Equity Resource Center

Science and Equity Digest

Becoming a Scientist

By Shirley Malcom, American Association for the Advancement of Science

In her pathbreaking book *Women Scientists in America: Struggles and Strategies to 1940* (1982), Margaret Rossiter notes the structural barriers that were erected within science from the 1800s to the 1940s: denial of opportunity for graduate education or credentialling, for employment, and for professional recognition. Women were described as unsuited by temperament and ability for such pursuits. There were actually outright efforts to exclude them should they succeed in attaining a science degree. Rossiter's book includes a letter from Robert Millikan urging scientists in a Duke University department not to hire a female candidate they were considering, because doing so would lower the department's prestige.

On the other hand, had Madame Curie been available, any of these departments would likely have been willing to hire her in spite of her gender. The breakthrough in science by Curie, which many women thought would lead to wider acceptance of women generally within science, instead simply reinforced the superstar phenomenon of holding women to a different and higher standard, underscoring the exception theory without in any way changing the stereotype. Many years later, the celebrated Renaissance woman Clare Booth Luce left much of her estate to be used to foster the movement of women into the sciences, which she believed to be one of the last remaining fields of endeavor that posed structural barriers for women.

Rossiter's history lesson ends just as America enters World War II. The vacancies that were created when men went off to war allowed the nation in general, and women in particular, to see that women were capable of undertaking science, of pursuing study in college and graduate education, of teaching, and of filling positions in industry and government. Women built airplanes and flew them too. They nursed and doctored, taught and professed, built bombs and made medicines, followed and led. They raised families with and without fathers present. They had to; America needed them to do this.

Just as it is today, the story of women in science in the 1940s is about allowing talent to be expressed, seizing opportunity, and serving whatever your calling may be. Rossiter picks up her story in *Women Scientists in America: Before Affirmative Action, 1940–1972* (1995), which covers women's role in science during the war as well as their postwar loss of ground. As men returned home to the workplace and to college (via the GI Bill) it became women's patriotic duty to step aside. The 1950s and 1960s became times of backsliding and retrenchment that represented real loss of ground in women's participation in science and engineering and a readjustment of women's expectations for themselves.

With the women's movement, laws to protect women's participation in education, and affirmative action, women's participation in science and mathematics education, degree programs, and employment began a steady climb. Now, at the turn of the century, women are finally approaching parity in degree conferrals in the life sciences and in medicine.

Today the opportunities for women are presented not by war but by demographics and the economy—a workforce dependent on women's presence in it and more space soon to be relinquished as the Baby Boom generation approaches retirement age. An economy and lifestyle increasingly defined by technology and

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Inside:

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science open the door to opportunity for women in science. As surely as women were needed in the war effort of the 1940s, they have been needed in the post-Cold War economy of the 1990s, and there is unlikely to be any decrease in the demand for talent for the information economy of the new millennium. Perhaps arguments based on need can open doors wide in the next millennium that arguments based on social justice were only able to crack in the 1970s and 1980s. Even though need is creating opportunity, however, vestiges of the old barriers remain.

The need to get different output from the system is providing opportunity and motivation to examine in fundamental ways the nature of the educational and social systems that keep certain people out. Too many of our educational strategies (e.g., tracking) have hitherto been based on finding the best and leaving the rest. We must change our strategy from culling to keeping, from weeding to cultivating.

Scientific knowledge must cease to be something that is avoided by the majority and instead become a necessary component of what it means to be an educated person.

Science as Essential

I have spent most of my professional life working within a movement to increase the options for all people—regardless of race, ethnicity, gender, or disability—to make choices I was allowed to make, to see science as a crucial element of liberal education, to realize that understanding of science (as knowledge and as process) is fundamental to citizenship. Science and technology deserve a more prominent place in the liberal arts, which have been seen for too long (both inside and outside science) as the domain of experts and majors. As science and technology have grown in importance in our world and in our economy, they have emerged from the pages of academic journals onto the front pages of newspapers and the covers of news magazines. Science must become accessible to everyone. We must share knowledge and our understanding of the implications of science:

- what it can tell us and what it cannot
- where fact ends and policy decisions begin
- where we must inject our values, our morals, and our ideas of social justice

Scientific knowledge must cease to be something that is avoided by the majority and instead become a necessary component of what it means to be an educated person. We must give people a foundation so that they are prepared to make decisions in their lives—for their children, their communities, and their world—that are based in science and technology. They must be prepared also to question the experts, and when these experts disagree or speak only in probabilities, to make decisions based on reasoned judgments.

Science has served as a currency of international and intellectual exchange, even among countries where official relationships have been uneasy. Because science is international, scientists work hard at finding a common language. Scientific knowledge is the basis of healing as well as destruction. It has been applied to rescue the innocent as well as to find the guilty. And it must now become a part of the process of environmental repair, of disease prevention, and of cure. Science is fundamental to a better understanding of ourselves and our universe.

