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submitted by:

American Association of University Women (AAUW)*

Access Necessary: AAUW's Perspective on Women in Science and Technology

AAUW is a charitable, U.S.-based nongovernmental membership organization with international reach. Dedicated to breaking through barriers for women and girls through advocacy, education, philanthropy, and research, AAUW has a nationwide network of more than 100,000 members and donors, 1,000 branches, and 500 college and university partners. As one of the oldest women's organizations in the world, AAUW has been a leading voice on the educational, social, economic, and political status of women and girls since 1881. For nearly a century, we have been one of the leading private funders of women's graduate education, providing more than \$3 million per year in fellowships and grants to U.S. and foreign women for study in U.S. universities. While our primary focus has been related to women in the United States, throughout AAUW's history, our programming has involved international issues, our philanthropy has included support of women from across the globe, and most of our research has addressed issues that have global applications in advancing the status of women.

AAUW is proud to participate in the United Nations' expert group meeting, "Gender, Science, and Technology," where so many come together in support of women and their families. We are grateful for this opportunity to learn from both experts and observers and to share our insights into this vital area that has so many implications for human rights, the worldwide economy, and the quality of life for billions of women and girls throughout the world. The potential to partner

* The views expressed in this paper are those of the author and do not necessarily represent those of the organization.

Economic and educational resources encumber women's access to technological and scientific fields in many parts of the world. Other obstacles are more subtle but no less important. Stereotype threat, gender bias, and other cultural beliefs can form obstacles for women and girls interested in pursuing a STEM field. This paper discusses these issues in depth in the section on AAUW's research.

Many countries struggle to remain competitive in STEM fields. In the United States, President Obama recently launched a national Educate to Innovate campaign to reignite students' interest in science, technology, engineering, and math as a way to keep the nation innovative, prosperous, and competitive:

[W]e're going to have an annual science fair at the White House with the winners of national competitions in science and technology. If you win the NCAA [basketball] championship, you come to the White House. Well, if you're a young person and you've produced the best experiment or design, the best hardware or software, you ought to be recognized for that achievement, too. Scientists and engineers ought to stand side by side with athletes and entertainers as role models, and here at the White House we're going to lead by example. We're going to show young people how cool science can be.

From the White House to the classroom, there is renewed interest in attracting the most talented students to STEM fields. AAUW is participating in these efforts, with special attention to the role of girls and women. But there is much to accomplish and little time to prepare for the projected job growth in these fields. The U.S. Bureau of Labor Statistics' occupational projections for 2018 show that 10 of the top 30 fastest-growing occupations will be in STEM fields and will require at least a bachelor's degree. Globalization of the workforce suggests that these trends are likely to spread across countries. To make necessary improvements and advances in science and technology, countries must tap into the immense talent pool of women currently underrepresented in these fields.

Across the world, leaders are becoming more aware of this underutilization of "woman power" and are sponsoring educational events to motivate youth to enter STEM fields. This October, AAUW joins more than 500 professional and educational organizations on the National Mall in Washington, D.C., for the country's first national science festival, celebrating scientific achievement and encouraging young people to get involved in STEM. Our participation in this event is just one example of the many ways AAUW continues to encourage youth, particularly girls, to pursue STEM education and careers. AAUW's research and policy recommendations in this area are discussed in the report "AAUW's Research on Women's Access to STEM Education and Careers" (AAUW, 2012). AAUW is also participating in the "AAUW Girls, Joining the STEM Revolution" campaign, which aims to increase girls' interest in STEM fields. AAUW's research and policy recommendations in this area are discussed in the report "AAUW's Research on Women's Access to STEM Education and Careers" (AAUW, 2012).

the potential of the field of study to improve

Despite these opportunities, women across the globe still share many challenges in education. They tend to go to school later, take longer to complete their degrees while also raising families, and have fewer financial resources to support their endeavors. We are proud that AAUW scholarships and fellowships help address the needs of these women, even covering child-care costs. Still, the need is so great and so much work remains that AAUW is determined to encourage and collaborate with all who will join us in helping to break through these educational and economic barriers for women.

