

4. Graduate Education: A Declining Share For SMET

Although overall graduate enrollments increased by 6% from 1992 to 1997, the number of graduate students in SMET degree programs declined by 5% over the same period (34) (44). Failure to increase the numbers enrolling and completing graduate degrees in SMET programs threatens our ability to generate new knowledge and transmit that knowledge to new generations of students. This trend is all the more alarming when focusing on the corresponding figures for women, minorities, and people with disabilities, who continue to be underrepresented in graduate SMET programs. For example, women constituted only about 40% of the students in graduate SMET programs in 1999—still short of parity. And the situation is even more disturbing for minorities in engineering, where first-year graduate enrollment dropped 21.8% for African Americans and 19.3% for Hispanic Americans between 1996 and 1997 (32). The decline in overall graduate enrollment in SMET disciplines calls for renewed efforts to recruit and retain underrepresented groups in these programs.

4.1 Number of Women in SMET Graduate Programs Increasing

In the 1990s, women continued an established trend of increased enrollment in graduate SMET programs. In 1976, women represented only one-quarter of SMET graduate enrollment. By 1999, they accounted for 40% of enrollment (Tables 4-1) (44). However, their

representation in graduate SMET programs other than the social and behavioral sciences still fell far short of parity in 1999. Women represented only 20% of full-time graduate enrollment in engineering and 30% of enrollment in mathematics and the computer sciences.

The percent of SMET graduate degrees earned by women between 1966 and 1997 reflects a trend similar to that observed for enrollment (Figure 4-1) (34). During this time period, women's share of SMET degrees increased from 12% to 39%, while their share of all graduate degrees rose from 31 to 55%. As was the case for enrollment, there are considerable differences in women's achievement by field. In 1997, women attained 58% of graduate degrees in the social and behavioral sciences, but only 17% of the engineering graduate degrees.

4.2 Few Minorities Complete SMET Graduate Studies

U.S. graduate programs in science, engineering, and mathematics are the envy of the world and have contributed greatly to the country's technological innovation and economic growth. The current decline in overall graduate enrollment rates in SMET, however, combined with the extremely small numbers of minorities completing graduate degrees in SMET fields, pose a significant challenge to our nation's continued economic vitality, national security, and quality of life. While the percentage of underrepresented minorities

Table 4-1: Full-Time Graduate Enrollment of Women in SMET, 1976/1999

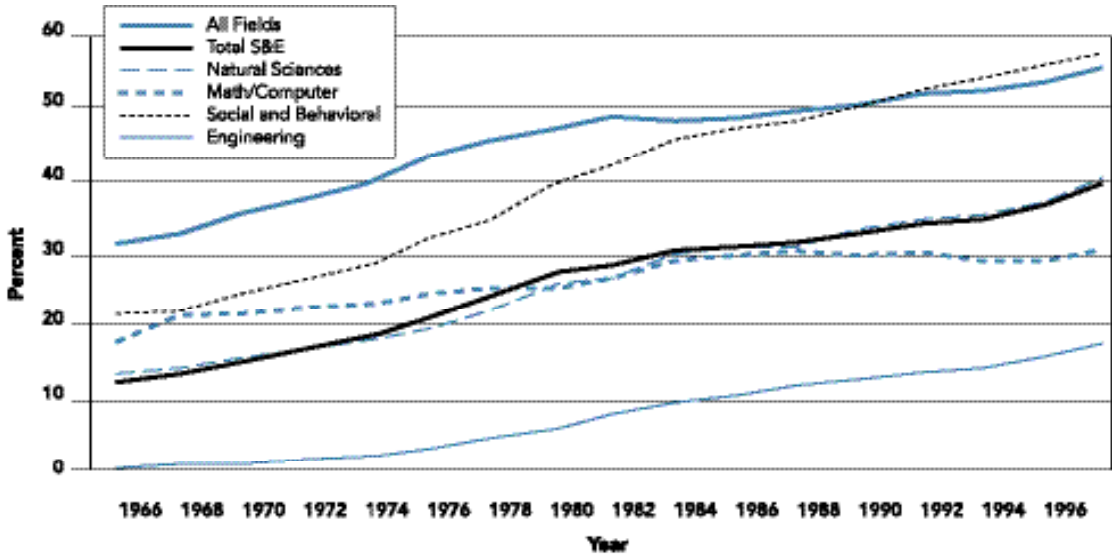
	1976		1999	
	Total	Women	Total	Women
Total SMET Enrollment	204,861	48,692 (24%)	283,915	114,890 (40%)
Field				
Natural Sciences (all) ¹	79,684	17,894 (22%)	93,610	39,666 (42%)
Physical Sciences	22,252	3,047 (14%)	26,640	7,564 (28%)
Earth, Atmospheric, Oceanic	10,091	1,634 (16%)	10,492	4,312 (41%)
Agricultural Sciences	9,436	1,491 (16%)	9,210	3,807 (41%)
Biological Sciences	37,905	11,722 (31%)	47,268	23,983 (51%)
Math/Computer Sciences	15,700	3,218 (20%)	34,500	10,513 (30%)
Social and Behavioral Sciences (all) ²	72,595	25,555 (35%)	87,973	51,217 (58%)
Psychology	25,643	11,052 (43%)	34,715	24,630 (71%)
Social Sciences	46,952	14,503 (31%)	53,258	26,587 (50%)
Engineering	36,882	2,025 (5%)	67,832	13,494 (20%)

