the Landscape

Riveters to Rocket Scientists: Exploring the Gender Gap in Quantitative Fields

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Women have made great strides in the last two decades, gaining access to all levels of higher education and entrée to many professions that once were the remote domains of men. In fact, undergraduate colleges and universities now enroll and graduate substantially *more* women than men. The number of women in graduate programs also has increased, and in professional schools where women were once virtually unknown they now constitute a solid proportion, and sometimes a clear majority.

Veterinary Medicine may be the most dramatic example. In the early 1970s, fewer than 9 percent of veterinary degrees were awarded to women. By the early 1990s, that proportion had grown to around 60 percent. In 1971, less than 6 percent of students graduating with professional degrees in law, medicine, and business were female. Twenty years later, women constituted 43 percent of law school graduates, 36 percent of the graduates of medical schools, and 35 percent of the students who earned MBAs.

Nevertheless, there remain certain professions and areas of study that women either avoid or are in some way discouraged from pursuing. Despite women's gains in some professions—and, perhaps, because our society increasingly depends on scientific expertise and technical skill to remain competitive—organizations like the National Science Foundation and the National Academy of Sciences are voicing concern that too few women are choosing to pursue "high tech" careers.

Indeed, figures recently released from the National Database of the Curriculum Assessment Service (CAS)—a collaborative effort of the Association of American Colleges and Universities and the University of Pennsylvania's Institute for Research on Higher Education—confirm that women remain academically underrepresented in mathematics and science in general, and that female students are particularly scarce in engineering and the physical sciences. This information, which was drawn from a statistical sampling of the college programs of over one million students who received bachelor's degrees in the arts and sciences and other fields in 1991, is a somewhat sobering corrective to any unbridled optimism about women's current status in the educational and professional marketplace. In this *Landscape*, CAS's national estimates about the distribution of majors, grades, courses, and patterns of attendance of the class of '91 will be used to explore the gender gap in the sciences and mathematics.

Portrait

National statistics show that women now receive more than half of all bache-

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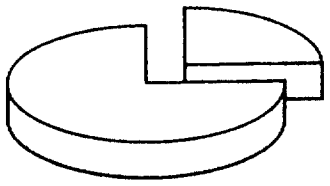
The Landscape *is a production of the Institute for Research on Higher Education at the University of Pennsylvania.*

lor's degrees granted annually in the United States. In 1991 women received nearly 55 percent of the more than one million bachelor's degrees awarded by the 1,360 schools from which the CAS sample was drawn. The CAS database is a collection of more than 42,000 transcript records of 1991 graduates from 81 American colleges and universities randomly selected from among 1,360. An examination of the database indicates that more than twice as many men as women—over 113,000 men, according to the study's estimate, as compared with about 52,000 women—majored in some field of mathematics, computer science, life or physical science, or engineering. Among class of '91 graduates, nearly a quarter of all men completed a major in one of those fields, while fewer than 10 percent of women did so (see Chart 1).

Chart 1

Graduates by Major: Mathematical and Computer Sciences, Life and Physical Sciences, and Engineering vs. Other Majors

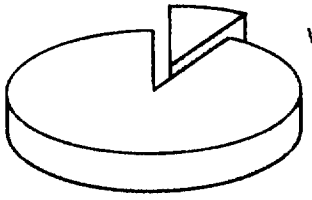
Men



24%
Men: Sciences and Engineering Majors

76%
Men: All Other Majors

Women



9%
Women: Sciences and Engineering Majors

91%
Women: All Other Majors

Engineering in particular, where men outnumbered women nearly five to one, had a paucity of female graduates, with just over 12,000 in 1991. In mathematics and computer science, almost twice as many men (24,000) as women (13,000) obtained degrees, largely because of a lack of women in computer science. Despite rising demand for software developers and information technologists, only 6,000 women, as compared with 15,000 men, graduated with degrees in those fields (see Chart 2).

While more men than women majored in some aspect of life and physical sciences, the gap—between about 33,000 men and approximately 27,000 women—was narrowed because of near parity in the biological sciences: of approximately 42,500 biology graduates, just under half were women. Women in large numbers also pursued such subjects as nursing, allied health, and business—disciplines that have science components or require quantitative skills like statistics and accounting. However, women tended to avoid subjects that require large doses of the most intensively mathematical or technical study. In highly quantitative physical sciences like physics and astronomy the absence of women was acute. Fewer than 20 percent of majors in those fields were women.

