WOMEN IN SCIENTIFIC FIELDS:
Doctoral Education and Academic Careers

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In this paper, I focus upon doctoral education and academic careers among women in scientific fields. Scientific fields encompass the eight classifications of the National Science Foundation and the National Research Council: physical, mathematical, computer, environmental, life, and engineering, as well as the psychological and social sciences. I concentrate upon doctoral education because of its direct connection with academic careers. Academic careers, in turn, are important for two reasons. First, issues of scientific research and its impact are particularly applicable for this group. Second and relatedly, the training of university students–and in turn, much of the future of science–are in the hands academic scientists.

Women, doctoral education, and academic careers

Over the past three decades, the numbers and proportions of women receiving doctoral degrees in scientific fields have increased. The proportion of women among the doctoral recipients in scientific fields increased from 8 percent to 15 percent between the decade of the 1960s and 1970s; by the decade of 1980s, women were earning 26 percent; and in the 1990s, 31%, of doctoral degrees in these fields (CPST, 2000: Table 2-1).

The issues, at hand, however, are not simply the presence or available pool of women but their location and status. Three key questions are: 1) How does gender shape location and rank in academic careers? 2) What accounts for the career attainments of

women in scientific fields? 3) What are the implications for improvement and advancement?

Gender, location, and rank

A significant dimension of location is that of field. Scientific fields encompass a wide range of areas, and women's degrees are far more concentrated by field than are men's. Over the decade of the 1990s ('90-98), over three quarters (77%) of doctoral degrees awarded to women in sciences were in psychology, social sciences, and life sciences. This contrasts with 49% of doctoral degrees in sciences awarded to men in these three fields (CPST, 2000: calculated from Table 2-1). Likewise, among employed doctoral scientists and engineers (across employment sectors, academic and nonacademic), the distributions of women are highly uneven. In 1997, 80% of women employed in science and engineering fields were in psychology, social sciences, and life sciences (assessed by field of doctoral degree) (CPST, 2000: calculated from Table 4-11).

These distributions of women and men by fields suggest non-uniform processes of selection by field (both self-selection of individuals and selection by institutions). However, the factors governing the distributions by field, particularly the higher proportion of women in life sciences and men in physical sciences, are not fully understood (Fox, 1995, 1999; Zuckerman, 1987). Even less is known about gender distribution by research subfield—and the consequences of these distributions for resources acquired and impact made (Fox, 1995).

A second significant dimension is rank. When considering rank, the focus is frequently upon academic rank, because in academia, ranks are clearly, and in most cases, consistently specified as professorial levels, and are telling indicators of position. A notable

issue is this: despite the number and proportions of women with doctoral degrees earned over the past three decades and the passage of years allowing these women to mature in professional experience, the proportion of women who attain academic rank as full professor has not kept pace. In 1973, women were 4 percent of the professors across scientific fields; in 1987, the proportion was 7 percent; in 1993, 10 percent (Fox, 1999; see also Gibbons, 1992); and in 1997, still just 11 percent (Table 1). These figures are inflated by the numbers of women in psychology, in particular, the one field in which women are over 20% (22.5%) of full professors (Table 1).

Explanations of gender disparity in career attainments

One potential explanation of gender disparity in academic career attainments is prestige of doctoral origins. The question is: are women receiving doctoral degrees from different types of institutions, and is this a root of career outcomes? The answer is no. With some disciplinary variation, women and men are about equally likely to have received their degrees from top-ranking institutions (see Fox, 2001).

Likewise, gender differences are found to be small in certain indicators of financial support for graduate training, measured as percentages of women compared to men who had held research or teaching assistantships during graduate school (Hornig, 1987; National Research Council, 1983). Such data on financial support, however, do not specify the character of that training—matters of inclusion and exclusion, nuances of advising, and evaluative practices as they operate for women and men. My research points toward these factors: different experiences and outcomes of women and men students in their departments, in research groups, and with advisors in departments of chemistry, computer science, electrical engineering, and physics (Fox, 2000, 2001, 2003).

