

WOMEN IN PHYSICS: MEASURING A CHILLY CLIMATE

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INTRODUCTION

In 1994, women earned more than 50% of all bachelors' degrees and 40% of the PhDs awarded in the U.S. (Department of Education). In physics, however, the picture was very different: less than a fifth of the bachelor's and PhD degrees awarded that year went to women. As Figure 1 shows, the number of female students taking introductory high school physics courses was nearly on par with the number of male students. A gender gap becomes evident beyond this point. In second-year and advanced placement high school physics courses only about 30% of the students are female (Neuschatz & Alpert, 1994).

Participation of Women at Different Points in the Physics Education Pipeline.

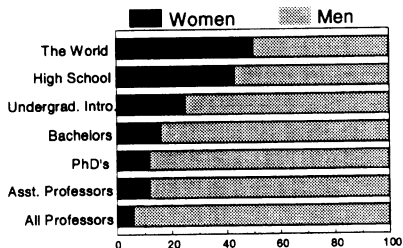


Figure 1

pace with the PhD production rate at 12%. But women comprise only 6% of the physics faculty as a whole (Blake, 1994). Even with these low percentages, improvement from a decade ago is evident.

The gap widens at the college level. About a quarter of the students in introductory undergraduate physics courses were women, and women earned only 16% of the physics bachelor's degrees which were awarded in 1994. The proportion of women earning PhDs in physics that year was slightly lower, 12%. While this proportion is very low, it nevertheless represents a gradual increase over the past decade. In 1985, women earned just 7% of the PhDs in physics.

The proportion of assistant professorships that are held by women appears to be keeping

Although the representation of women in physics has made some gains over the past decade, it is clear that gender equity remains a distant goal at all stages in the pipeline beyond introductory high school physics. Before they enter college and throughout their college careers, an increasing proportion of women become "turned off" to physics, and opt out of further study. In recognition of this fact, the women's committees of the American Physical Society and the American Association of Physics Teachers undertook a joint study



to examine the conditions present in physics departments that influence a woman's decision about completing a degree in physics. The Committees devised a two-part plan to identify the problems women are experiencing in physics departments. The first part consisted of a series of site visits. The second part consisted of a national survey of men and women undergraduate and graduate students.

THE SITE VISITS

Methods

A team of women physicists visited 17 graduate and undergraduate physics departments to assess the university climate for women physics students. The visiting team met with physics department chairs, university administrators, physics faculty members, student advisors and women and men graduate and undergraduate students. The major purpose of the site visits was to gather general and specific information about the climate for women in physics departments and make suggestions outlining how each department can assess its own climate and then act to improve it.

Results

The climates the teams encountered ranged from welcoming to hostile, but most were described as chilly for women (Dresselhaus, Franz, & Clark, 1995). During the site visits, female graduate students identified many factors that they believed contributed to this chilly climate in their physics departments. Many of the issues they raised were of concern to men as well. The overriding concern for women was the lack of women faculty. The site visit team reported that there was a direct relationship between the quality of the climate and the proportion of women faculty and students (Dresselhaus, Franz, & Clark, 1995).

In addition to few female faculty, other concerns discussed by women graduate students during the site visits included: a) the absence of a support net; b) the absence of a networking group; c) the absence of department advocates for women's special concerns; d) poor communication with the Department Chair; e) the absence of welcoming signals, such as visibility of women in the physics brochure, and welcoming receptions or parties for incoming students; f) unsupportive attitudes of some faculty toward women in the department; g) the lack of female role models who have successfully combined a physics career and family; h) the lack of personal safety during late hours; and i) the lack of established policies and procedures for responding to practices that exclude, threaten, or demean women (Dresselhaus, Franz & Clark, 1995).

THE DEPARTMENT CLIMATE SURVEY

Methods

In addition to the site visits, information about the climate in physics departments was obtained by distributing questionnaires to a nationwide sample of graduate and undergraduate physics students. The American Institute of Physics Education and Employment Statistics Division collaborated with the women's committees of the AAPT and the APS in developing questionnaires to assess the university climate for women physics students.

The graduate student questionnaires were sent to a sample drawn from respondents to AIP's 1992 annual Graduate Student Survey. All the female graduate students (approximately 1000), both U.S. and non-U.S. and a similar number of male graduate students, both U.S. and non-U.S., received questionnaires. There was approximately equal representation of U.S. women, U.S. men, non-U.S. women and non-U.S. men in the sample. The overall response rate was 60%.

Undergraduate physics students were also surveyed. There were virtually no gender differences in the responses from undergraduates about the climate in their physics departments. Possible explanations for the similarity in responses include: a) undergraduates may not be as integrated into the fabric of the department, due to outside activities; b) undergraduates usually do not have any other college experience to compare against; c) the sample was drawn on the only available list of names and addresses of undergraduate physics majors, SPS members, who may have the benefit of belonging to a group; or d) the questionnaire may not have been adequately designed to identify differences. Due to the similarity in responses from female and male undergraduates, results from these groups will not be discussed.

The questionnaires used in the study were deliberately silent on issues relating to gender. That is, they omitted explicit questions about sexual harassment and other experiences related to gender. Opportunities for comments and open-ended responses were placed at strategic places throughout the questionnaires.

Graduate Student Survey Results

Reasons for Discouragement

A major goal of the questionnaire component of the Department Climate Study was to identify the special problems and concerns of female students, and to contrast them with those of male students. To address some of these problems, graduate physics students were questioned "The last time you felt discouraged in physics, what were the two major reasons for feeling that way?" The major source of discouragement for both men and women was uncertainty about long term career opportunities. U.S. women chose long term career opportunities less often than other students did. They were much more likely to identify the department climate as a source of discouragement than other students were.