Women must be a part of the community and the process of generating scientific knowledge, of expanding the intellectual base of science. Women must be a part of the decision-making process of science issues: what is studied, how, and by whom. How will the knowledge be used, and to what societal ends? The decision makers in science, as well as in politics and business, must become a more accurate reflection of the larger society.

For too many years science has lost the opportunity to recruit interested and talented people. In some cases the opportunity to study was not available, with poor schools and poor teaching limiting many. In other cases, although the opportunity was available, it was not encouraged. Because women did not fit the image, they were directed exclusively into stereotypical or traditional female fields or roles and counseled out of the rigorous coursework necessary to pursue science, in spite of their interests and aspirations.

Women Changing the Face of Science

When I was a child growing up in Birmingham, Alabama, it was assumed by everyone, including me, that I would go to college. I had to do this if I wanted a good job. In those days and times—1940s to 1950s—for us African Ameri-

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Gender Equity Issues in Science Careers

By Sue V. Rosser, Ivan Allen College, Georgia Institute of Technology and
Julie Montgomery, University of Florida

"The laboratory climate makes a tremendous difference. Everyone needs a work environment that is comfortable, supportive, and nonthreatening. I feel fortunate to have this now, at this stage in my career, but I know that many women do not. My sense is that younger women are often not taken seriously enough in their work environment and many women are excluded from important informal information exchange that goes on in the laboratory. I have had to work extra hard to build and maintain good communication with my colleagues here." (1997 Respondent 24)

"For me, the biggest issue was children, not just the physical act of bearing them. But the emotional act each day of raising them. I'm unusual for a female researcher. I had two children in graduate school and still finished in four years. Now I'm trudging along trying to get tenure, having become a single mother along the way—no one's stopped my clock or bought me out of a course. No institution has ever given me a break. While I've had a couple of wonderful fairy godfathers in my career (which is probably why I'm still in this career at all), the institutions themselves have felt quite cold and unforgiving. I KNOW that a huge amount of my creative energy is siphoned away from my research into [my children's] lives and development. I KNOW that if I were a male with a wife at home raising the children, my work would be different. But the institutions have no way of dealing with this inequity." (1998 Respondent 11)

Much of the concern surrounding gender equity in science, engineering, and mathematics has focused on attracting and retaining women during the educational process. Middle school, transition from high school to college, and the first year in graduate school have been identified as critical junctures in the educational pipeline. Quite logically, federal, organizational, and individual resources have been aimed at studies and strategies to retain sufficient numbers of girls to provide a critical mass of well-educated women scientists and engineers to enter the labor force.

Not surprisingly, fewer studies have explored the equity issues faced by women scientists and engineers when they become faculty members and researchers. Teaching and conducting research at a college or university signal career achievement in education; obtaining a grant from the National Science Foundation marks particular success in scientific circles. Because of their relative success, an exploration of issues identified by academic women scientists and engineers who received National Science Foundation Professional Opportunities for Women in Research and Education (POWRE) in fiscal years 1997 and 1998 yields valuable information about gender equity in the careers of women scientists and engineers.

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The POWRE program states two main objectives in its attempts to address the need to develop full use of the nation's human resources for science and engineering: "To provide opportunities for further career advancement, professional growth, and increased prominence of women in engineering and in the disciplines of science supported by NSF; and to encourage more women to pursue careers in science and engineering by providing greater visibility for women scientists and engineers in academic institutions and in industry."[1]

To obtain information about major issues women scientists and engineers face in their careers, the POWRE program sent out a questionnaire via e-mail to the 98 recipients from 1997 and the 182 recipients from 1998. The survey included the following two questions: (1) What are the most significant issues/challenges/opportunities facing women scientists today as they plan their careers? (2) How does the laboratory climate (or its equivalent in your subdiscipline) impact upon the careers of women scientists? About 71.6% of the 1997 recipients and 76.6% of the 1998 recipients responded to the e-mail request.

Question 1

Table 1 outlines the 14 basic categories into

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Science Careers . . . continued

Most of the major issues/ challenges/ opportunities facing women scientists and engineers today as they plan their careers also face men scientists and engineers.

which answers given to question 1 were placed. Although one recipient from each year did not answer the question, most respondents gave more than one answer. Overwhelming numbers of respondents from each year found balancing work with family responsibilities to be the most significant challenge facing women scientists today. Not only does this finding replicate data from other studies on women scientists, it also correlates with an aim of POWRE to increase the participation of "women whose careers have been interrupted" and "provide extra support at a critical career stage . . . after a career interruption to accommodate family responsibilities or relocation requirements."[2] Large percentages of respondents from each year ranked time management issues, isolation and lack of camaraderie and mentoring due to small numbers, gaining credibility and respectability from peers, and two-career placements as major challenges, although time management appeared to be less of a problem and affirmative action backlash/discrimination more of a problem for 1998 than for 1997 recipients.

