mind•full: a brainsnack for future leaders with ethical appetites

Volume III • Number 4 • March 2000 • Student Pugwash USA

women and science

Women are still largely underrepresented in science despite many recent efforts to promote greater diversity. Programs at nearly every level are aimed at encouraging girls and women to study science and more women practice science today than twenty years ago. However, these efforts have yet to overcome the impact of women's formal exclusion from the field in the 1800s and beyond. A wide range of approaches are being taken. These include examining how science is introduced in grade school classrooms, better sensitizing science teachers, creating incentives for more women to study science, and researching the extent to which modern science is gender-biased.

More women are earning science and engineering degrees at all levels than ever before. However, women comprised only slightly more than 22 percent of the science and engineering workforce in 1995, according to the US National Science Foundation (NSF). Science risks missing critical questions, overlooking important populations, and coming to incomplete and incorrect conclusions by allowing the rate of diversification to remain so low. For example, the Massachusetts Institute of Technology, one of the leading science research institutes in the US, estimates it will be 40 years before women comprise 40 percent of the faculty at the current rate of change.

There are many challenges to overcome. Both male and female professionals need to have a better understanding and awareness of the many facets of discrimination. We also need to explore what societal factors are influencing why more women are not choosing careers in science. Some of this will depend upon political will as we determine the best educational approaches to creating equity and assess the financial and social costs of reforms in the educational and professional arenas. It also will depend upon individual scientists as they consider their roles in ensuring this greater diversity.

The mission of Student Pugwash USA is to promote the socially responsible application of science and technology in the 21st century. As a student organization, Student Pugwash USA encourages young people to examine the ethical, social, and global implications of science and technology, and to make these concerns a guiding focus of their academic and professional endeavors.

The **mind•full** series encourages readers to explore crucial ethical dilemmas associated with the application of science and technology.

STUDENT PUGWASH USA

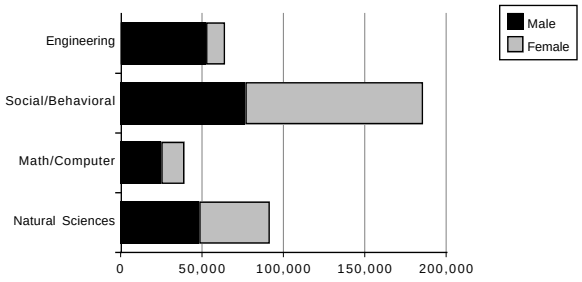
go figure!

More women are being educated in science today than twenty years ago. In fact, women actually earn more bachelor's degrees in behavioral and social sciences today than men. But there are still underrepresentations. For example, women are still very much a minority in computer science and engineering, having earned 29 percent of computer science and 17 percent of engineering baccalaureate degrees in 1995.

Women are less likely to continue their studies to advanced degrees and less likely to be employed in what the NSF considers the science and engineering sector. However, it is very interesting to note that women earn a higher percentage of science-and-engineering than non-science-and-engineering doctoral degrees. In other words, if a woman starts in science, she's more likely to continue her formal education than if she doesn't. Women earn approximately 47 percent of all science and engineering undergraduate degrees, but they earn just over 30 percent of all science and engineering doctoral degrees.

degrees of separation?

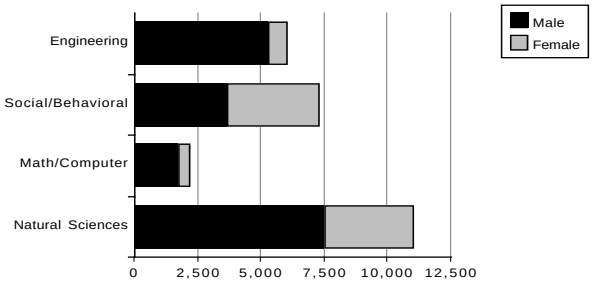
Bachelor's Degrees Earned, 1995



	Male	Female
Natural Sciences	48,474	42,371
Math/Computer Sciences	25,066	13,554
Social/Behavioral Sciences	76,256	109,056
Engineering	52,421	10,950
Total	202,217	175,931

Doctoral Degrees Earned, 1995

	Male	Female
Natural Sciences	7,534	3,490
Math/Computer Sciences	1,737	451
Social/Behavioral Sciences	3,658	3,638
Engineering	5,313	694
Total	18,242	8,273



Source: National Science Board, *Science and Engineering Indicators—1998*, Appendix Tables 2-20, 2-30. National Science Foundation, Arlington, VA, 1998 (NSB 98-1).