Source: Data from U.S. Department of Education/NCES, *Survey of Opening Fall Enrollment*, and National Science Foundation, Division of Science Resources Studies, Joan Burrelli, *Graduate Students and Postdoctorates in Science and Engineering: Fall 1999* [Early Release Tables], 2000 (<http://nsf.gov/sbe/srs/srs01402/start.htm>; <http://nsf.gov/sbe/srs/srs01402/tables/5.xls>; <http://nsf.gov/sbe/srs/srs01402/tables/7.xls>) (44).

1 Natural Sciences includes Physical Sciences, Earth, Atmospheric and Oceanic Sciences, Agricultural Sciences, and Biological Sciences

2 Social and Behavioral Sciences includes Psychology and Social Sciences

Figure 4-1 Percent of Graduate Degrees Awarded to Women, By Field: 1966-96



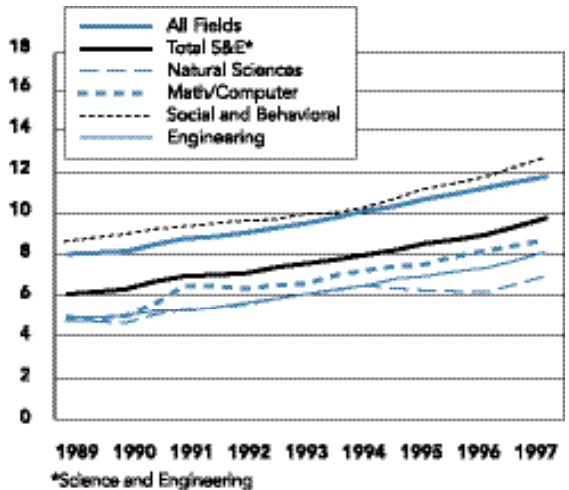
Source: National Science Foundation, Division of Science Resources Studies, Susan T. Hill, *Science and Engineering Degrees: 1966-96*, 2000 (NSF 00-310). {34}

enrolling in and completing graduate degrees in SMET has risen in the past decade, the numbers are not yet equivalent to their representation in the U.S. population.

In 1998, underrepresented minorities constituted 12% of full-time citizen or permanent resident graduate student enrollment while constituting 24% of the total U.S. resident population (46). Although this means that graduate enrollment of underrepresented minorities (African Americans, Hispanic Americans, and Native Americans) is considerably below parity, it is encouraging to note that underrepresented minorities have made strides towards equity in the last few years. In 1992, only 9% of the full-time enrollment of citizens and permanent residents in graduate school were underrepresented minorities.

The participation rate of underrepresented minorities varies considerably by field. For example, in 1997, underrepresented minorities constituted 12.9% of the social sciences, but only 7.1% of the natural sciences. The time trends reflecting the graduate degree attainment of underrepresented minorities reflect a pattern similar to the trends with respect to enrollment (Figure 4-2) (47). There has been an increase in the proportion of graduate degrees earned by underrepresented minorities in Science and Engineering (S&E) disciplines (from 6.1% in 1989 to

Figure 4-2: Percent of Graduate Degrees Awarded to Underrepresented Minorities, by Field (U.S. Citizens and Resident Aliens Only): 1989-97



Source: National Science Foundation, Division of Science Resources Studies, Susan T. Hill, *Science and Engineering Degrees, by Race/Ethnicity of Recipients: 1989-97*, 2000 (NSF 00-311) (47).