Quotations from the respondents provide the qualitative context to round out these categories and facilitate understanding of the women's responses concerning the specific ways these issues affect their careers. The opening quotations for this article provides an example of category A: pressures women face in balancing career and family. The following quotation exemplifies category B: issues faced by both men and women scientists and engineers in the current environment of tight resources, but which may pose particular difficulties for women:

> *"In contrast to other issues related to women choosing careers in science, the two-body problem [finding jobs for both spouses or partners] has received far too little public as well as governmental attention. Universities are basically tackling the problem individually; some act progressively, others don't. The fates of these capable women depend too much on the individual deans or department chairs involved."* (1998 Respondent 45)

The following response illustrates some of the subtle behaviors that categorize problems faced by women because of their low numbers and stereotypes held by others regarding gender:

> *"I think women have to prove their competence whereas men have to prove their incompetence. For example, I have often heard men question whether a particular woman scientist (say, one who is defending her thesis or is interviewing for a faculty position) actually contributed substantially to the work she presents, whereas, I have never heard a man questioned on this."* (1997 Respondent 6)

In contrast, category D contains examples of more overt discrimination and harassment:

> *" . . . and the affirmative action backlash. Many male colleagues think that women are where they are because of special treatment, not because of their accomplishments. Women have to constantly prove how good and deserving [they] really are. Because the job market has been so tough in recent years for all physicists, I think that the resentment by unemployed or underemployed male physicists toward women physicists has increased. Many think that a woman physicist has her position solely because she is a woman."* (1997 Respondent 24)

Most research surrounding gender differences has revealed that considerable overlap exists between the populations of men and women; differences become significant for population means only with relatively large sample sizes. Most of the major issues/challenges/opportunities facing women scientists and engineers today as they plan their careers also face men scientists and engineers. Some individual men may find more problems arising from these issues than some individual women. However, a variety of factors makes these issues more problematic on the whole for most women than for most men scientists and engineers.

Although family responsibilities become difficult to balance with work for some men who take on significant child-care responsibilities, balancing the tenure clock with the biological clock challenges women scientists and engineers who want to become biological mothers in ways never faced by men. However, most women scientists and engineers are also married to men scientists and engineers, often in the same field; the relatively low numbers of women scientists means that the reverse is not

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Science Careers . . . continued

the case, or most male scientists would not be married.[3]

The continuing low numbers of women in many science, engineering, and mathematics fields provide other particular challenges and some opportunities. These low numbers mean that a woman often serves as the first or one of few women in her department and college. Women may have no senior women colleagues to act as role models, serve as mentors for them, and provide them with access to networks of necessary professional information. In addition, because of their low numbers, women scientists and engineers are asked to serve on more committees (even at the junior level) and to advise (either formally or informally) more students.

Although these service activities may not be valued by the institution for promotion and tenure and may lead to difficulties with time management, they also provide opportunities for women to be visible and experience leadership and administration at an early stage in their career. Similarly, the low numbers that result in active recruitment of women into many areas of science, engineering, and mathematics have both positive and negative consequences. Demand in the engineering and computer science fields gives women starting salaries that are equal to or higher than that of their male counterparts.[4] The recruitment can lead to various forms of backlash, however, ranging from overt discrimination to difficulties gaining credibility from peers and administrators who assume that the woman was hired to fill a quota. Ironically, because POWRE is itself an award for women that seeks to address some of these issues, it is often perceived by male scientists and administrators as lacking in credibility and prestige, despite its 20 percent success rate, which makes it more competitive than most NSF awards.

The low numbers that result in active recruitment of women into many areas of science, engineering, and mathematics have both positive and negative consequences.

CATEGORIES	1997 % of Responses		1998 % of Responses	
1. Balancing Work with family responsibilities (children, elderly relatives, etc)	61.8	(42/68)	72.0	(85/118)
2. Time management/balancing committee responsibilities with research and teaching	23.5	(16/68)	9.3	(11/118)
3. Low numbers of women, isolation, and lack of camaraderie/mentoring	23.5	(16/68)	17.7	(21/118)
4. Gaining credibility/respectability from peers and administrators	22.1	(15/68)	17.7	(21/118)
5. "Two career" problem (balance with spouse's career)	20.6	(14/68)	11.0	(13/118)
6. Lack of funding/inability to get funding	8.8	(6/68)	5.0	(6/118)
7. Job restrictions (location, salaries, etc)	8.8	(6/68)	8.4	(10/118)
8. Networking	5.9	(4/68)	<1	(1/118)
9. Affirmative action backlash/discrimination	5.9	(4/68)	13.5	(16/118)
10. Positive: active recruitment of women/ more opportunities	5.9	(4/68)	9.3	(11/118)
11. Establishing independence	2.9	(2/68)	0	(0/118)
12. Negative social images	2.9	(2/68)	2.5	(3/118)
13. Trouble gaining access to non-academic positions	1.5	(1/68)	<1	(1/118)
14. Sexual harassment	1.5	(1/68)	<1	(1/118)
15. N/A	1.5	(1/68)	<1	(1/118)

Table 1

Question 2

Difficulty balancing career and family/time away from home (the same response as for question 1) was the problem cited by more respondents from both years than any other single issue in response to the question, "How does the laboratory climate (or its equivalent in your subdiscipline) impact upon the careers of women scientists?" In contrast to question 1, this response to question 2 was much less frequent; 1998 recipients ranked both negative factors (hostile environment/intimidating/lack of authority, lack of camaraderie, isolation, and establishing respect/credibility) and positive impact higher than did 1997 recipients.