Focus

Can women do the work? If high scholastic marks can be taken as a measure of students' mastery of subject matter, then women certainly make the grade. In fact, women in the class of '91 tended to graduate with higher grades on average than men. Not only was this true for students in general, it was also true for students majoring in the sciences, engineering, and mathematics. In fact, in *any* quantitative discipline women decided to tackle, they outscored their male peers in average cumulative GPA.

For example, not only did women pursuing engineering majors have overall GPAs that were almost indistinguishable from those of women who majored in other areas, their average GPA was also measurably higher than the GPA of men in engineering: almost 63 percent of the women, versus under 50 percent of the men who majored in engineering, had GPAs of B or better (see Chart 3). The average GPA of women was higher in other quantitative subjects as well. While fewer than 750 women chose physics or astronomy as their major, more than three-quarters of those who did graduated with at least a B average, versus under 60 percent of their male counterparts. Nearly 65 percent of women pursuing mathematics or computer science majors achieved an overall GPA of B or higher, compared with fewer than 50 percent of the men who majored in those fields.

What is more, women graduates tended to "stick with the program" to a greater extent than did men. In general, a slim majority of today's students attend school in what may be termed the traditional

way—that is, they attend a college or university full time, they do not transfer among institutions, and they do not stop out for a semester or more. While this traditional pattern of full-time, straight-through study was a path more likely to be chosen by science and engineering majors than by other students (56 percent of engineering majors and 66 percent of science majors could be called traditional), women majoring in those fields were even more likely to stay the course. In fact, almost two-thirds of women engineering majors were traditional, compared with only 54 percent of the men.

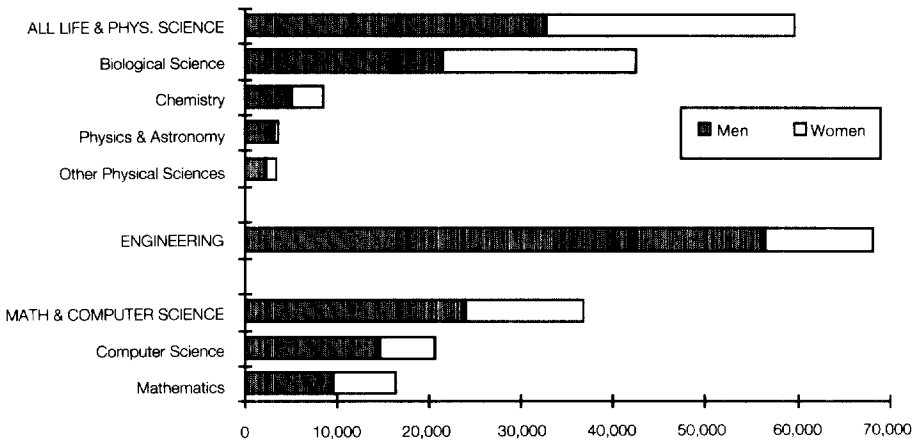
Nor does it appear that women who majored in science and engineering took an easier route to their higher grade point averages by electing to take courses outside their chosen fields of study. In fact, the data show little difference between men and women in the number of major courses completed: women became every bit as immersed in their majors as did their male counterparts. For the class of '91, the vast majority of both male and female students who majored in life and physical sciences, mathematics and computer science, or engineering tended to take at least nine courses in their own or related fields. The only exception to the overall parity between men and women in the number of courses taken was in engineering, where 87 percent of men were likely to have taken 13 or more courses in their major, as compared with only about 78 percent of women.

The CAS database promises more answers about why women are less likely than men to pursue the "hard sciences" or technical studies. For now, the data show that female students in general construct programs containing fewer math and computer science courses than men generally take. Among students who do not major in these areas, women are less likely than men to take even one math or computer course, and are considerably less likely to take five or more (see Chart 4). Further analysis will be required to discover whether women abandon the possibility of majoring in technical subjects and the physical sciences after an initial stab at calculus, computer science, or introductory physics, or whether women never even enroll in these fundamental courses.