Proportion of Female (and Male) Freshmen in 1996 Intending to Major in Science & Engineering

	Total	Natural Sciences	Math & Computer Sciences	Social Sciences	Engineering
White Students	26.5 (38.8)	11.5 (11.5)	1.2 (4.3)	10.9 (6.8)	2.9 (16.2)
Asian Students	35.3 (50.1)	17.0 (15.0)	2.5 (7.3)	10.4 (4.8)	5.4 (23.0)
Black Students	32.1 (37.2)	10.5 (7.7)	4.7 (6.9)	12.4 (6.2)	4.5 (16.4)
Hispanic Students	30.1 (41.2)	9.6 (9.9)	1.9 (4.3)	14.6 (8.8)	4.0 (18.2)
Native American Students	27.5 (38.5)	11.7 (11.6)	1.6 (5.7)	11.7 (7.8)	2.5 (13.4)

Source: University of California at Los Angeles, Higher Education Research Institute, "Survey of the American Freshman: National Norms," Los Angeles, 1995, and unpublished tabulations, quoted in National Science Foundation, *Science and Engineering Indicators—1998*.

in control or out of it?

Efforts are being made to encourage women to enter into science. Determining what disincentives or impediments are affecting the percentage of women practicing science is a problem that is being examined on many levels. At the local and state level, recommended reforms include mentorship programs, teacher training in content-knowledge, and teaching strategies that encourage female achievement in science and mathematics. Strategies for the classroom include using more cooperative education models and diminishing the competitive "weed-out" classes at the university level. Providing female role models and personal encouragement also are important to the success of women in science, as women are more likely than men to underestimate their performance in course work.

learn the lingo

gender equity—a set of actions, attitudes, and assumptions that provide opportunities and create expectations about individuals, regardless of gender.

Gender equity is an equal chance for females and males at:

- learning, regardless of the subject
- preparing for future education, jobs, and careers
- high expectations
- developing, achieving, and learning
- equitable treatment and outcomes in school and beyond.

Gender equity is linked to and supports race, ethnic, economic, disability, and other equity concerns.

Source: EQUITYOnline: www site of the WEEA Equity Resource Center, 1998, Education Development Center, Inc. Available February 2000 at www.edc.org/WomensEquity/genderdef.html.

There are different approaches taken nationally. The mission of the US Department of Education's Office for Civil Rights (OCR) is "to ensure equal access to education and to promote educational excellence throughout the nation through vigorous enforcement of civil rights." There are five federal statutes that prohibit discrimination enforced by the OCR. Title IX of the Education Amendments of 1972 prohibits discrimination on the basis of sex. This means that any program or activity—including but not limited to academic programs, student treatment and services, admissions, and financial aid—that receives Department of Education funds must operate in a nondiscriminatory manner. The OCR lists programs with "promising practices designed to enhance the participation of . . . underrepresented students in mathematics and science programs" that receive funding from the Department of Education. However, as the OCR oversees such a large number of institutions, it mostly assists schools in voluntarily complying with Title IX but it also investigates sex discrimination complaints. Other governmental organizations, like the grant-making NSF and the National Institutes of Health, have policies against discrimination. Non-profit organizations like the American Association of University Women make programmatic recommendations to help identify and reduce instances of sex-discrimination on a national level.

Women and science is also an international issue. The UN Commission on Science and Technology Development established a Gender Advisory Board in 1995. The Gender Working Group (GWG) identified seven key issues considered particularly important. Those issues include: removing obstacles to women in scientific and technological careers, making the science and technology decision-making process more "gender aware," and addressing the gender dimension of ethical issues in science and technology. The GWG also recommended transformative actions for each of the key areas discussed, some of which were ratified by the UN. For example, they recommended, among other items, tax relief

for payment of childminders; pay equity legislation; and an increase in the number of women appointed to policy advisory and decision-making bodies. Since these initial recommendations, the Gender Advisory Board has helped national governments and other institutions implement the above-mentioned recommendations. In July 1999 at the World Conference on Science for the Twenty-First Century, organized by UNESCO and the International Council for Science, participants finalized the "Declaration on Science and the Use of Scientific Knowledge." This declaration draws clear attention to "the difficulties encountered by women . . . in entering, pursuing and advancing in a career in the sciences and in participating in decision-making in science and technology. . . ."