Although many women did not mention problems in their laboratory or work environment related to gender issues, the largest number of responses did suggest that to some degree their gender led to their being per-

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Science Careers . . . continued

ceived as a problem, anomaly, or deviant in their laboratory/work environment. The following quotations provide examples of some of the negative factors experienced by women scientists and engineers in their laboratory/work environment:

> *"Male scientists dominate the scientific community and laboratory, and they tend to form boys' clubs that provide junior male members with more information, education, opportunity, visibility, and protection. Because female scientists have little chance to get benefits of this kind from such clubs, it is mandatory for female researchers to either spend extra effort to communicate with powerful male researchers, or to make an impeccable career record that highly exceeds that of her male colleagues."* (1998 Respondent 4)

> *"There are almost no women in my field, no senior women, and open harassment and discrimination are very well accepted and have never been discouraged in any instance I am aware of."* (1998 Respondent 53)

In contrast, some women have found the laboratory to be a place where their skills and experiences find best expression and use:

> *"I find that the laboratory is a great place for a woman and less and less a great place for an egocentric loner type. (I am not saying 'man' here because that would be sexist!! I certainly know some women who qualify for this title.) I have observed women to be overall more outgoing and willing to be team players, making them excellent contributors to research performed by a group of people. The women are the ones who organize the others. This is a double-edged sword, because we end up 'serving' others who are not so community minded, but in that this behavior is for the greater good, it also serves the women. Women are included in the intellectual environment of the lab and promote its openness. Given these positive roles for women in the lab, I do not see environment as a component of the proportionate loss of women in the higher ranks of academia. It is likely that precisely because they are such good team players, women are less good at 'blowing their horn' in job application/interview situations, and this hurts them for sure."* (1998 Respondent 76)

> *"I find the laboratory climate more liberal than, say, the 'office climate.' I also feel autonomous, powerful and free in this environment (maybe it's because I get to use power tools?). In the laboratory climate, I am able to create and build; I am also able to ask for help and delegate responsibility. Sometimes my colleagues ask me for help. There is a hierarchical structure at the laboratory in which I work, but it is more fluid; roles switch as projects come through. Sometimes I will take the lead and other times I will follow. In terms of my career, working in a laboratory offers a fantastic opportunity to work alone, work with a large group and manage a project, offer support to a colleague, and to build a small community."* (1997 Respondent 27)

"Working in a laboratory offers a fantastic opportunity to work alone, work with a large group and manage a project, offer support to a colleague, and to build a small community."

These positive comments suggest that the progress of women in science and engineering have positive aspects for both science and technology and the women themselves. Their presence represents the gender equity for which we strive, because it encourages the most creative, productive work from all scientists regardless of their gender and fosters the improvement of science as a whole. Attracting and retaining a critical mass of women in each subdiscipline in science, engineering, mathematics, and technology provides the first step toward creating a favorable laboratory climate. Acceptance of diverse approaches, lifestyles, and alternatives to problem solving creates supportive work environments in which all scientists are likely to thrive. ❖

Notes

1. National Science Foundation, *Professional Opportunities for Women in Research and Education.* Program announcement (Washington, DC: National Science Foundation, 1997).
2. Ibid.
3. G. Sonnert and G. Holton, *Who Succeeds in Science? The Gender Dimension* (New Brunswick, NJ: Rutgers University Press, 1995).
4. B. M. Vetter, "Myths and Realities of Women's Progress in the Sciences, Mathematics, and Engineering." In C.-S. Davis, A. B. Ginorio, C. S. Hollenshead, B. B. Lazarus, P. M. Rayman, and associates (Eds.) *The Equity Equation: Fostering the Advancement of Women in the Sciences, Mathematics, and Engineering* (San Francisco: Jossey-Bass, 1996): 29-56.

