DOCUMENT RESUME

ED 446 998 SE 064 303

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TITLE	Women in Science and Technology, and the Role of Public Policy.
PUB DATE	2000-11-04
NOTE	10p.; Paper presented at the Meeting of the Association for Public Policy Analysis and Management (Seattle, WA, November 4, 2000).
PUB TYPE	Guides - Classroom - Teacher (052) -- Speeches/Meeting Papers (150)
EDRS PRICE	MF01/PC01 Plus Postage.
DESCRIPTORS	Elementary Secondary Education; *Equal Education; *Females; Higher Education; Preservice Teacher Education; Science Careers; *Science Instruction; *Sex Differences; Technology Education

ABSTRACT

This paper first presents statistical snapshots of the situation for girls and women in education and employment. It focuses on the place of females in science and technology, and discusses what those facts make them into problems. It offers the role of teacher education in creating more gender-equitable classrooms. (ASK)

WOMEN IN SCIENCE AND TECHNOLOGY, AND THE ROLE OF PUBLIC POLICY

Association for Public Policy Analysis and Management

Seattle, Washington
November 4, 2000

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WOMEN IN SCIENCE AND TECHNOLOGY, AND THE ROLE OF PUBLIC POLICY

As you probably know, women are underrepresented in science, technology, and mathematics, even now, 30 years after the advent of the modern women's movement. Here are some statistical snapshots of the situation for girls and women in education and employment:

- Standardized achievement tests taken in 1996 show that while 9-year-old boys and girls score almost the same in math and science, the gaps widen when children are 13 and 17. [1]
- Boys still considerably outnumber girls in high school Physics: 32 percent of boys and 26 percent of girls took it in 1998. [2]
- Girls took 17 percent of the lower-level Advanced Placement exams in Computer Science in 1999, and 9 percent of the higher-level CS exams. [3]
- Here is the percentage of Masters and Doctoral degrees earned by women in 1996 in selected fields: [4]

	Masters	Doctorates
Physical sciences and science technologies	32.2 %	23.1 %
Computer and information sciences	26.7 %	14.5 %
Engineering	17.2 %	12.5 %

- Women are 46 percent of the entire labor force, but 22 percent of the science and engineering labor force. [5]

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[1] U.S. Department of Education, National Center for Education Statistics, *NAEP Trends in Academic Progress, 1997.*
[2] U.S. Department of Education, National Center for Education Statistics. "High School and Beyond," 1998 High School Transcript Study.
[3] The College Board (1999) Advanced Placement Program: Washington and National Summary Reports.
[4] U.S. Department of Education, National Center for Education Statistics, 1998.
[5] National Science Foundation (1999). Women, Minorities, and Persons with Disabilities in Science and Engineering: 1998. Arlington VA, p. 99.

- Women's participation in science and engineering occupations ranges from a high of 40.4 percent for the biological sciences to a low of 5.1 percent for mechanical engineering. [6]
- In addition to being underrepresented in science and engineering occupations, women earn less than men: [7]

Occupation	% women	Women's avg. salary	Men's avg. salary
Computer systems analysts and scientists	28.5 %	$47,164	$56,108
Engineers	10.6 %	$48,516	$55,016
Natural scientists	30.1 %	$38,012	$48,828

- While women are 11 percent of the board members of Fortune 1000 companies, they represent only 3 percent of the board members of so-called "new economy," or high technology, companies. [8] A woman who runs an Internet company is quoted as saying, "You look around and see mostly male faces, especially at the higher management levels." [9]

The Imbalances Matter

These are facts. What makes them into problems?

First, the imbalances are bad for the national economy and our global competitiveness. They limit the talent pool available to scientific and technical enterprises. Because scientific and technical jobs tend to pay more than traditional "women's" jobs, the forgone higher salaries mean that taxes that could be paid, aren't. Products that would have been invented by women cannot be sold. If Bose hadn't hired female engineers, they would have lost out on their best-selling speakers — one of their female engineers

[6] Ibid., Table 5-1.
[7] U.S. Department of Labor, Bureau of Labor Statistics (2000). Household data annual averages, Table 39 and Table 11, 1999 data.
[8] Griffith, Victoria (2000). "It's a Man's New Economy." FT.com (Financial Times), August 24, 2000.
[9] Ibid.

had pushed for it in the belief that small speakers would be more popular with women.