"math class is tough"

In 1992, a talking Barbie doll debuted with “math class is tough” included in her repertoire of phrases. Many women’s groups responded loudly with outrage and the phrase was removed from the toy’s available "thoughts." Most do not consider it malintent by Mattel that Barbie found mathematics challenging, but many considered it very irresponsible. The question was raised, "What made the creators of this toy think that Barbie (with so many of her traits considered socially ultra-feminine) would find math tough?"

Other examples of societal factors influencing who is interested in science and technology can be found in the toy aisle. For instance, computer games are primarily designed and marketed for boys. This increases boys’ comfort level with technology when encouraged to use it in the classroom, whereas for more girls the classroom is their first (or near first) direct use of computers. This sort of problem perpetuates itself when fewer women enter the computer programming or design fields and men continue to design products usually, but by no means always, targeted at themselves or boys.

women's workplace

In 1999, "A Study on the Status of Women Faculty in Science at MIT" was published. The study was undertaken by a committee of women faculty in the School of Science. For the most part, this committee was easily formed with few female senior faculty unwilling to serve. It was determined that the percentage of women faculty in the School of Science had not gone above nine percent in the 10, probably 20, years prior to 1994. The study also indicated inequities in salary, teaching assignments, space, awards, and distinctions, among other areas. From interviews, the study found many tenured women faculty experienced exclusion and invisibility in their professional environment. In response to these findings, the dean "made great effort to identify and recruit exceptional women at all faculty ranks" and also moved to increase the inclusion of women faculty in departmental activities. These efforts are having some effect, in 1999 the percent of women faculty in the School of Science rose above 10 percent. One of the main challenges for the School of Science faculty was recognizing discriminating behavior. They found that "discrimination consists of a pattern of powerful, but unrecognized assumptions and attitudes that work systematically against women faculty even in the light of obvious goodwill."

women + underrepresented minorities = success?

Women of minority racial/ethnic groups face different challenges in entering the scientific arena and possibly at a much earlier age. This is a complex issue and not easily summarized. But, according to the NSF report on "Women, Minorities, and Persons with Disabilities in Science and Engineering—1998," women of underrepresented minority racial/ethnic groups earn approximately half of all science and engineering master’s degrees awarded to their respective racial/ethnic group.

However, only 11 percent of graduate (master's and doctoral degree) science and engineering students (male and female, US citizens and permanent residents) were underrepresented minorities (African Americans accounted for 6 percent, Hispanics for 4 percent, and American Indians for 1 percent). The proportions of these groups in the general population are: African Americans (14 percent), Hispanics (13 percent) and American Indians (0.8 percent). So, while the news for women minorities is increasingly hopeful, there is still a need to involve more of these underrepresented communities in science and engineering.

(anything but a) conclusion

Women are not proportionally represented in science. This problem is perhaps not as pervasive as it was twenty years ago, but many question whether enough attention is being paid to the issue. The benefits of increased diversity in who is practicing science are far-reaching. Affirmative action programs that have been in place for some time are having an effect, but many feel it is important to take care to protect and advance their standing. Reforming education, increasing funding for women entering the fields, or redistributing responsibility among senior scientists and researchers are all approaches that need to be further explored.

How do **you** answer the **tough questions**

The percentage of women faculty at the MIT School of Science is rising. At the current rate, it will be 40 years before 40% of the faculty are women. Is this an acceptable rate? Should more resources be directed at recruiting women faculty members? Do you think this influences the number of young women who will study science at MIT? Why or why not?

Why do you think the participation of women in computer science is so low? Do you think the popularity of the World Wide Web will help bring more girls and women into the field or do you think the Web has a male bias? What steps would you recommend to encourage more girls and women to study computer science?