WEEA Resources for Gender and Science

Encouraging Girls in Math and Science

Many talented and interested girls still need encouragement to pursue math, science, and engineering. This pamphlet series opens the doors of opportunity for girls in math, science, and engineering by translating current research into practical suggestions and concrete action steps. *Math, Science, and Your Daughter: What Can Parents Do?* (also available in Spanish) helps parents encourage their daughters in math and science. *Working Together, Making Changes: Working in and out of School to Encourage Girls in Math and Science* addresses school staff and special program staff about the importance of working together to provide the highest level of success for girls. *Nothing Can Stop Us Now: Designing Effective Programs for Girls in Math, Science, and Engineering* addresses good program development for schools and communities to interest more girls in math and science. Covering the why, the what, and some of the how of program evaluation, *What Works and What Doesn't? Ways to Evaluate Programs for Girls in Math, Science, and Engineering* helps schools and program directors use evaluation effectively.•By Patricia B. Campbell 1992•#2738•$18.00

Girls and Young Women Inventing

Twenty True Stories about Inventors Plus How You Can Be One Yourself

How do young inventors get their ideas? What problems do they face, and how do they solve them? Not only for girls and young women, this book will inspire and motivate all inventors ages 11 and up. *Girls and Young Women Inventing* includes real-life stories by successful young inventors, step-by-step instructions on how to be an inventor, up-to-date information about inventors' associations and organizations, a chronology of women inventors, inspiring quotations from successful innovators, and a comprehensive list of suggested readings. From Free Spirit Publishing.•By F. Karnes and S. Bean (184 pp.) 1995•#2783•$12.95

How High the Sky? How Far the Moon?

An Educational Program for Girls and Women in Math and Science

This comprehensive program teaches science and equity at the same time. Girls can explore careers in physical sciences, life sciences, earth sciences, and engineering, and read about women scientists. It includes checklists to help students think through their own interests, abilities, and acquired skills. Activities are arranged by grade level and contain lesson plans and materials. By Sharon Menard (131 pp.) 1979•#2104•$21.00

Lifting the Barriers

600 Strategies That Really Work to Increase Girls' Participation in Science, Mathematics, and Computers

This book contains hundreds of teacher-friendly and teacher-tested strategies for successfully involving girls in math, science, and technology. Based on the experiences of 200 K–12 educators from every state in the country, the strategies range from the simple to the complex and from the obvious to the ingenious.•By Jo Sanders (111pp.) 1994•#2809•$13.95

Science EQUALS Success

Research has shown that females and people of color are underrepresented in science-related careers. *Science EQUALS Success* builds on the "fun" of science, motivating students during middle and secondary school—a critical period when many lose interest in math and science. Activities are designed to stand alone or supplement existing programs, so teachers may pick and choose activities to integrate into their science classes. The more than 30 hands-on, discovery-oriented science activities were field-tested by classroom teachers, and identified by the nationally recognized EQUALS Program as particularly successful with or needed by girls and students of color.•By C. R. Conwell (118 pp.) 1990•$25.00

Practical Tools and Support for Gender-Fair Learning

The WEEA Equity Resource Center at EDC can help you find the tools you need to create gender-fair multicultural learning environments.

Call the Center's hotline at **800-225-3088** or **TTY 800-354-6798** for resources and referrals.

The Center's website is full of exciting information and tools, from fun facts about the history of equality to a list of practical curricula designed to help make any subject gender-fair. The Center's website was designed to be accessible to users with disabilities.

www.edc.org/WomensEquity

On-line Math and Science Course for Teachers

In collaboration with the New England Comprehensive Assistance Center, the Center offers an on-line course called *Engaging Middle Schools Girls in Math and Science*. Using interactive on-line technology to build a "nation-wide classroom," this course allows teachers to explore ways to create middle school environments that support girls' math and science success. The course goals are to understand how to increase girls' interest and achievement levels. For more information, visit the Center's website.

The Scientist Within You, Vol. 1

Experiments and Biographies of Distinguished Women in Science

An excellent step-by-step guide to hands-on science experiments and activities inspired by the work of 23 female scientists. Girls and boys in grades 3–9 can discover their own science skills while learning about women's historical achievements in science and mathematics. Each unit includes a biography, photos, drawings, experiments using easy to obtain items, reproducible student sheets, a timeline, a lesson plan, and a bibliography. From ACI Publishing. • By R. L. Warren and M. H. Thompson (182 pp.) 1996• #2781•$18.95

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Becoming a Scientist . . . continued

can women, that usually meant working as a teacher, nurse, social worker, or in some other position serving the Black community in segregated Birmingham. I always expected to work outside the home—my mother worked, my aunts worked. Although I wanted marriage and children, I don't know if I really expected to have these—not because I believed marriage, family, and career to be incompatible, but more because I wasn't sure I would find a spouse who shared my view on this subject. My family valued education, as most of the people in the community did, seeing it as the way to a better life and, ultimately perhaps, the way to equality. I would seek higher education and a job, in that order. It was expected.

All of these were wonderful things to do, but they did not give me the joy that I felt in exploring science—to know, to understand, to find out about the world and my place in it.

Although I did what was expected in some ways, in other ways I was a maverick. My career aspiration was a bit off the well-traveled road. I wanted to be a medical doctor, or so I thought at the time. That was, after all, the only career with which I was familiar that would allow me to continue a lifelong interest in mathematics and science. I loved math and science and was good at these subjects. In fact I was better than any boys in my class. In my high school, which was all Black even at my graduation almost ten years after *Brown v. The Board of Education*, you had to take math and science. Male or female, you could not opt out of these subjects; you were tracked in.