Table 4-2: Full-Time Graduate Enrollment of U.S. Citizens and Permanent Residents in SMET, by Race/Ethnicity: 1992-98

Field	1992		1998	
	Total	Underrepresented Minorities (%)	Total	Underrepresented Minorities (%)
Total SMET Enrollment	197,473	17,346 (8.8%)	192,407	22,351 (11.6%)
Natural Sciences ¹	66,216	4,467 (6.7%)	68,052	5,951 (8.7%)
Math/Computer Sciences	17,791	1,243 (7.0%)	16,131	1,416 (8.8%)
Social and Behavioral Sciences ²	73,568	8,798 (12.0%)	74,807	11,616 (15.5%)
Engineering	39,898	2,838 (7.1%)	33,417	3,368 (10.1%)

1 - Natural Sciences includes Physical Sciences, Earth, Atmospheric and Oceanic Sciences, Agricultural Sciences, and Biological Sciences

2 - Social and Behavioral Sciences includes Psychology and Social Sciences

Source: National Science Foundation, Division of Science Resources Studies, *Graduate Students and Postdoctorates in Science and Engineering: Fall 1999*, November 2000 (NSF 01-302) {45}.

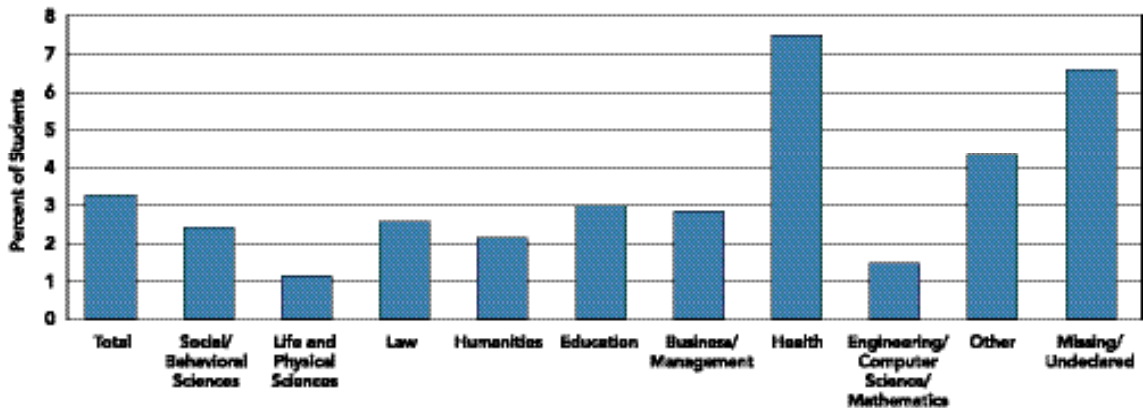
9.9% in 1997). Representation of underrepresented minorities is higher in the social and behavioral sciences (13% in 1997) than in other SMET disciplines. As is true for women, the SMET disciplines other than the social and behavioral sciences lag behind the non-science and engineering fields.

4.3 Persons with Disabilities Likely to Enter Graduate School

Training of future scientists and educators who live with disabilities is hampered by the difficulty of determining the extent to which they currently

participate in the SMET enterprise and their career progression compared to individuals without disabilities. We do know, however, that college graduates with disabilities are as likely as those without disabilities to enroll in graduate school within a year after graduating from college {41}.

Information from the National Postsecondary Student Aid Study reveals that about 3% of graduate students studying in all fields reported a disability, but in 1996 this percentage was lower in the life and physical sciences, engineering, computer sciences, and mathematics than in the social and behavioral sciences and in the non-

Figure 4-3: Percent of Graduate Students with Disabilities, by Field: 1996

Source: National Science Foundation, Division of Science Resources Studies, *Women, Minorities, and Persons With Disabilities in Science and Engineering: 2000*, using data from U.S. Department of Education, National Center for Education Statistics, 1995-96 National Postsecondary Student Aid Study, data analysis system {48}.

Improving Graduate Level Opportunities for Minorities

University Cooperation to Support Minority Education

The Centers of Research Excellence in Science and Technology (CREST), formerly known as Minority Research Centers of Excellence, upgrade the research capabilities of the most productive minority institutions, increasing the number of minorities with PhDs in SMET fields.

Centers serve as hubs for conducting competitive research in such fields as materials science and computing and serve as models for the integration of education and research.

