



# In Their Nature

## Compelling Reasons to Engage Girls in Science

**B**abies are natural scientists. We can't help but notice their endless curiosity, their fresh perceptions, their sense of wonder at the workings of our planet, their immense joy of discovery.

It is this enthusiasm, retained in adulthood, which lures people into the fields of science. Sadly, that enthusiasm fades more often and sooner for girls than for boys. Fortunately, the reasons for this, which we will explore later in this article, revolve to a great extent around actions and attitudes that can be changed. We all have the opportunity to help open the doors of science and technology to girls.

### WHY IS IT IMPORTANT TO ATTRACT GIRLS TO SCIENCE AND MATHEMATICS?

**A**s we turn the corner to a new century, sophisticated technology is increasingly important for our nation's economic, political and social health. Almost every element of society—fields as diverse as music, sports and agriculture—is being affected by changing technologies. Statistics predict that by the year 2000, 80% of all jobs will require a substantial degree of scientific and technological literacy. (1)

At the same time that the importance of technology in the workplace is growing, the ways

of doing science and engineering are changing. Teamwork and project management are transforming a traditionally competitive and hierarchical style to one that is more collaborative. Often considered a "female" style of working, collaboration generates a more

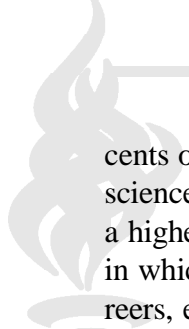
synergistic effort that results in a broader range of input, ideas and solutions.

If we fail to adequately prepare young women to excel in the fields of science and mathematics—that is, if we fail to instill in them a sense of competence, ownership and excitement in these fields—we are setting up our daughters for a future of economic dependence and limited opportunity. We are also doing a disservice to the enterprise of scientific discovery itself. The inclusion of more women in the diverse fields of science has the potential to benefit these fields by integrating

women's diverse intellectual and problem-solving skills into the workings of a vast array of enterprises. We cannot afford to overlook so much of our nation's intellectual potential.

However, the strength of our nation's economy and the health of scientific endeavors are not the only reasons we need to encourage young women in the sciences. Women have traditionally earned among the lowest incomes of all workers, and women still earn only 69

**“Girls’ natural instincts to explore our world should be nurtured simply for the joy of it, but also as the key to lucrative and meaningful careers that can help make the world a better place.”**



cents on every dollar compared to men. However, science and engineering careers generally provide a higher income than many of the traditional fields in which women work, and in some science careers, especially computer science, women and men are earning comparable salaries—quite possibly for the first time in the history of our country.

By directly or indirectly excluding women from significant educational opportunities, we are jeopardizing their chances of attaining the professional careers that might lift many women from the cycle of poverty. Girls' natural instincts to explore our world should be nurtured simply for the joy of it, but also as the key to lucrative and meaningful careers that can help make the world a better place. Moreover, as society embraces more technology, opportunities for employment in an ever-increasing range of fields will increase exponentially for those with the appropriate skills. In addition, as the option of telecommuting becomes more and more viable in a wide range of scientific and technological careers, women with the right skills will be better able than ever to fully integrate family and career life.

### WHAT IS THE CURRENT STATUS OF GIRLS AND WOMEN IN SCIENCE, MATHEMATICS, ENGINEERING AND TECHNOLOGY?

**T**hirty years after the many advances in women's health, education and welfare brought about by the women's movement of the 1970's, women continue to be under-represented in the sciences—as school girls, undergraduates, graduate students and career professionals.

This underrepresentation of women in the sciences increases as girls grow up. At the middle and high school levels, girls are closing the gender gap in science, with girls making significant strides in science and math enrollment in the last 20 years. However, girls still lag behind boys in taking physics and advanced math courses such as calculus, and girls are still significantly less likely

than boys to envision themselves in a science career at the end of high school or declare a science-related major when beginning college studies.<sup>(4)</sup>

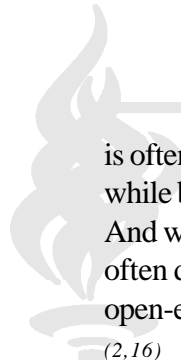
At the college and graduate level, this gap widens, with women earning only 28% of bachelors' degrees in physics, calculus, engineering and mathematics, and only 9% of doctorates in engineering, 23% in mathematics and 12% in computer sciences. Only 16% of all career scientists are women, even though women comprise 45% of our country's overall workforce and 51% of the American population. In some fields the figures are even more dramatic: women make up only 10% of mathematicians, 6% of computer scientists, and 4% of engineers. <sup>(21)</sup> Eighty-six percent of men work in fields related to science; only 25% of women do.<sup>(7)</sup>