Birmingham had its problems in 1963, the year I left home to go to college. We didn't have a senior prom; instead we were living under curfew and martial law. Many students in my graduating class were in jail for participating in the demonstrations, and it was not clear until only a week before graduation whether they would be allowed to march and receive their diplomas. Dr. Martin Luther King had gone to Atlanta and gotten a federal court order that required the Board of Education to let these students finish. There were lots of disadvantages growing up in those times in Birmingham. But after conversations with my white female friends in college at the University of Washington, I realized that there were also many advantages to growing up Black and female in the South during the 1950s and 1960s. I never had to argue about going to college, never had to hide my desire for something nontraditional, and even the possibility of a graduate education did not scandalize anyone too much.

My idea of pursuing a medical education was approved, but three years into my undergraduate education I decided that medicine was not for me. My wise and caring adviser said, "Why not academic science?" Was he suggesting that I do what he did? (He was.) And could I do this? (He believed I could.) He saw something in me that I could not yet see in myself.

Since none of my family knew any scientists, there were no images, either negative or positive, to affect the choice I later made. My choices were open because neither I nor anyone else had closed them for me. I had encouragement and permission to enter science from someone whom I admired and respected. That there may have been negative comments or raised eyebrows from some of the others mattered very little. I had a lot of practice ignoring such gestures.

Had I decided to become a scientist earlier, I might have taken advantage of different opportunities, such as doing undergraduate research. I knew a lot of science, but I had not yet learned to think like a scientist. I had knowledge, but I did not yet have understanding.

The world does not suddenly stop when you are in school. As the larger issues of the day rose up to meet me, I wondered about my choices. For me the issues that intruded into my world were America's struggle to overcome its history of race discrimination; the growing unrest of women, who, like Blacks and other minorities, were seeking civil rights and questioning the traditional roles assigned to them; the Vietnam War; the environmental movement; and the fall of one leader after another to the assassin's bullet. Shouldn't I go into some field where I could affect some of these issues, where I could do some good—maybe law, social work, teaching? All of these were wonderful things to do, but they did not give me the joy that I felt in exploring science—to know, to understand, to find out about the world and my place in it. I was not hiding out in the lab. I came to understand that concern for social justice could be expressed anywhere: by mentoring freshmen women, reassuring them that it was OK to do something nontraditional; by refusing to settle for anything less than excellence so as not to reinforce low expectations; by

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Additional Resources

Achieving Gender Equity in Science Classrooms

Designed to examine the role that science education plays in the underrepresentation of women in science. Includes case studies of introductory science classes at the colleges belonging to the New England Consortium of Undergraduate Science Education, surveys of syllabi and textbooks used in science classrooms, a survey of literature on the history of women in science and current research on gender and science education, and interviews with male and female science faculty.•New England Consortium for Undergraduate Education (1996). Office of the Dean of the College at Brown University, Providence, RI. Web: **www.brown.edu/Administration/Dean_of_the_College/homepginfo/equity/Equity_handbook.html**

Breaking the Barriers

Helping Female and Minority Students Succeed in Mathematics and Science

Describes barriers to participation and success in mathematics and science by female and minority students. The authors demonstrate that early intervention, especially in grades 4 through 8, can help overcome some of these obstacles; increased career awareness and exposure to mentors and role models can help students see science- and math-related careers as desirable and viable options. Also discusses test preparation, cooperative learning, and tutoring.•B. Chu Clewell et al. (1992). Jossey-Bass, Inc., 350 Sansome Street, San Francisco, CA 94104.

Girls Can Succeed in Science!

Antidotes for Science Phobia in Boys and Girls

Girls Can Succeed in Science! is a collection of time tested methods and activities designed to inspire genuine interest and enthusiasm for the sciences, while at the same time building self-confidence. These activities can be implemented easily and used successfully by anyone. The book offers specific techniques that can be applied immediately to help all students overcome the misconception that "we are not good at science."•Linda S. Samuels (1999). Corwin Press, Inc. 2455 Teller Road, Thousand Oaks, CA 91320; (805) 499-9734. Web: **www.corwinpress.com**

A Hand Up

Women Mentoring Women in Science

Contains recommendations and reflections from accomplished women scientists, dispels myths about mentoring, and encourages female scientists to mentor young women. Includes a resource listing useful to all women who seek mentors or who wish to mentor.•Association of Women in Science (1995). Association for Women in Science, 1200 New York Ave., NW, Suite 650, Washington, DC 20005; fax (202) 326-8960. Web: **www.awis.org**

Has Feminism Changed Science?

Explores the history of women in science as well as the role gender has played in the pursuit of scientific knowledge. Compelling and well-researched, this history not only debunks many popular myths—such as that women are better at "soft science"—but also provides a backdrop for Schiebinger's next argument: that women have already changed the way that science itself is studied.•L. L. Schiebinger (1999). Harvard University Press, 49 Garden Street, Cambridge, MA 02138; (800) 448-2242.

