RESEARCH NOTE

COLLEGE STUDENTS' PERCEPTIONS OF BARRIERS TO WOMEN IN SCIENCE AND ENGINEERING

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In 1960, only 10% of the natural scientists and less than 1% of the engineers employed in the United States were women. Since that time, women have made progress in entering these fields. By 1988, they represented 30% of scientists and 4% of engineers. However, women today remain disproportionately represented in these fields (Brush, 1991; Pool, 1990; Task Force on Women, Minorities, and the Handicapped in Science and Technology, 1989). Additionally, during the mid-1980s, the number of degrees earned by women in science and engineering began to fall (Lane, 1990), and recent data from college-bound women indicate that they do not plan to major or have careers in engineering and in the physical sciences in the same proportions as college-bound men (LeBold, 1987).

The underrepresentation of women in science is not a new concern (Daffin, 1937; Schiebinger, 1989). Rossi's (1965b) answer to "why so few?" addressed the obstacles facing women who might want to enter science. She emphasized especially the priority placed on marriage and motherhood—leaving little time for "responsible careers as scientist, engineer, or doctor, except for those rare Amazons among us who can live two lifetimes in one" (Rossi, 1965a, p. 53). More recently, Brush (1991) has addressed the

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question of what is preventing more women from going into science and engineering—ranging all the way from covert discrimination to Scholastic Aptitude Test (SAT) bias to work and family conflict.

How do college students today perceive the barriers to women in science and engineering? Have they changed over time? Are there differences by sex in these perceptions? These are the questions addressed in this research note.

In 1961, the National Opinion Research Center (NORC) conducted research on a sample of June graduates from 135 colleges and universities to determine their postgraduate plans (Davis, 1964). From that group of students, a sample of women were sent four questionnaires during the period from the spring of 1961, when they were college seniors, to the summer of 1964, when they had been out of college for 3 years (Rossi, 1965a, p. 96). In 1964, this sample of women were asked why they thought few American women enter engineering or the sciences. The respondents could choose from seven reasons, with a provision for them to fill in a response of "other". For research scientist (12,393 responses), the major reasons women gave were the difficulty of combining professional work with home and child responsibilities (54%), and the desire of women for part-time work rather than full-time commitment to a career (38%). Inadequacy of skills (6%), or an image of a woman being "unfeminine" if she were to become a scientist (23%) were not ranked very high. Engineering, however, showed a different profile of perceived reasons. Of the 14,500 women surveyed, 60% expressed a concern that women would be considered unfeminine if they entered engineering; this was closely followed by "most parents discourage their daughters from training for such a field" (57%) and "men in this field resent women colleagues" (56%). A much higher percentage of women believed that engineering requires skills and characteristics women do not have (24%) compared to science (6%). As Rossi pointed out, the perceived obstacles for engineering apparently occur earlier in life through socialization, whereas the perceived obstacles for science and medicine operate at a later point when young women believe there would be too much conflict with family obligations.

Rossi (1965b) advocated changing the social climate in a number of ways. She recommended a different socialization of young girls

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but also noted that being a professional, wife, and mother constitutes a social problem to be "dealt with by social engineering" rather than by individual women (p. 1200).

DATA

This research note examines the perceptions of barriers to women entering science or engineering of 283 students at three universities, replicating the NORC instrument used in Rossi's study. In addition to the seven reasons listed in that instrument, students could write in other responses. An analysis of the written-in responses led to three additional items, making a total of 10. The survey was conducted in undergraduate classes during the 1990-1991 academic year at the University of Texas (San Antonio), the University of Oklahoma, and the University of Maryland (Baltimore campus).

Approximately 39% (110) of the surveys came from University of Oklahoma students; 30% (84) from University of Texas students; and 31% (89) from University of Maryland students. Female students constituted 61% (173) of the sample; males, 39% (110). The majority of students (80%) were in the age category 18-23, although there was some variation by school.

Table 1 shows reasons given by the sample as a whole for women's limited participation in science and engineering. For science, the reason most often given is the same as it was in the 1964 study: the difficulty of managing demanding professional work with home and child responsibilities. However, the reason given second most often has changed over time. In 1964, women's desire for part-time work was listed second as a barrier; by 1990-1991, the second most often given response was the perception that men resent women colleagues. Ranking third was the belief that parents (and others) discourage women from training for a science field, and fourth, that women lack the skills and characteristics for a career in science.

Engineering shows a similar profile of perceived reasons. As shown in Table 1, the major reason given is that men resent women colleagues (21.3%), followed closely by a concern that women

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TABLE 1
College Students' Perceived Reasons for Low Representation of Women in Science and Engineering, 1990-1991

Explanation	*Science*	*Engineering*
A job in this field is too demanding for a woman to combine with family responsibilities	23.6%	21.0%
Men in this field resent women colleagues	19.6%	21.3%
Most parents discourage their daughters from training for such a field	14.0%	18.0%
Such a job requires skills and characteristics women do not have	11.4%	7.7%
Women today want to work only part-time, which they can seldom do in this field	11.1%	11.0%
This is a male-dominated field that is hard for women to enter	7.4%	6.3%
Women are afraid they will be considered unfeminine if they enter this field	6.6%	9.6%
To enter this field before marriage restricts a woman's chance to marry	3.0%	2.6%
Women feel they cannot succeed in this field	2.6%	1.8%
Women should not be in this field	0.7%	0.7%
N	271	272
Missing responses to this question	12	11

have difficulty combining family and career (21.0%). The discouragement by parents and others from studying engineering was the third most often given barrier in both the 1964 and the 1990-1991 studies. A concern that women cannot work part-time in engineering ranked fourth among responses. Although women's concern with their femininity if they chose engineering was the top given reason in the 1964 NORC study, by 1990-1991 it seemed less a barrier.