### WHY DOES THIS GENDER GAP EXIST?

**C**lassroom Bias. Studies point to a number of factors to explain the gap between boys and girls in the science. One of the most significant factors is bias in the classroom. This bias can take many forms, and is usually unintended. Teachers often allow boys to dominate classrooms by interrupting and calling out answers. Girls, who are generally taught to be polite and quiet, often raise their hands and wait in vain to be called upon. <sup>(16)</sup> One study showed that boys spoke out of turn eight times more often than girls did. <sup>(4)</sup> This same study noted that teachers tended to listen to boys when they called out, but chided girls if they did, instructing them to "raise your hand if you want to speak." As a result, girls come to feel unimportant, if not invisible, in the classroom. <sup>(4)</sup>

Teachers can unintentionally reinforce this sense of invisibility by calling on boys more frequently than girls. In one study, teachers initiated discussion with boys 10% more often than with girls. <sup>(2)</sup>

The kinds of feedback girls and boys receive from teachers differs as well. Girls' work



is often praised for clerical values such as neatness, while boys receive praise for intellectual quality. (16) And when teachers do call on girls, studies show they often do not ask the kind of complex, abstract and open-ended questions that consistently challenge boys. (2,16)

Another difference between boys' and girls' experiences in the classroom is in the amount of hands-on learning. In hands-on classroom projects, boys use scientific instruments and computers more frequently than do girls, even though girls say they are interested in using them. (7) In one study, boys carried out 79% of all student-assisted science demonstrations, while girls were 300% more likely to be the group "note-taker." (4)

Other studies have revealed that boys are more often provided with detailed instructions for working on projects. When boys are struggling with projects, teachers ask them questions and listen to their difficulties, while girls who are struggling frequently have the work simply done for them by the teacher. (16) In one science class that was studied, girls who had difficulty constructing an electrical switch were told to "go and ask the boys for help." (2)

**Learning Styles.** Studies have revealed that other aspects of classroom science negatively affect girls. For the most part, the choice of classroom activities and teaching styles appears to be biased toward those that appeal to boys' interests. Even though considerable research has shown that girls learn better when they work cooperatively on projects, competition and presentation formats that appeal to boys are still dominant teaching mode. (4)

**Textbook Bias.** Another factor that affects girls' low participation in the sciences is the subtle bias towards men that is often found in the contents of textbooks. Men are pictured more often than women, and shown in more active roles. The accomplishments and contributions of women are usually omitted or mentioned only in a token manner. Science topics that are may be of more interest to women—for example, subjects such as menstruation and menopause—are excluded. (22)

Textbooks used in schools at all academic levels frequently reinforce the notion that science is a man's world. Sadly, what's portrayed in the textbooks is often personified in the classroom—nearly all advanced science and mathematics courses are taught by men. (7)

**Loss of self-esteem.** Girls and boys begin elementary school with similar self-esteem levels and fairly equal academic abilities, with girls demonstrating a slight advantage in language skills. However, in their middle school years, girls show a drop in math confidence and achievement. (In one classic study, the girls' decline in confidence *preceded* their lowered achievement.) (4) By the end of high school, boys have surpassed girls in higher-level mathematics, biology, general science and physics, even though the girls have a higher overall academic achievement. (25)

Even gifted and talented adolescent girls exhibit less confidence about math skills, which makes them less likely to take college-preparatory math and less likely to choose college majors and careers in fields that require mathematics. (4,14)

As a group, girls experience a dramatic and well-documented loss of self-esteem as they enter adolescence. Some of this loss can be attributed to the over-emphasis placed on physical appearance, peer popularity and the mixed messages girls often receive about sexuality and the role women should play in society. In this age group, boys who are asked to describe something they like about themselves will most often mention a talent or ability, while girls are nearly twice as likely to point out some physical attribute. (26) Moreover, studies show that when faced with social or academic failure, boys tend to attribute the failure to external forces, while women tend to blame themselves. (7)