Nobel Prize Women in Science

Their Lives, Struggles, and Momentous Discoveries

Exploring the reasons why only nine of the more than 300 recipients of the Nobel Prize in science have been women, science writer McGrayne examines the lives and achievements of 14 women scientists who either won a Nobel Prize or played a crucial role in a Nobel Prize–winning project. Their stories are case studies of triumph over relentless gender discrimination.•S. Bertsch (1998). Carol Publishing Group, 120 Enterprise Avenue, Secaucus, NJ 07094.

Procedures to Increase the Entry of Women in Science-Related Careers

Once courses become optional in secondary school, the downhill spiral in enrollment of female students in mathematics and physical science begins, accompanied by decreases in achievement and interest. This digest explores why this topic is important, what can be done to improve the situation, what kinds of interventions are possible, and how intervention programs fit into the educational reform movement in science education.•Patricia E. Blosser (1990). ERIC Clearinghouse for Science, Mathematics, and Environmental Education, Columbus, OH; (800) LET-ERIC.

Women, Minorities, and Persons with Disabilities in Science and Engineering: 1998

This report is the ninth in a series of Congressionally mandated biennial reports on the status of women and minorities in science and engineering. The report documents both short- and long-term trends in the participation of women, minorities, and persons with disabilities in science and engineering education and employment. This year, the online versions offer additional features that take advantage of Web technology to assist in finding and displaying information.•National Science Foundation, 4201 Wilson Boulevard, Arlington, VA 22230; 703-306-1234. Web: **www.nsf.gov/sbe/srs/nsf99338/start.htm**

Women in Science

A video overview of the history of women in science for grades 8–12. This positive and compelling video opens with a summary of the factors that have historically kept women from playing a major role in science and how that story is changing. Six contemporary women tell about their careers as scientists. Video, 42 minutes, color, plus full script.•The National Women's History Project. National Women's History Project, 7738 Bell Road, Windsor, CA 95492-8518; (707) 838-6000. Web: **www.nwhp.org**

Innovations . . . continued

Programs in innovative settings offer opportunities to reach populations other than those reached by classroom-based interventions.

new opportunities to capture girls' interest in SMET and SMET careers and, equally important, to engage community resources in SMET and gender equity issues in innovative ways.

Traditional Settings
- Classrooms in schools

Innovative Settings
- Museums and parks
- Health care facilities
- Television and radio stations
- Research facilities
- Government and university laboratories
- Industrial and commercial sites
- Community groups
- Community centers
- On-line

Traditional interventions in the classroom include SMET courses (usually at the high school or university level), gender-fair SMET curricula, and gender equity training for educators. These components are integrated into the regular curriculum or school setting with varying degrees of success. The populations engaged in traditional settings are generally limited to educators and students.

Informal and nontraditional settings, including after-school clubs, neighborhood or community centers, local organizations (such as Girl Scouts and 4-H), museums, radio and television stations, and community industries, provide new contexts and opportunities for girls. Specifically, they engage new audiences in community dialogue about SMET and gender equity; involve multigenerational approaches; draw on new material resources; and provide the framework to deliver proven strategies to encourage girls to pursue SMET interests.

Expanding Audiences and Resources

Programs in innovative settings offer opportunities to reach populations other than those reached by classroom-based interventions. These programs may engage whole new audiences—for example, paraprofessional staff at a neighborhood community center or scientists at a government or commercial research facility—who have not previously thought about SMET and gender equity. Outside the traditional one-grade classroom, multiple layers of service recipients and deliverers can be incorporated in innovative settings. For example, older students can be engaged in a learning process that includes leading activities for younger children, transforming the experience into a multigenerational exercise.

In addition, programs in nontraditional settings bring new resources (funds, facilities, technology, human capital) to the gender equity arena. Capitalizing on extant material and personnel resources—assets that are frequently beyond the average school or school district's resources—broadens the scope of SMET experiences available to girls. Outside resources are particularly valuable in the most underfunded urban and rural districts, where girls have few authentic classroom-based SMET experiences because of lack of materials and equipment.

Intervention Strategies

Innovative settings permit the implementation of proven strategies to engage girls in SMET more effectively than those used in the class-

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Becoming a Scientist . . . continued

confronting bigotry and narrow-mindedness from those who saw deficiency in difference.

I believe that women's presence in science will affect the makeup of the audience of professional meetings and the faculties of universities. We will also affect the values and perspectives that are brought into play, the science that is done, and the applications that flow from the science. But economics and decision making aside, we will find the joy of knowing, the empowerment that comes from understanding, and hopefully the wisdom to put it all to good use. ❖

Innovations . . . continued

room. Some intervention strategies are particularly suited to innovative settings, particularly mentoring / role modeling, summer camp experiences, internships, and electronic communication.

Mentoring / Role Modeling. This strategy links SMET professionals with girls who have limited knowledge of the availability and relevance of SMET study and career opportunities. Interacting with scientists and engineers from local industry, universities, or research facilities; physicians; nurses; veterinarians; radio and television technicians; and others in technical professions permits girls to see SMET professionals active in the community. Interventions that take place in the work place, such as career-shadowing field trips, are particularly suited to this purpose.

