Interventions to Increase the Participation of Women in Physics

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Despite the major progress that has been made during the past decade to increase the opportunities for women in science and engineering, the results to date in certain physical science fields, especially in physics, leave much room for further effort.

At the B.S. level, only 15% of the physics degree recipients at American universities are women, and at the Ph.D. level, the percentage decreases to 11%. In the faculty ranks, the percentage of women with tenured or tenure-track appointments in physics is only about 3%, the lowest percentage of the many countries shown in Table 1 that are seriously engaged in physics research. It is commonly believed that a presence of 15% is necessary to achieve critical mass in the education process (*1*). When women in a particular institution achieve critical mass status, their performance in the classroom and in the workplace tends to become indistinguishable from that of their male counterparts. However, when the number of women falls below critical mass, their retention rate decreases relative to men, as does their average performance.

In recent years, the physics community in the United States has become concerned about the small number of women in physics and the reduction in this number as women move toward faculty positions (see Table 1). Although the physics community has been concerned about the relatively small number of women beginning in physics, considerable effort is also being made to sustain the women who have already committed to physics. This article thus focuses on women already in the pipeline. The program we describe concentrates on change at the local level, at the colleges and universities where physicists are educated and where they get their first exposure to the profession and to practicing physicists.

We have two reasons to believe that appropriate interventions should have salutary effects. First, women in other countries, such as France and Italy, have had significantly greater participation in the physics enterprise (on a percentage basis) than American women (see Table 1). French women physicists have benefited from the notable success of Marie Curie and Italian women have had a long history of scientific involvement. These international comparisons indicate to practicing physicists that local societal factors play a key role in women's choices about careers in physics. Second, the fluctuations in the distribution of women students and faculty in physics from one American university to another are quite large, and the percentage of women physicists in the department is not correlated with the academic rankings of these departments.

If we were to rank the physics departments in the United States according to their success in educating and employing women physicists, the distribution of women in the top 5% of the physics departments would likely compare favorably with the data from other countries (see Table 1). Thus, if one could identify the factors contributing to the supportive atmosphere found in the "best" departments (again, ranked in accordance with their success in attracting women faculty and students) and replicate this supportive atmosphere in departments that have been less successful, but wish to improve, then we have the basis for introducing a successful intervention program to increase the opportunities for women in physics. If the retention of women in physics, starting with college, could be improved so as to be more comparable to that of other countries, then we believe that the percentage of American women physics professionals would also increase.

The impetus for action came at the 1990 meeting of Physics Department Chairs, sponsored by the American Association of Physics Teachers (AAPT) and the American Physical Society (APS), where a resolution was passed that both organizations should consider a course of action to improve the climate for women physicists working and attending American universities. In response, the women's committees of the AAPT and the APS proposed a program of physics department site visits, to be done only upon request from the departments. With the initial program, funded by the APS, visits to five universities, both public and private, were made in 1991 and 1992. The institutions visited were Bryn Mawr College, the University of Maryland, the University of Pennsylvania, Rensselaer Polytechnic Institute, and the University of Virginia. The site visit teams generally consisted of five women physicists, most being well established and with considerable research experience.

With support from the National Science Foundation (NSF), we have now begun a study of 10 additional schools (*2*), and a national survey of undergraduate and graduate physics students on the academic and general atmosphere of a department from a student viewpoint. The questionnaires currently used benefited from experience gained from the first group of site visits, and focus on relations between students and their peers and teaching assistants, as well

Table 1. Degrees to women in physics and women as physics faculty (in percent) (*4*).