Perspective

Women's underrepresentation in the hard sciences is increasingly likely to be seen as a work force issue. During World War II, Rosie became a riveter—not by accident, but because she was needed. Can a nation entering an age of expanding technological development afford, deliberately or inadvertently, to discourage—or simply *fail to encourage*—half of the population from preparing for careers in the very disciplines that are expected to become most critical to the country's future growth and well-being? In trying to move closer to gender parity in engineering and the physical and mathematical sciences, are there lessons that can be learned from examining the ways in which disciplines like law and medicine became more accessible and attractive to women?

Chart 2
Male and Female Graduates: Majors in Mathematical and Computer Sciences, Life and Physical Sciences, and Engineering



The hard sciences gender gap does not begin at the collegiate level. There is ample evidence that it is in the K through 12 environments, where students first are introduced to math and science, that the gen-

Chart 3
Grades by Gender: All Graduates vs. Engineering Majors

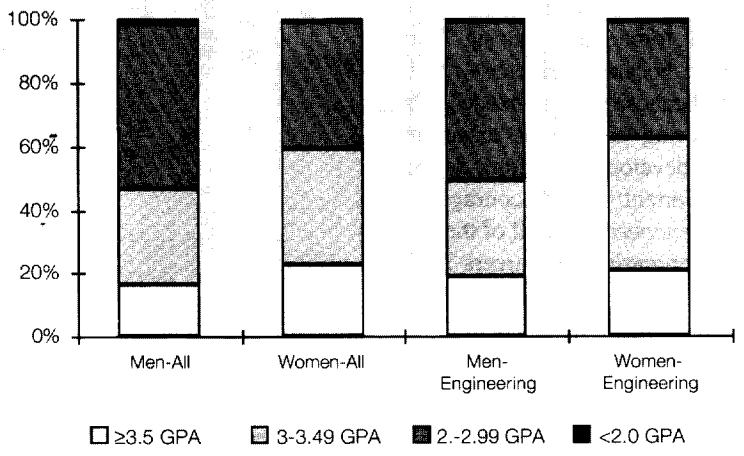
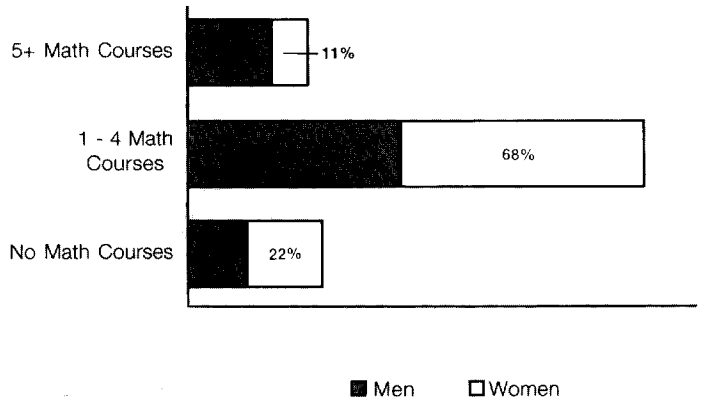


Chart 4
Mathematics and Computer Science Coursework of Students in Other Majors



der gap develops. Girls are discouraged about their abilities in these disciplines even before they start college, while boys are encouraged to persevere even in the face of initial difficulties. Because of the structured nature of quantitative subject matter, there is usually a window of introductory opportunity that, once missed, can never be revisited.

The challenge for educators, then, is to find ways to engage girls' interest in quantitative material early, and to keep them interested throughout their scholastic careers. Collaboration between educational sectors is essential to ensure that students of both genders are inspired and well prepared for the 21st century. To help achieve these goals, several questions must be addressed:

- In what ways might colleges and universities help the K through 12 sector develop science and math programs that encourage girls and prepare them to pursue mathematics and the hard sciences later in their academic careers? How can research about various ways of learning be applied to methods of teaching quantitative subjects in elementary and secondary schools?
- Can colleges and universities find resources that will allow them to look for creative ways to open new "windows"—ways of making quantitative material accessible to late bloomers and undecided beginners? Can curricula be adapted to allow women to become comfortable with technical subject matter? How can colleges and universities efficiently develop new technologies that would allow underprepared students to catch up on their own time and in their own ways?
- How can institutions ensure that their discussions of women's engagement in the hard sciences avoid becoming mired in gender politics?

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