Summer Camp. The opportunity to spend a week or more in a setting that encourages girls to pursue their SMET interests in the company of like-minded peers can be invaluable for girls who do not receive positive support in the traditional school setting. Summer camps sponsored by universities, community groups, museums, or research facilities offer an intensive exposure to SMET concepts and skills, often in more depth than school curricula provide. Personal growth (enhanced self-confidence and SMET self-efficacy) as well as academic accomplishment often result from such summer camp experiences.

Internships. Research in teaching and learning demonstrates that for many students the best way to learn is to do. Engaging girls in the research process through meaningful internships in local industry or universities broadens their horizons, gives them opportunities to learn new skills and demonstrate their proficiencies, provides role model contact with SMET professionals, and sparks personal and academic growth. Early internship experiences may shape the education and career plans of girls as early as middle school, encouraging them to form long-term career goals.

Cyberspace as a New Setting. As technology proliferates, so do opportunities to engage girls in meaningful SMET experiences on-line. The electronic realm of cyberspace has become a "setting" for SMET interventions in recent years. Several recent interventions centered on helping girls make connections with female SMET professionals via e-mail or the Internet . Although electronic mentoring, or "telementoring," lacks the immediacy of face-to-face relationships between mentors and mentees, the benefits to girls in communities where female role models in SMET are unavailable are very real.

Conclusions

Traditional in-school interventions often benefit participants, but their scope and impact are limited by the structure and resources of the school or school system. In addition to augmenting the number and types of science experiences girls receive, informal science programs in innovative settings offer girls access to "real world" SMET environments, broaden their perspectives, and provide opportunities for more authentic SMET experiences. Beyond direct benefits to target populations, innovative settings also provide opportunities to engage SMET professionals and others in SMET and gender equity issues. Finally, creativity in intervention settings provides opportunities to draw on new human and material resources beyond those available within schools. ❖

Informal science programs in innovative settings offer girls access to "real world" SMET environments, broaden their perspectives, and provide opportunities for more authentic SMET experiences.

Notes

1. S. J. Farenga and B. A. Joyce, "Beyond the Classroom: Gender Differences in Science Experiences," *Education* 117 (1997): 563-568; S. J. Farenga and B. A. Joyce, "What Children Bring to the Classroom: Learning Science from Experience," *School Science and Mathematics* 97 (1997): 248-252; J. Butler Kahle and M. K. Lakes, "The Myth of Equality in Science Classrooms," *Journal of Research in Science Teaching* 20 (1983): 131-140.
2. Kahle and Lakes, "The Myth of Equality in Science Classrooms," 131-140.
3. S. J. Farenga, "Out-of-School Science-Related Experiences, Science Attitudes, and Selection of Science Mini-Courses in High Ability, Upper Elementary Students," *Dissertation Abstracts International* (1995), p. 1242 (University Microfilms No. 9525483); J. Butler Kahle, "Why Girls Don't Know," in *What Research Says to the Science Teacher: The Process of Knowing*, ed. by M. Budd Rowe Vol. 6 (Washington, DC: National Science Teachers Association, 1990), 55-67.
4. V. Crane, "An Introduction to Informal Science Learning and Research," in *Informal Science Learning: What the Research Says about Television, Science Museums, and Community-Based Projects*, ed. by V. Crane (Dedham, MA: Research Communications, Ltd, 1994), 1-14.

Innovations in Intervention Settings

By Katherine Darke and Beatriz Chu Clewell, The Urban Institute

Innovative, nontraditional settings may be the key to achieving gender equity goals in science, math, engineering, and technology.

By the time they reach school, boys and girls have had quite different out-of-school science experiences, and this disparity persists through high school.[1] There are marked differences between male and female levels of participation in extracurricular science activities, with males participating more often in activities such as working on science projects or hobbies.[2] This lack of informal science experience may negatively affect future learning outcomes in science for girls.[3]

Informal science learning is promoted by activities that occur outside the school setting, are not developed primarily for school use, and require voluntary as opposed to mandatory participation as part of an accredited school experience.[4] Out-of-school intervention programs offer opportunities for informal science learning in a host of innovative settings that help bridge the gap between girls' everyday lives and science.

Traditional vs. Innovative Settings

With increasing frequency, experimental interventions to make science, math, engineering, and technology (SMET) accessible to girls demonstrate that innovative, nontraditional settings may be key to achieving goals in SMET and gender equity. "Setting" refers both to the physical location of the intervention (e.g., a museum, zoo, or commercial pharmaceutical laboratory) and to the context in which the intervention is delivered (e.g., through the Girl Scouts or 4-H or neighborhood community center). A recent review of projects funded by a multimillion dollar government program revealed a range of innovative settings in SMET programming for girls. These nontraditional settings yield

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WEEA is the Women's Educational Equity Act: federal legislation to promote educational equity for girls and women.