Country	Degrees to recent graduates		Faculty
	Bachelor's	Doctorate	
Belgium	33	29	11
Brazil	24	31	18
Democratic German Republic	12	18	8
France	24	21	23
Hungary	50	27	47
India	25	26	10
Ireland	22	20	7
Italy	29	21	23
Japan	7	4	6
Korea	20	5	3
Netherlands	20	4	6
New Zealand	10	11	6
Philippines	28	60	31
Poland	14	17	17
South Africa	24	21	9
Spain	17	21	16
Turkey	38	17	23
Union of Soviet Socialist Republics	34	25	30
United Kingdom	16	12	4
United States	15	9	3

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as classroom and research experiences. Certain consistent patterns are beginning to emerge. Factors that appear thus far to be most important for creating a favorable climate for women include the commitment of the department chair and key faculty to the success of women physics students, the presence of more than one senior woman physics faculty member, the effectiveness of communication between students and faculty, the availability of day care, and a safe environment. The ability of Kenneth Krane, who chairs the Oregon State University physics department, to improve dramatically the number of women students and faculty and the general climate for women is an outstanding example of what can be accomplished by a chair whose commitment to change is strong (3).

At each university, the site visit team meets initially to discuss the agenda, and then sequentially with the physics department chair, groups of physics faculty members, women faculty members in physics (or in related areas), women graduate students, women undergraduates, and administrators responsible for faculty appointments. These meetings aim to provide the site visit team with both quantitative and anecdotal information on the status of women physics students and faculty, including problems they may be encountering that are preventing them from pursuing their studies or careers in physics on an equal basis with men. Following review of the findings, the site visit committee meets again with the department chair. This is followed by a report by the committee to the department chair, and a response from the department chair 6 months later describing actions taken to improve the climate for women physicists, whether undergraduate, graduate, or faculty.

We expect a variety of outcomes from this intervention program. Changes will likely be made at each university visited, stemming from suggestions made through the site visit or through the department's own creative actions. Some of the most common actions that have been reported thus far include efforts to recruit additional women faculty members, and actions to open channels of communication between women students with one another and with the department chair through meetings, pizza parties, coffees, or other departmental events. From our experience thus far, it seems that the site visits will identify factors which are responsible for a supportive environment for women, and which lead to successful outcomes for women in physics. At the end of the project, a report will be written under an NSF grant to provide a framework to help other physics departments (not explicitly visited under our program) establish through their own efforts on a self-evaluation basis a supportive environment for physics study and careers for women. It is our expectation that the interventions resulting from the site visit program will improve the climate for all physics students and faculty, both women and men.

The general features of the intervention program described above go beyond the physics community, and could have an impact on other areas of science and engineering. In this connection, the Association for Women in Science has been studying this initiative of the physics community, and is exploring ways to promulgate the site visit concept more broadly to other fields of science and engineering, and to replicate effective programs and practices found in those academic departments that are most successful in training and employing women physicists.

From the site visits that have been carried out, we have found that it is not enough for faculty members to give good lectures and engage in world-class research. As educators, faculty members must also be concerned about providing a welcoming and supportive environment for their colleagues and their students. Constructive attitudes, a caring approach, open communication channels between faculty and students, and good will can go a long way toward enhancing successful outcomes for students and young faculty members.

REFERENCES AND NOTES

1. M. L. Matyas and L. S. Dix, Eds., Report of the Ad Hoc Panel on Interventions of the Committee on Women in Science and Engineering, Office of Scientific and Engineering Personnel, National Research Council, "Science and Engineering Programs: On Target for Women?" (National Academy Press, Washington, DC, 1992).
2. Five of the ten NSF-funded visits have already taken place: to the University of Illinois at Urbana, Michigan State University, the University of New Mexico, Kansas State University, and Stanford University. We have been requested to provide site visits to North Carolina State University, the State University of New York at Stony Brook, Harvard University, the University of Rochester, and the University of Texas at Austin. We plan to complete these visits during 1994. The site visit teams have all been led by the authors of this article.
3. M. Fehrs and R. Czujko, Eds., *Proceeding of the Conference on the Recruitment and Retention of Women in Physics*, Washington, DC, 1989 (American Institute of Physics, New York, 1990).
4. W. J. Megaw, "Gender distribution in the world's physics departments," paper prepared for the meeting, Gender and Science and Technology 6, Melbourne, Australia, 14 to 18 July 1991.