Some of the findings: 1) In experiences in departments, women are less likely to report that they are taken seriously by faculty; and that they are respected by faculty. 2) In experiences within research groups, compared to men, women report that they are less comfortable speaking in group meetings. Despite strong preferences for collaboration by both men and women students, women report collaborating with fewer male graduate students and male faculty in research and publications over a three-year preceding period. 3) In advisor-advisee relationships, women are less apt to report receiving help from advisors in crucial areas such as: learning to design research, write grant proposals, co-author publications, and organize people. Women are also more likely than men to report that they view their relationship with their advisor as one of "student-and-faculty" compared to "mentor-mentee" or "colleagues." And in outcomes, men graduate students publish more papers than women, and are more likely to report that they will receive their degrees.

These matters of gender, social context, and participation are important because science is a social process—a system of communication, interaction, and exchange (Merton, 1996). If women are constrained within the social contexts of departments – and/or in larger communities of science—that has consequences not simply to participate in a social circle, but more fundamentally, to do research and show marks of significant status and performance in science (Fox, 1991).

This brings us then to another area: the relationship between gender and publication productivity. In analysis of gender and career attainments, publication productivity is important for two reasons: First, publication is a central social process of science, because it is through publication that research findings are communicated and

verified, and that the priority of work is established (Fox, 1983; Merton, 1973; Mullins, 1973). Second and accordingly, until we understand productivity differences, we cannot adequately address other gender differences in location, rank, and rewards, because they are related to—but not wholly explained by–productivity (see Fox, 1991, 1999; Long and Fox, 1995).

Although the gender gap in publication has been narrowing more recently in biological and social sciences, women publish less than men, especially in physical sciences (see Creamer, 1998; Long and Fox, 1995; Long, 2000; Sonnert and Holton, 1995). Women's depressed publication productivity is both a cause and an effect of their career attainments. That is, it both reflects women's depressed rank and prestige of institutional locations, and it partially accounts for it. "Partially" is a key term: holding constant levels of publication productivity, women's career attainments, especially rank, remain lower than men's (see Cole, 1979; Long and Fox, 1995; Sonnert and Holton, 1995).

What are the implications?

Twenty-plus years ago, increasing numbers and proportions of women began to enter doctoral programs and complete degrees in scientific fields. It was expected that rank would be "a matter of time" – time for women to mature professionally, and attain high rank. However, women's degrees do not appear to be translating into rank of full professor, in particular, over time (these discrepancies are documented in chemistry, in mathematics, and across fields in higher education [American Statistical Association, 1993; Vetter, 1992; University of Wisconsin, 1991).

The relationship between gender, education, and status is complex – it is not a simple, linear progression of more education among women and improved social and economic status (Fox, 1996). Practice and policy have tended to focus upon increasing the numbers of women in science (Fox, 1998). Certainly, increasing the numbers of women in science is requisite and important. However, increasing numbers of doctoral-level women in science, by itself, will not necessarily change patterns of gender and status in academic employment. For this, we need to address matters beyond numbers in the educational pipeline (Fox, 1996, 2000, 2001, 2003) – such as ways of evaluating participants and coordinating human and material resources, not just for attainment of more degrees, but for gender equity in character and quality of doctoral education, in range and scope of collegial opportunities, in access to professional networks, and in career outcomes.

TABLE 1

Doctoral Scientists and Engineers in Academic Institutions, by Field and Rank, 1997

Field	Total*	Full Professor	Associate Professor	Assistant Professor
Physical Sciences	36,940	13,770	6,680	5,510
%Women	*13.3*	*4.2*	*13.5*	*26.1*
Math & Computer Sciences	18,740	7,520	5,470	4,120
%Women	*14.2*	*6.7*	*14.3*	*24.1*
Life Sciences	68,640	21,210	13,120	13,090
%Women	*27.8*	*13.1*	*22.9*	*36.7*
Psychology	27,190	9,570	5,840	4,790
%Women	*43.1*	*22.5*	*44.3*	*61.0*
Social Sciences	45,510	18,230	11,880	9,150
%Women	*28.3*	*14.9*	*32.4*	*39.6*
Engineering	26,960	11,230	6,080	4,900
%Women	*6.5*	*1.4*	*6.3*	*13.7*
Total, all fields	233,180	83,670	51,880	44,410
%Women	*25.1*	*11.6*	*25.7*	*36.9*

*Total includes instructor/lecturer, other faculty, and "does not apply."

SOURCE: Commission on Professionals in Science and Technology. *Professional Women and Minorities: A Total Human Resource Data Compendium* [13th edition]. Washington, D.C., 2000: Table 5-1.

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