Interactions with Advisors and Other Faculty

Most U.S. graduate students enjoyed collegial relationships with their advisors, but women significantly less than men. Most non-U.S. women (about 60%) lacked this relationship with their advisors (see Table 1).

In general, students found that faculty who were not their advisors were accessible and encouraging about academic and career goals, but did not believe that they treated them as colleagues. Significantly fewer U.S. women found it easy to discuss ideas with faculty members than did U.S. men.

Table 1: Interactions with Advisors and Other Faculty

	U.S.		Non-U.S.	
	Women	Men	Women	Men
	(%)	(%)	(%)	(%)
Advisor treats me as a colleague	54	62	39	52
Faculty treat me as a colleague	28	34	27	31
Faculty are easy to discuss ideas with	38	52	46	49

Interactions with Other Students

Students were positive overall about their interactions with other graduate students, but U.S. women differed significantly from U.S. men on nearly every item that dealt with relationships with other students. U.S. women were less likely than men to agree that other graduate students readily discussed ideas with them, respected their opinions, or valued them as individuals. They were slightly less likely to agree that other graduate students treated them as colleagues. In addition, more women than men felt that other students were too competitive.

Environment in the Department

The majority of graduate students characterized the physics departments as friendly places, but not places that encourage self-confidence. Only about a quarter of U.S. women agreed that their physics departments encouraged their self confidence, compared to about 40% of all other physics students who felt this way.

Student Self-Rankings

Despite sources of discouragement and the effect that being in graduate school have on one's self-confidence, students had positive feelings about their abilities, especially in comparison to other students in their physics departments. As shown in Table 2, about half of the U.S. students, both men and women, believed they were in the top 25% of the students in their physics departments academically.

Table 2: Students' Academic Self-Rankings, Compared to Other Graduate Students in Their Departments

	U.S.		Non-U.S.	
	Women	Men	Women	Men
	(%)	(%)	(%)	(%)
Top 10%	20	20	32	44
Top 25%	26	31	36	31

Professional Expectations

Overall, 85% of the graduate students expect to become professional physicists, and the majority plan to be involved in both teaching and research, suggesting that they picture traditional academic careers for themselves.

The majority of physics graduate students (80% of U.S. students and 65% of non-U.S. students), would study physics if they had it to do over again. Among those who would not, the number one reason for not pursuing physics is the lack of jobs. Some of the other reasons which women frequently cited include: a) it takes too long to get a degree and the return is minimal; b) personal preference for more applied, cross-disciplinary work; c) physics is too narrow a field, detached from the real world, not relevant; d) the environment is too competitive; e) everything has been done already; f) it is difficult to have both a physics career and a family; and g) would choose a field with more women.

DISCUSSION

Recommendations for Improving the Climate

Based on these two sources of information, the site visits and the survey, some recommendations for change were made. The first set of recommendations was summarized by the site visit team. They include: a) hire more women faculty; b) recruit more women graduate students; c) establish a supportive environment for women faculty and students; d) accommodate the needs of faculty and students with children; e) provide opportunities to increase interactions; f) invite more women physicists to speak at colloquia; g) insure a safe work environment; and h) place greater importance on the quality of teaching (Dresselhaus, Franz, & Clark, 1995).

The graduate students who responded to the survey were asked to identify one or two changes that could improve the department. This list includes: a) provide sensitivity training for faculty and students; b) make women feel welcome in the department, not because it looks good, but because it is a worthy goal; c) establish a department-wide policy on parental leave; d) make graduate school more accessible to students with family responsibilities (make part-time grad school a realistic option; make child care available; e) retire the most prejudiced of old men; and f) put more women's bathrooms in the building.

Balancing academic research and motherhood was a predominant theme in many of the female graduate student's comments. Recommendations were made to extend the time until a tenure decision is reached so that women with families would not be penalized. It was also suggested that postdoctoral fellowships for part-time work and programs concerning child care, parental leave, recruitment and retention be implemented. Another recommendation is a little more radical: compulsory retirement for faculty who refuse to treat women fairly. At the very least, it has been suggested, these faculty members should not teach courses where they can do a great deal of damage.

Impact of the Study

The reports returned from the department chairs indicate that the site visit program has made a difference. The 17 departments have implemented or planned several changes, including: a) increased efforts to recruit women faculty members; b) increased efforts to recruit women graduate students; c) opening communications between women students and women faculty, and between women and department chairs; d) efforts to increase faculty awareness of issues that concern both women and men students, and women faculty and staff; e) establishment of advisory committees to address problems identified in the site visit reports; f) increased department activity in career counseling, job fairs, and industry contacts; g) more women speakers invited to speak at colloquia; and h) improvements in safety in the workplace (Dresselhaus, Franz, & Clark, 1995).

Another result of the site visits is that other disciplines are adopting the model to evaluate the climates in their departments. The Association for Women in Science has received funding to develop a similar program in chemistry, biology, and math.

Although there are no plans for APS and AAPT to conduct additional site visits to physics departments, the program described here can be adopted by any department that wishes to evaluate itself. The women's committees of APS and AAPT can provide guidelines for carrying out an evaluation. As Franz (1995) noted, "the climate for all students and faculty, both male and female, improves when steps are taken to improve the climate for women."

Final Note

Conditions are improving, albeit slowly, for women in physics. The change is evident in the membership of the American Physical Society. The APS is by far the largest organization of physicists in the United States, with more than 40,000 members. Women account for about 8% of the overall membership (Curtin & Chu, 1994). But among young physicists (age 30 or younger), they account for 17%. The age distribution by gender, reveals that the profile for men is relatively flat, but among women the younger members predominate. In fact, the median age for men is 45, while for women it is 33. The future of physics lies with young physicists, and increasingly these physicists are women.

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