Funding at Work

AAUW provides vital funding to women who are preparing research for publication, advancing their careers, reentering the workforce, or changing careers, with weighted preferences allotted to those preparing for STEM careers. One AAUW American Postdoctoral Fellow, Leah Casabianca, explained the need for funding in this area, particularly for women:

Researchers working in STEM fields are solving the world's problems, from the energy crisis to medical breakthroughs, to development of new technology that will allow us to lead fuller, more productive lives. ... [This] requires collaboration among a diverse group of scholars who can approach the problem in many different ways. Thus it is important that no group be excluded from science, especially women and minorities.

Accomplishing that goal has been slow but steady. An AAUW International Fellow from Burkina Faso who was deciding on her career had heard about a traditionally male field that was often considered too difficult for women—engineering. The more she learned about it, the more intrigued and excited she became. Breaking through the barriers before her, she received AAUW funding and pursued her new passion. This story is one example of the thousands of AAUW awards that have given women around the world the

Why So Few? draws largely on research conducted in the United States yet contains valuable lessons for any nation where gender biases and stereotypes exist. For societies in which women's and girls' mathematical achievements lag behind men's and boys', the AAUW report and the following summary may help explain some of the psychological and institutional barriers that women and girls face, in addition to identifying possible solutions to these barriers. Copies of the full report, available at www.aauw.org/learn/research/whysofew.cfm, may be downloaded at no charge.

Girls' Achievement and Interest in Math and Science Are Shaped by the Environment around Them

Why So Few? Women in Science, Technology, Engineering, and Mathematics documents how negative stereotypes about girls' abilities in math can measurably lower girls' test performance—and, later, their aspirations for a mathematically demanding career. “Stereotype threat” refers to a negative impact students experience when confronted with a reference to a negative stereotype. Researchers have found that stereotype threat can lower test performance by adding a burden of worry that detracts from performance. When test administrators take away the stereotype threat—for example, by telling students that girls and boys are equally capable in math—the difference in performance essentially disappears. Stereotype threat has been documented in a wide variety of situations, and it has been found to be especially important for African American students in the United States (Blascovich et al., 2001). Research on stereotype threat in other countries is underway, including a recent study in China (Tsui, 2007) that may shed light on regional similarities and differences.

Other psychological barriers can affect girls' achievement and interest in science and math as well. A “growth mindset,” or believing in the potential for intellectual growth, improves outcomes, especially for girls in mathematics, where a negative stereotype about girls' abilities persists. Girls who hold a “fixed mindset” on the nature of intelligence, such as those who believe that boys hold an innate advantage in mathematics, tend to underperform on mathematics exams relative to their peers. Girls with a growth mindset are also more likely to say they want to continue to study math in the future. Research on the growth mindset has been successfully replicated in the United Kingdom (Ahmavaara & Houston, 2007), but more research is needed to examine how the growth mindset might affect children in other countries.

The issue of self-assessment, or how we view our

The report highlights fascinating research on the mental rotation of objects, an important skill in engineering and higher mathematics. Remarkably, the research demonstrates that with a short instructional course, women's performance starkly improves and compares favorably with men's average performance. If spatial skills can be learned, then any "innate" differences become considerably less important. Furthermore, the research shows that if girls grow up in an environment that includes spatial-skills training, including early play with manipulative toys,