The scientific community's hesitance to use women as participants in scientific research experiments has been a topic of debate for many years. For example, researchers investigating breast cancer for many years studied only males. What impact do you think it would have if more women participated as subjects in this research?

What do you consider the current obstacles preventing women from entering the hard sciences? Do you think any of the following play a role: a hostile learning environment, hostile working environment, lower pay, expectation of extra committee work if accepted into the field, etc.? What can be done to remove these obstacles?

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Why do you think the participation of women in the engineering sector is so low? What would you do to encourage more girls and women to enter the field? Are these challenges different than those facing the field of computer science? Do you think the universities with engineering programs have a special responsibility to address this imbalance?

If you were part of a university planning committee considering faculty benefits, what priority would you place on family-planning issues when restructuring professional benefits? Do you think this will impact women's professional development more than men's professional development, or vice-versa?

Is science gender-neutral? If not, should it be? Is the culture of science in conflict with societal culture?

Carol Cohn, in a June 1987 article in the *Bulletin of the Atomic Scientists* entitled "Nuclear Language and How I Learned to Pat the Bomb," pointed out that the vocabulary shaping and reflecting nuclear strategy was very male-dominated and abstract in relation to the horrors it described. Do you think that women can be excluded from a field by something as basic as the language used? Are there other subtle forms of exclusion that you think can keep women out of various fields?

Do you think affirmative action programs are effective in increasing diversity while maintaining qualifications of science practitioners? How do you think the responsibility to enact and enforce such programs should be distributed among educational institutions, industry, and government? What do you think the role of individuals should be, if any, in creating a more sensitive and diverse study and work environment?

Do you agree that children's toys help familiarize boys with technology at an earlier age than girls? Do you see this trend changing? What role does the media, Hollywood, and other forms of popular culture play in this respect?

female findings

• *Achieving Gender Equity in Science Classrooms: A Guide for Faculty*—compiled by the New England Consortium for Undergraduate Science Education in 1996. Gives a clear breakdown of some classroom problems and solutions. Available on-line at www.brown.edu/Administration/Dean_of_the_College/homepginfo/equity/Equity_handbook.html.
• "Declaration on Science and the Use of Scientific Knowledge," World Conference on Science for the Twenty-First Century, July 1999. Full document available at UNESCO's site: www.unesco.org/science/wcs/eng/declaration_e.htm.
• "Gender Differences in Research Productivity," Yu Xie and Kimberlee Shauman—brief commentary on publication rates of female vs. male scientists. *The Scientist*, September 27, 1999 and available on-line at www.the-scientist.com/yr1999/sept/comm_990927.html.
• *Gender Gaps: Where Schools Still Fail Our Children*, American Association of University Women—follow-up to the AAUW's 1992 report *How Schools Shortchange Girls*. Presents updated statistics and discusses social challenges and influences in the US education system. Marlowe & Company: New York, 1999.
• "Gender in the Internet Age," Computer Professionals for Social Responsibility—CPSR's winter 2000 newsletter. Available at www.cpsr.org/publications/newsletters/issues/2000/Winter2000/inde.
• *Has Feminism Changed Science?* Schiebinger, Londa—Gives a thorough look at science and gender; women in the history of science; gender in the culture and substance of science. Harvard University Press: Cambridge, Mass, 1999.
• "Mathematics and Science Achievement, State by State, 1998," National Education Goals Panel—US Government Printing Office, Washington, DC, 1998.
• *Missing Links: Gender Equity in Science and Technology for Development*, by the Gender Working Group of the United Nations Commission on Science and Technology for Development. August 1995. Table of contents and ordering info available at www.idrc.ca/books/missing.html.
• *Nature* Debates—check out the debate on women in science in the 9 September 1999 issue. Available at helix.nature.com/debates/women/women_navbar.html.
• *Nobel Prize Women in Science: Their Lives, Struggles, and Momentous Discoveries*, Sharon Bertsch McGrayne—Simon & Schuster Trade: October 1992. Revised December 1998.
• *Report on Discrimination Against Women in the School of Science*, Massachusetts Institute of Technology—March 23, 1999, available on-line at http://web.mit.edu/fnl/women/women.html.
• *Science & Engineering Indicators—1998*—One of the most widely used source of statistics on who is doing science. National Science Foundation, Arlington, VA, 1998 (NSB 98-1). Available on the Web at www.nsf.gov/sbe/srs/seind98.
• "Women and Minorities: Maintaining Diversity During Adversity"— *Science* magazine special issue. Vol. 271, 29 March 1996.
• *Women, Minorities, and Persons with Disabilities in Science and Engineering: 1998*, National Science Foundation—an excellent source of stats. Available on-line at www.nsf.gov/sbe/srs/nsf99338/start.htm.

