were about three times more likely than young women who did not take calculus to choose a quantitative major in college. In comparison, young men who enrolled in calculus were only about twice as likely as young men who did not take calculus to choose a quantitative major. Thus it appears that taking calculus in high school is a better predictor of selecting a quantitative college major for women than it is for men. Another interesting finding was that higher verbal self-assessments decreased the odds of enrolling in calculus and choosing a quantitative major, indicating that students use relative understandings of their competencies when making career-relevant decisions. Lubinski and Benbow (2006) showed that girls who do very well at math are more likely than their male peers to do very well at verbal tasks as well. In addition to societal expectations, relatively strong verbal abilities may encourage mathematically talented girls to consider future education and careers in the humanities or social sciences rather than science and engineering fields.