The loss of self-esteem experienced in early adolescence can carry over into later life, where young women remain much less likely than men to express outstanding confidence in their abilities. One study, known as the Illinois Valedictorian Project, followed the progress of almost 100 boys and girls who graduated at the top of their class. After four years of college, students of both

sexes had continued their high academic performance. Yet when asked to describe their level of intelligence at that point, 25% of the men perceived themselves as “Far Above Average,” while 0% of the women did, even though their GPA was higher than the men’s. Although the women had performed academically better than the men during those four years, the men’s self-esteem *increased* in college while the women’s *decreased*.<sup>(27)</sup> This and other studies have shown that girls’ interest in higher education and non-traditional fields peaks at 13, while men’s self-esteem and ambitions continue to rise throughout their schooling.<sup>(2)</sup>

**Lack of Direction.** When the time comes to choose course schedules, girls are too often denied information about or steered away from advanced courses in math and science.<sup>(16)</sup>

Numerous studies prove that girls are frequently tracked into low-ability math and science classes, even when girls have similar scores to boys who were assigned to the high-ability groups.<sup>(5)</sup>

When girls do succeed in high-level math and science courses, they are often still not encouraged to pursue scientific careers. In one study of high school students who had taken physics and calculus, 64% of the boys were planning to major in science and engineering, while only 18.6% of the girls had similar goals.<sup>(4)</sup>

**Parental Support.** Research shows that boys receive more toys related to math and science, thereby encouraging them in those fields even at a very young

age.<sup>(2)</sup> Often the parent has few choices; educational games, such as “Baseball Math,” tend to be oriented towards boys, and products for girls are difficult to find. Computer games are marketed almost exclusively to boys, and as a result boys often come to the classroom feeling much more confident and competent about their computer skills and other scientific or mathematics principals.<sup>(20)</sup>

Another study found that parents make more of an investment in their sons’ college educations, regardless of their abilities and achievements, than they invest in their daughters’.<sup>(23)</sup> More women attend college than ever before, but everything from the G.I. Bill to expectations that a career in science will conflict with a woman’s family life can discourage girls from careers in the sciences.

**Gender Stereotypes in Careers.** The attitude that engineering, mathematics and science are inappropriate fields for women is still culturally pervasive. Studies show that girls as young as age

two or three are aware of occupational segregation by gender, and the appropriateness of this segregation is then reinforced in many ways throughout their lives.<sup>(2)</sup> In addition to perceiving careers as gender specific, misperceptions about the careers themselves can prevent girls from pursuing certain fields. For example, the traditionally feminine values of listening, feeling and maintaining strong interpersonal relationships may seem incongruent with scientific careers perceived as impersonal.





## HOW CAN WE HELP BRIDGE THE GENDER GAP?

The most successful efforts to support girls in the sciences begin in elementary school and follow students throughout their high school years. In addition, successful advocacy for girls in the sciences involves the resources of an entire community—parents, schools, businesses and other local leaders.

**The value of mentors.** Study after study has pointed to the presence of positive female role models in the sciences as being the single most important factor in sustaining girls' interests in the sciences. In fact, most professional women scientists can point to a single individual whose support enabled them to pursue their careers.

Mentors can help young women envision themselves as scientists by providing them with an image of a "scientist" that differs from the stereotype of the man in the lab coat, as well as with a model of how to balance career with family, friendships, activities and hobbies beyond work. In addition, mentors can help girls with scientific and mathematical concepts, open their eyes to an array of scientific fields, give them a realistic sense of the challenges and rewards of science careers and help them to understand the educational paths necessary for scientific career options.

Role models can take other forms than formal mentorships while still having a significant impact on girls' perceptions of the sciences. In one study, women scientists were brought into middle schools as part of the students' science instruction. Within just a two month time period, students developed a more positive attitude toward scientists and specifically women scientists. <sup>(25)</sup>

Women scientists speaking before student groups, at career fairs and other events can respond to questions and encourage girls interested in careers in science. Even one-day programs like "Take Your Daughter To Work Day" offer girls the chance to see firsthand what it would be like to hold a job in a scientific field.

Thus mentoring—whether formal or informal, on-going or short-term—is one of the most successful tools for reversing the under-representation of women in the sciences.

## CONCLUSION

The attitudes and beliefs that keep women from pursuing careers in the sciences are the same attitudes that, for generations, kept women from voting, flying airplanes, playing professional sports, and holding political offices. Like countless other activities, women have now proven that they are not only capable of doing these things, but of truly excelling at them.

Girls deserve to have everyone in their community expect the best of them, and they deserve praise when they rise to this standard. This must include the expectation that girls' curiosity is as active and as valid as that of boys', and the recognition that the intellectual energy girls bring to the world and the questions they ask of it may open the doors to discoveries that will change all of our lives. By nourishing every girl's intellectual promise, we are giving them the greatest gift we can—not only the possibility of becoming scientists, but of becoming fully human.