check it out !

challenging clips

• NIH Video Casting—use the Web to see past events by the Office of Research on Women's Health for programs related to the use of women as participants in scientific research. Available at videocast.nih.gov/PastEvents.asp.
• *Girls, Science, and Mathematics*—check out this video on how to promote girls' interest and confidence in science and math (17 minutes, 1993), ehrweb.aaas.org/cgi-bin/list.pl.
• *Silkwood*—This 1983 film with Meryl Streep as a nuclear power plant worker raises a bizillion questions, including why it was so hard for a woman to be taken seriously about hazardous conditions at her workplace.
• *Stand and Deliver*—This excellent 1995 film starring Edward James Olmos explores the challenges facing girls (and boys) in East LA as they learn to excel in math.

cyberspace

top picks

• Association for Women in Science (excellent organization and site!)—www.awis.org

• Equityonline (site of the Women's Education Equity Act Equity Resource Center with active discussions about educational equity in a multicultural context)—www.edc.org/WomensEquity/edequity/index.html

best of the rest

• Ada Project (clearinghouse for info related to women in computing)—tap.mills.edu
• Gender and Science and Technology Association (see this site for 50 international papers on these topics)—www.wigsat.org/gasat/index.html
• The Guide (Toby Levine, Inc. has created a great index of gender equity programs, searchable by region, form of program, subject matter, and more!)—www.learner.org/theguide
• National Center for Education Statistics (part of the US Department of Education, stats galore!)—nces.ed.gov/
• Once and Future Action Network (OFAN) (international consortium of gender, science, and technology organizations)—www.wigsat.org/ofan/ofan.html
• SmartGrrls (creates educational programs for schools and institutions that need help reaching girls)—www.smartgrrls.org
• Third World Organization for Women in Science—www.ictp.trieste.it/~twaws/TWOS.html#TWOWSObjectives
• UN Gender Advisory Board (recommendations and links to related organizations)—gab.wigsat.org
• US Dept. of Education, Office of Civil Rights (shows what sorts of programs are being presented and tried for science education for women and/or minorities)—www.ed.gov/offices/OCR
• Women in Global Science and Technology (great links)—www.wigsat.org

www-omen's issues !

This **mind•full** was written by Audrey K. Nash, national chapter coordinator of Student Pugwash USA. Special thanks to Mary Golladay of the Human Resources Statistics Program, Division of Science Resources Studies at the National Science Foundation and Judy Kass of the American Association for the Advancement of Science's Directorate for Education and Human Resources and member of the Student Pugwash USA board of directors for their comments. Any errors are the responsibility of Student Pugwash USA.

but wait, there's more!

• **mind•full: a brainsnack for future leaders with ethical appetites**. Volume two issues available: pugwash conferences; exploring human genetics; science, technology, & culture; communications technologies; beyond nuclear weapons; nuclear energy; computers and human genetics; energy and international security; science, ethics, and education; environment and energy; war-free world. Volume three issues available: genetic testing; terrorism and weapons of mass destruction; technology & human rights.

• **Jobs You Can Live With: Working at the Crossroads of Science, Technology, and Society**. The fifth edition of the Student Pugwash USA internship directory. It highlights approximately 200 organizations that work to promote the ethical use of science and technology and provides suggestions on how to go about the internship and job search.

• **Science, Technology, and Ethical Priorities: Proceedings of Student Pugwash USA's Ninth International Conference**.

• **Pugwatch.** The chapter newsletter.

• **Chapter Organizing Guide.** Provides chapter members with an A to Z guide to getting a campus-based chapter up and running.

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