The limited talent pool is especially critical in the high technology sector of the economy. There are now 800,000 technical jobs open in technology-driven companies, according to the Information Technology Association of America. [10] Each of these vacant positions is delaying or preventing the introduction of products or services that could be sold, that could be making people's lives better or easier.

Another cost is to women's careers and their families' financial well-being. Many thousands of American families today are living on less income than they would otherwise have had if more women were in the sciences and technologies.

To the extent that women's socialization results in approaches and mindsets that differ from men's, we lose benefits that research done or advocated by women would have brought. The field of primatology has been all but revolutionized by the advent of women. [11] Medicine, too, has been significantly improved now that drug trials are conducted on female subjects as well as male subjects, enabling us to achieve more accurate prescriptions and dosages for the other half of the population. [12]

In still another area, when women are underrepresented in the sciences and technical areas, they are unavailable as role models for their daughters and other young girls. This tends of course to perpetuate the imbalance. They are also unavailable to serve as living proof to boys and men that women can indeed make excellent scientists.

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[10] Geewax, Marilyn (2000). "If women ruled: Female techies imagine a world." The Atlanta Journal-Constitution, August 27, 2000.
[11] Schiebinger, Londa (1999). *Has feminism changed science?* Cambridge, Mass.: Harvard University Press.
[12] Ibid.

These are all national concerns. They legitimately call for the development of public policy concerning women in science and technology.

The Role of Teacher Education

If our classrooms were more gender-equitable, we wouldn't have the science and technology gender gaps we do, but there is no national law that requires classrooms to be gender-equitable. Title IX, a federal law, exclusively concerns *equal access* to educational benefits in schools accepting federal monies (with a few carefully specified exceptions), and therefore has had more success in athletics than in academics. Because of constitutional constraints where education is concerned, states retain the right to determine curriculum and teacher certification requirements, among other areas, which have more impact on what happens in the classroom.

There has been a considerable effort at bringing gender equity training and materials to the classroom for the last quarter-century. However, in view of the fact that the effort has never been adequately funded at either the state or federal levels, it has been inconsistent. In addition, there are three and a half million instructional staff in our public schools alone, with more of them in private schools. [13] How would we ever deliver adequate staff development to all these people?

A much easier way, at least for the long run, is via teacher education for *pre-service* teachers, that is, student teachers. Compared to millions of instructional staff, there are only 1,128 institutions of higher education in the United States that confer bachelors degrees in education, and 877 that confer masters degrees, the two entry-level degrees depending on state certification requirements. [14] It is likely that most of the 877 overlap with those in the 1,128, which reduces the numbers considerably. Let us say, then, that our

[13] : U.S. Department of Education, National Center for Education Statistics (2000). *Digest of Education Statistics 1999*, Table 83.
[14] Ibid., Table 262.

goal is to be sure that gender equity — in curriculum, in classroom interactions, in pedagogy — is effectively taught to new teachers and administrators in 1,200 colleges and universities across the country, an average of 24 per state. This is certainly feasible in terms of scope.

Several studies carried out in the 90's confirm, however, that gender equity is in its infancy in teacher education. In a Michigan survey of 30 administrators and 247 faculty members from 30 pre-service teacher education programs statewide, Mader found that while faculty thought gender equity was important, only 11 percent of them reported extensive coverage while 38 percent reported minimal to no coverage. [15]

A nationwide survey by Campbell and myself of a randomly selected national sample of 353 methods instructors in mathematics, science, and technology revealed that while three-fourths of the respondents said they considered gender equity important, most taught it less than two hours a semester. They focussed almost exclusively on problems, such as biased classroom interactions, and very little on solutions, such as gender-fair pedagogical techniques. [16]

Taking another angle, an analysis by Titus of recent textbooks used in educational foundations courses found that they did not include significant material on gender equity. [17] A recent survey by Pryor and Mader of pre-service students and faculty found once again that while faculty thought gender equity important and taught it relatively little, students indicated that they were most likely to learn about gender equity — if they did —in teacher

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[15] Mader, Cynthia (1994) Gender equity instruction in Michigan teacher education programs. Doctoral dissertation, Michigan State University. *Dissertation Abstracts International*, 55, 1917-A.

[16] Campbell, Patricia B. and Sanders, Jo (1997). Uninformed but interested: Findings of a national survey on gender equity in pre-service teacher education. *Journal of Teacher Education*, (48)1, 69-75.