- **Teach girls that intellectual skills, including math and science skills, grow over time.** Interventions designed to promote a growth mindset (viewing intelligence as a changeable, malleable attribute that can be developed through effort over time) among students as opposed to a fixed mindset (viewing intelligence as an inborn, uncontrollable trait) will lessen the effects of stereotype threat in girls.
- **Encourage and help girls to develop their spatial skills.** One of the largest and most persistent gender differences in cognitive skills is in the area of spatial skills, where boys consistently outperform girls (Voyer, Voyer, & Bryden, 1995). Girls with well-developed spatial skills may be more confident about their abilities and express greater interest in pursuing STEM subjects in elementary and middle school; likewise, well-developed spatial skills also promote persistence in engineering majors in college. Provide girls with opportunities to develop their spatial skills by encouraging them to play with construction toys and 3-D computer games, sketch, and take shop, drafting, and mechanics.
- **Help girls recognize their career-relevant skills.** Girls are less likely than boys are to interpret their academic successes in math and science as an indication that they could be successful in STEM careers. Encourage girls to see their success in math and science for what it is: not just a requirement for going to college but also an indication that they have the skills they need to succeed in a whole range of science and engineering professions. Women and girls tend to choose careers that they believe will contribute to society, and educators should stress the social value of scientific and technological work in their efforts to attract and retain female students in STEM.

Counteracting bias

Women in “male” jobs like engineering can (and often do) face discrimination resulting from implicit bias. Research profiled in *Why So Few?* found that people judge women working in a scientific or technological profession to be less competent than their male peers unless they are clearly competent in their work—in which case they are considered to be less likeable. Because competence and likeability are both important for success in the workplace, women working in STEM fields find themselves in a double bind.

AAUW makes the following recommendations for counteracting bias:

- **Learn about your own implicit bias.** Take the Implicit Association Tests at <https://implicit.harvard.edu> to gain a better understanding of your own biases.
- **Keep your biases in mind.** Although implicit biases operate at an unconscious level, individuals can resolve to become more aware of how they make decisions and monitor whether and when their implicit biases may be at work in that process.
- **Take steps to correct for your biases.** Educators can look at the effects their biases have on their teaching, advising, and evaluation of students and can work to create an environment in the classroom that counters gender-science stereotypes. Parents can also resolve to be more aware of messages they send their sons and daughters about their suitability for math and science.
- **Create clear criteria for success and transparency.** When the criteria for evaluation are vague or no objective measures of performance exist or are understood, the assessment of an individual’s performance is likely to be ambiguous and less effective.

is equivalent. Women and others facing bias are likely to do better in institutions with clear criteria for success, clear structures for evaluation, and transparency in the evaluation process.

V. Public Policy Recommendations

In addition to research, AAUW also advocates for legislation and regulations that will increase the number of women pursuing careers in STEM fields. Members and staff at both the federal and the grassroots levels work hard to promote our policy agenda with the voting public. They also put pressure on legislators, regulators, and other key decision-makers to pass and implement legislation and policies. AAUW supports the following public policy efforts to improve girls' achievement in STEM and to increase the number of women who choose these careers.

- **Enforce educational equality laws to improve the climate for women entering STEM fields.** AAUW recommends broad and proactive enforcement of equity compliance laws in educational settings. Where they do not already exist, policies that ensure gender equity in educational activities should be enacted. Public funding of educational institutions should be linked to fulfillment of such regulations, positive reviews of institutional policies and practices, creation and publishing of grievance procedures, and creation of a formal anti-sex discrimination policy. Simply put, these policies would help ensure that women are not discriminated against.
- **Improve teacher training and address the teacher shortage.** AAUW supports efforts that train teachers to encourage girls and other underrepresented groups to pursue STEM careers. Teachers need to be trained to be sensitive to gender differences when teaching all subjects, especially science and mathematics. Teacher training would include ways to engage students and strategies for addressing gender-based peer pressure and parental expectations. This is particularly important because, although studies show that all students start to lose interest in science and math by junior high, the loss is particularly steep for girls at puberty and likely results from gender-based social expectations and peer pressure (Congressional Commission, 2000). Efforts also must be made to increase the number of highly effective teachers, given the aging and shrinking global population of teachers (International Labour Organization, 2002).
- **Measure student achievement in science.** AAUW supports measuring student achievement in science to provide schools with information on how well students are progressing and the improvements that still need to be made. The data gathered from such testing programs should always be disaggregated by sex, race, and socioeconomic status and cross-tabulated.