**For more information about AWSEM, contact:**

**AWSEM**

**Saturday Academy  
20000 NW Walker Road  
Beaverton, OR 97006**

**Phone:** (503)748-1504

**Fax:** (503)748-1470


**E-mail:** [info@awsem.org](mailto:info@awsem.org)

**Internet:** [www.awsem.org](http://www.awsem.org)



## BIBLIOGRAPHY

- (1) "Calculus-Based Physics Exploratory Study," Illinois Mathematics and Science Academy Report
- (2) "Equitable Treatment of Girls and Boys in the Classroom," American Association of University Women Report, June, 1989
- (3) "How Schools Shortchange Girls," AAUW Report, Executive Summary, 1992
- (4) "How Schools Shortchange Girls," AAUW Report, Action Guide, 1992
- (5) "Restructuring Education: Getting Girls into America's Goals, AAUW Report, August, 1990
- (6) The National Coalition of Educational Equity Advocates, Educate America: A Call for Equity in School Reform, Chevy Chase, MD, The Mid-Atlantic Equity Consortium, 1994.
- (7) Antony, Mary, "Gender and Science: A Review of the Research Literature," Programs for Educational Opportunity Equity Coalition, Fall 1993-Spring 1994.
- (8) Bailyn, Lotte, "Experiencing Technical Work: A Comparison of Male and Female Engineers," Human Relations, Vol. 40 No. 5, November 5, 1987.
- (9) Beck, Joan, "Smart students being locked out of opportunities," The Oregonian, February 12, 1992
- (10) Bloch, Nini, "Mothers of Invention: What are Women Doing to Science?" Earthwatch, October/November 1995
- (11) Estrich, Susan, "Separate is Better," New York Times Magazine, May 22, 1994.
- (12) Frenkel, Karen A., "Woman and Computing," Communications of the ACM, Vol, 33, No. 11, November 1990
- (13) Hall, Roberta M. and Sandler, Bernice R., "Academic Mentoring for Women Students and Faculty: A New Look at an Old Way to Get Ahead," Association of American Colleges, 1983.
- (14) Junge, Michael E. and Dretzke, Beverly J., "Mathematical Self-Efficacy Gender Differences in Gifted/Talented Adolescents," Gifted Child Quarterly, Vol. 39, No. 1, Winter 1995
- (15) Koballa, Jr., Tahoma R., "Persuading girls to take elective physical science courses in high school: Who are the Credible Communicators?" Journal of Research in Science Teaching, Vol. 25, No.1, 6, 1988.
- (16) Mann, Judy, "Bridging the Gender Gap: How Girls Learn," The Difference: Growing UP Female in America, Warner Books, 1994,
- (17) Massey, Sharon, "Co-Ed Schools are Studying All Girl Classes," Wall Street Journal, August 10, 1993.



(18) McCormick, Megan E. and Wolf, Joan S., "Intervention Programs for Gifted Girls," Roeper Review, December, 1993.

(19) Miller, Peter, "Jane Goodall," National Geographic, Vol. 188, No. 6, December, 1995.

(20) Morse, Susan, "Why Girls Don't Like Computer Games," AAUW Outlook, Winter, 1995

(21) Pearl, Pollack, Riskin, Thomas, Wolf and Wu, "Becoming a Computer Scientist," Communications of the ACM, Vol. 33, No. 11, November, 1990

(22) Potter, Ellen F. and Rosser, Sue V., "Factors in Life Science Textbooks that May Deter Girls' Interest in Science," Journal of Research in Science Teaching, Vol. 29, No.7., 1992.

(23) Scarr, Sandra and Weinberg, Richard, "Educational and Occupational Achievements of Brothers and Sisters in Adoptive and Biologically Related Families," Behavior Genetics, Vol. 24, No. 4, 1994

(24) Smith, Thomas Ewin, "Gender Differences in the Scientific Achievement of Adolescents: Effects of Age and Parental Separation," Social Forces, University of North Carolina Press, December 1992.

(25) Smith, Walter S. and Thomas Owen Erb, "Effect of women science career role models on early adolescents' attitudes toward scientists and women in science," Journal of Research in Science Teaching, Vol. 23, No., 8, 1986.

(26) Warren, Rebecca Lowe, "Gender Gap, Confidence Gap," The Oregonian, September 29, 1995

(27) Widnall, Sheila E., "AAAS Presidential Lecture: Voices from the Pipeline," Science, Vol. 241, 30, Sept. 1988