[17] Titus, Jordan (1993). Gender messages in education foundations textbooks. *Journal of Teacher Education*, 44(1), 38-44.

education courses. [18] So if students don't learn gender equity in teacher education, they pretty much won't learn it at all.

The scarcity of attention to gender equity is particularly surprising in view of the opportunity provided by several reports issued by major education organizations in the last two years on reform in teacher education. The Association of American Universities passed a resolution on teacher education, which did not address gender equity. [19] The American Council on Education published "To Touch the Future: Transforming the Way Teachers are Taught," and did not address gender equity. [20] The American Association of State Colleges and Universities published its "Call for Teacher Education Reform," and passed up a perfect and easy opportunity when it referred to "the challenges presented by the full range of ethnic, economic, and intellectual diversity." [21] In fact, the title of a new publication by Blackwell *et al.* says it all: "Education reform and teacher education: The missing discourse of gender." [22]

Leaving attention to gender equity in teacher education up to a committed individual faculty member is not an adequate professional response to the need. Leaving students' gender equity learning up to whatever they might glean from television or the newspaper is even worse.

Just about the only help in this area has come from the Program for Gender Equity at the National Science Foundation, which has supported

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[18] Pryor, Sherrill E. and Mader, Cynthia E. (1998). Gender equity instruction in teacher education: What do students learn? What do faculty teach? What are the influences" Paper presented at the annual meeting of the American Educational Research Association, April 16, 1998, San Diego.

[19] Association of American Universities (June 1999). Resolution on Teacher Education. www.tulane.edu/~aau/Resolution

[20] American Council on Education (October 1999). To touch the future: Transforming the way teachers are taught. Executive summary at www.acenet.edu/about/programs/programs&analysis/policy&analysis/presnet/exec-summary.cfm#must-act

[21] American Association of State Colleges and Universities (March 1999). Call for teacher educ;ation reform: A report of the ASCSU task force on teacher education.

[22] Blackwell, Peggy, with Applegate, Jane; Earley, Penelope; and Tarule, Jill Mattuck (2000). Washington DC: American Association of Colleges for Teacher Education.

several projects dealing with gender equity in teacher education, including three of mine since 1993. Because gender equity involves far more than mathematics, science, and technology (NSF's key areas), I have urged the people I've worked with to take advantage of the opportunity to extend the project's reach to areas such as literacy, history, the arts, and others. And often they have.

Many valuable lessons for the profession have emerged from these projects, but all of them rest on one fundamental decision. Colleges, schools, and departments of education must decide if they believe that gender equity has a legitimate place in the pre-service teacher education curriculum — in other words, if they believe that preparing future teachers with an understanding of gender roles will result in better academic and social learning for girls and boys which would better equip them for life in the twenty-first century. If so, then several points follow.

First, gender equity must be systemic. It doesn't work to rely on a personally committed faculty member to teach it: if that person leaves the university, no knowledge is left behind. Even if the person remains there, unless the department is *very* small then only some fraction of the students will learn about gender equity. Making gender equity a required course is also problematic: it achieves coverage but there is so little available course time in most programs that it's out of the question. Moreover, when gender equity (or multicultural education for that matter) is delivered in the form of a required course it becomes balkanized, a sidebar for students to the "real" work of education, and leaves other faculty ignorant of important gender equity dimensions in educational foundations, methods courses, and field experience.

Second, while teacher educators very much want to learn about gender equity so they can teach it to their students, they understandably aren't about to embark on time-consuming self-education on top of their other work. They need a concise program of instruction and materials to jumpstart their

new expertise, and a way must be found to give it to them. This is called "education," and it should not be beyond the capabilities of educational institutions to provide it.

And the third point is that for the first two to happen, gender equity needs to be on the agenda of the teacher education profession. Professional associations need to issue position papers and commission reports on it. Professional meetings need to feature well-known speakers addressing the importance gender equity in teacher education. Academic journals and presses need to solicit manuscripts and publish on gender equity in teacher education. Accreditation organizations need to make gender equity an explicit standard for review. The silence on the topic must not continue.

And it need not. A consensus of educators, scientists, and public policy specialists can agree on the role of teacher education in ameliorating the nation's shortages of technically trained people by teaching new teachers how to encourage girls and women to persist in these areas. It can be done. Let's get to it.

SE014303

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