The 1964 study was based on women's responses only; the 1990-1991 sample contains both women and men. However, the perception that a career in science or in engineering may be too demanding to combine with family responsibilities is perceived as a major barrier for both time periods. Rossi's (1965b) call for "social engineering" to resolve the problem of women combining career and work has largely gone unheeded, and students' perception of the "balancing act" required of women in these professions

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TABLE 2
Top Four Perceived Reasons for Low Representation of Women in Science by Sex, 1990-1991

Explanation	*Males*	*Females*
A job in this field is too demanding for a woman to combine with family responsibilities	36.8%	33.1%
Men in this field resent women colleagues	26.5%	29.7%
Most parents (and others) discourage their daughters from training for such a field	19.1%	21.2%
Such a job requires skills and characteristics women do not have	17.6%	16.1%
N	68	118

NOTE: $\chi^2 = 0.479$; $df = 3$; $p = .92$.

reflects this. Of interest is the perception of men's resentment of women colleagues. This was recognized for engineering in 1964 but was not often given as a reason for the absence of women in science. By 1990-1991, it is given often as a response. No doubt this has been prompted by larger numbers of women entering male-dominated fields, however small the overall percentage.

Because men are included in the 1990-1991 study, the next question concerns sex differences in responses. For this purpose, the first four barriers chosen for science and engineering are analyzed by sex. As shown in Table 2, there are no significant gender differences in the most chosen reasons for science, although males are slightly more likely than females to see work and family in conflict and females are more likely than males to think that men resent women colleagues.

Also, no statistically significant sex differences are found in perceived barriers to engineering. Males are slightly more likely to see the lack of part-time work as a barrier; females are more likely to believe that women are discouraged from training for science and that men resent women colleagues (see Table 3).

Analyses by age group and by university also fail to show statistically significant differences in responses (not shown). It might be argued that the lack of significant differences by age, sex, and university can be attributed to lack of representativeness of the

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TABLE 3
Top Four Perceived Reasons for Low Representation of Women in Engineering by Sex, 1990-1991

Explanation	*Males*	*Females*
Men in this field resent women colleagues	26.4%	32.0%
A job in this field is too demanding for a woman to combine with family responsibilities	33.3%	27.0%
Most parents (and others) discourage their daughters from training for such a field	20.8%	27.9%
Women today want to work only part-time, which they can seldom do in this field	19.4%	13.1%
N	72	122

SOURCE: $\chi^2 = 3.14$; $df = 3$; $p = .37$.

sample. However, it also seems likely that there is a consensus among college students as to the difficulties inherent for women entering these nontraditional career fields.

CONCLUSIONS

Several educational interventions are cited as a solution to the projected shortage in science and engineering (LeBold, 1987; McDonald, Clarke, & Dobson, 1990; Vandell & Fishbein, 1989). The National Science Foundation has a Visiting Professorship for Women program that supports 30 women at research universities per year. These women scientists serve as role models for students while they further their own research (Eisner, 1990). A 2-year study of science and math programs at 200 of the nation's colleges and universities, Project Kaleidoscope, calls for reshaping introductory math and science courses, providing more fellowship and research opportunities for professors at all career stages, revamping of teacher-education programs, and establishing better relationships among federal and state agencies, foundations, businesses, and colleges (Nicklin, 1991).

Reforms in education will no doubt increase the opportunity for better-prepared students. However, in the study of college stu-

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dents reported on here, the perceived barriers had little to do with education—and much more with work/family conflict and gender relations. If we want to encourage more women in science and engineering, we will have to confront the latter issues. Conflicting work and family demands continue to present barriers for women in demanding professional fields. Until we address the "work-family system" (Pleck, 1980), we will make little progress in encouraging women to enter these fields. As Rose (1986) reminds us, the spatial and time demands of being a laboratory scientist are much more in conflict with the demands of child care than are the demands of being a historian: "While both the woman laboratory scientist and the woman historian may have in common the problem of the double day, the former has much less flexibility in choosing when or where to work" (p. 63). Perhaps within science the traditional definitions of work and time will have to be modified to allow for more flexible opportunities for participation by women. Universities may have to accommodate the needs of women researchers and their families—including the revision of the tenure systems to allow for a longer tenure-probationary period, more "family care" leave, and subsidized child care (Brush, 1991).

According to the students who responded to the survey, fear of resentment from colleagues is a major barrier to women's participation in science and engineering. This concern is consistent with the findings of studies that report that women in nontraditional fields may suffer the negative consequences of not being chosen as often as romantic partners or as friends (Kulik & Harackiewicz, 1979; Pfost & Fiore, 1990; Shaffer & Johnson, 1980). It is difficult for public policy to affect these perceptions. However, as Kanter (1977) and others have pointed out, organizational change comes only after women constitute a "critical mass." As there are more women engineers and scientists, the stigma of "deviance" will gradually be removed. Just as the negative stereotype of working mothers was removed when women's labor was required during World War II, negative stereotypes of women scientists and engineers may be removed as the societal need for them becomes crucial.

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