VI. Related Issues: Fighting for Equal Pay and against the “Chilly Climate”

Any discussion of women in the workplace must include pay equity and gender discrimination, two key issues in the advancement of women around the world. The status of pay equity is not where it should be. Even in wealthy nations, where high levels of economic competitiveness often correlate to levels of gender equality, women still lag significantly behind men.

In the United States, women who work in the same full-time jobs as their male counterparts receive less pay for the same work—just 77 cents on the dollar, on average. Meanwhile,

according to the statistical office of the European Commission, women in Europe earn 18 percent less than do men, and Germany's gender pay gap is wider, with women taking home almost 24 percent less in 2009 than men did. The pay gap is even worse in Estonia, the Czech Republic, Austria, and the Netherlands (Harman, 2010).

Fortunately, the wage gap can be reined in through advocacy. AAUW activists are currently advocating for passage of major legislation that promises to better ensure that women in the United States receive equal pay for equal work. Through direct lobbying, social media networks, communications events, and other outreach programs, AAUW is harnessing the considerable power of our members and our friends to get this legislation passed before the end of the current session of Congress.

AAUW is also committed to breaking through barriers with direct assistance to those who take up a personal fight against discrimination. For more than 25 years the AAUW Legal Advocacy Fund (LAF) has worked to combat sex discrimination in higher education and the workplace. While initiatives include community and campus outreach programs, a resource library and online advocacy tools, and a legal referral network, LAF is best known for providing funding to support plaintiffs in workplace sex discrimination cases that have the potential to set or reinforce precedents that benefit women. Here are the stories of just two of the many women we have supported.

When Graciela Chichilnisky, a tenured professor of statistics at Columbia University and UNESCO Professor of Math and Economics, found out she was being paid 30 percent less than her male counterparts in the department, she sued. When the university did not make good on its promises, she sued again. With AAUW's support, she was able to settle in 2008 for an undisclosed amount.

Sherry Towers, a postdoctoral employee with the physics department at the State University of New York at Stony Brook, received a promotion and a raise before finding out she was pregnant. Towers alleged that her supervisor then became hostile and that she received disparate pay. She sued, claiming that she was effectively fired in retaliation for her complaints. She settled her case in 2008 after four years in court.

Gender discrimination goes beyond the wage gap; it is often embedded in the workplace culture itself. The World Economic Forum's *Corporate Gender Gap Report 2010* found that "female employees tend to be concentrated in entry- or middle-level positions and remain scarce in senior management or board positions in most countries and industries." Norway is the only exception, because a government mandate there ensures that at least 40 percent of public companies' boards are women. The report also found that less than 5 percent of the 600 companies surveyed had women CEOs. Finland, with 13 percent, had the highest percentage of women CEOs in the survey, followed by Norway and Turkey at 12 percent and Italy and Brazil at 11 percent.

A huge cause of this problem is the "chilly climate"—which occurs when sexist practices cause women in the workplace to feel unwelcome, discriminated against, or harassed. The chilly climate is an especially important issue in STEM fields, which is why LAF supports college campus-based programming that teaches students and educators about the problem. If we want to

not only recruit women but keep them, then teaching people how to “warm up” the workplace is essential to helping women feel welcome in STEM fields. Some common barriers include

- addressing or treating women in ways that reinforce stereotypes and social roles
- focusing on and judging a woman’s appearance rather than her achievements
- using different vocabulary to describe similar behavior or accomplishments performed by women and men
- ignoring women in meetings or excluding them from attending
- interrupting women more often than men and paying less attention when women speak

zones and country borders to build a bigger community that will solve global problems. We're already on our way. The United Nations' organization of this expert group meeting shows that the world has the heart and the resources to move this issue forward. Still, it's clear we will need to harness all the international brainpower we can get, and we extend an invitation to join us to all who see barriers that need breaking, particularly the barriers in STEM fields that are keeping a woman from becoming the founder of the next Facebook, whatever it may be.

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