CREST has supported the Center for Systems Research at Tennessee State University, a member of the team that first observed planets circling another star system. Another CREST initiative supported research at the University of Puerto Rico, the nation's leading Hispanic institution, which confers 20 percent of all baccalaureate and doctoral degrees in science, mathematics, and engineering that are awarded to Hispanics.

CREST also promotes cooperation among faculty at different institutions and establishes alliances among minority students and business, government laboratories, and other universities.

Minority Support from Recruitment to the Workplace

The Alliances for Graduate Education and the Professoriate (AGEP) seek significant increases in the number of minority students pursuing doctoral degrees and faculty positions in science, mathematics, and engineering.

Regional and statewide Alliances link federal and private institutions. Efforts focus on recruitment, mentorship, and retention of minority students in SMET doctoral programs.

AGEP also supports research to identify major factors that may help minority students transition from undergraduate to graduate study, from course work to dissertation research, and from academe to the workplace.

Universities receiving AGEP awards conferred close to 20 percent of the PhDs awarded to minority students in science, mathematics, and engineering in 1998 and 1999.

Students with Disabilities Excels at PhD Level

Kurt Hoffman, a Ph.D. student in Animal Behavior at the University of California at Davis, was born with no arms. He completed his undergraduate studies at Bucknell University, where he participated in research in animal behavior. He so impressed his mentors at Bucknell that they recommended him for the top animal behavior program in the country at UC-Davis, where he chose to work with primates. Behavioral research requires a good deal of observation and recording, so Kurt developed a system to use a computer keyboard with his toes and a modified foot. He insisted on receiving no physical help from others other than a chair to be placed in the room where he carried out his research.

Kurt was the beneficiary of a campus graduate opportunity fellowship and an NSF Research Training Grant in Interdisciplinary Approaches to Animal Behavior. He finished his Ph.D. in less than the normal time and, according to his advisor, he turned in a thesis that was more polished than any first draft this professor had seen. When Kurt finished his Ph.D. he had three employment options: a full-time academic teaching job, a full-time academic research job, and a postdoctoral position. Kurt chose the postdoctoral offer and, when finished, will be in a prime position to continue his academic career at a research university.



Multidisciplinary Approach to Graduate Research

NSF's Integrative Graduate Education and Research Traineeships (IGERT) program provides support for Institutions of Higher Education to experiment with new paradigms in graduate education. Students and faculty have developed programs enabling each to experience and work in collaborative environments wherein multidisciplinary research and education are emphasized. Moreover, institutions are afforded the opportunity to explore mechanisms that facilitate multidisciplinary research and education.

IGERT is a Foundation-wide activity in that financial and personnel support is garnered from every Directorate and the Office of Polar Programs.

Features of the program include:

1. Problem-based research and education as opposed to disciplinary focused projects.
2. Graduate student education in the traineeship mode is emphasized over new pure knowledge production.
3. Recruitment, retention, and graduation of individuals from underrepresented groups is of prime significance.
4. Personal and professional skill development for multiple careers is significant.
5. Other activities include internships and promotion of global awareness.

To date there are 57 sites located across the country in 31 states and the District of Columbia. On average, each site supports 12 trainees per year for a 2-year period. After the 2 years of support a new cohort is recruited. Last year NSF had a 9.8% representation of minorities in the entire program. Efforts to improve this number are being made. Each year a significant part of the PI meeting is devoted to elaborating best practices in recruitment and retention of individuals from underrepresented groups and to acquainting PIs with sources for recruiting. Approximately one-third of the trainees are women.

SMET fields. (See Figure 4.3) (48). No data are available for master's degrees granted to persons with disabilities. The percent of SMET doctorate recipients reporting disabilities stayed at approximately 1.3% between 1993 and 1997 (40).

As with other underrepresented groups, individuals with disabilities may be reluctant to enter graduate studies or are not encouraged to do so by their undergraduate or high school mentors. There are now a number of government agencies—federal, state, and local—that have targeted resources to assist people with various types of disabilities. With targeted outreach programs, the community of persons with disabilities could be afforded more graduate educational opportunities and embark on subsequent professional paths. The remarkable advancement in technologies to remove barriers to access and achievement is another promising sign for greater participation of people with disabilities in the SMET enterprise. Assistive technologies, such as voice recognition systems, automated Braille printout, and “all-terrain” wheelchairs, will make possible and enrich the contributions of a wider pool of future scientists.