Best and Brightest: Education and Career Paths of Top Science and Engineering Students

A Research Report Prepared for the Alfred P. Sloan Foundation

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Executive Summary

The strength of the U.S. scientific and technical enterprise depends in part on the career choices of academically talented students. Who will educate the scientists and engineers of the next century? Will the quality and quantity of students already in the science and engineering (S&E) educational pipeline be adequate for training future scientists and engineers?

Ten years ago, there was major concern about a possible "brain drain" from science into other professions. Since that time, significant changes have taken place, for example, in the labor markets for scientists and engineers.

Therefore, this study, performed by the Commission on Professionals in Science and Technology (CPST) for the Alfred P. Sloan Foundation, looks at the questions of what fields promising students are choosing and why, and specifically whether science and engineering are attracting a larger or smaller share of these promising students than in the past. Data were analyzed all along the educational pipeline from the choices of high school graduates, through college and graduate/professional school, and out into the labor force. In addition, a workshop of experts and interested parties was held to gather additional data and perspectives.

Study Objectives

The study focuses on the following five questions:

1. Is there a change in the quality of talent flow into S&E undergraduate programs? Are these programs attracting a larger or smaller share of top students now than in the past?
2. Do top students persist in science majors or switch to other majors?
3. Is there a change in the quality of talent flow into S&E graduate programs?
4. Are top students still interested in doctoral programs?
5. After graduation, do the top students in science fields persist in science or pursue other employment?

Findings

Our general findings related to the study questions are as follows:

1. Is there a change in the quality of talent flow into S&E undergraduate programs? Are these programs attracting a larger or smaller share of top students now than in the past?

The quality of incoming freshmen is higher.

Of the available pool of freshmen, top students made up a larger percentage in 1995 than in 1985. Thus, of the students choosing S&E, more of them are top students, indicating that the quality is higher.

On the other hand, the S&E fields' share of the talent pool of top students has dropped in engineering and math. Biological sciences' share has increased, while the physical sciences' share has remained the same.

The number of National Merit Scholars choosing S&E majors is consistently higher than other majors.

2. Do top students persist in science majors or switch to other majors?

Many top freshmen do not stay in S&E.

There are some losses in all S&E fields with large losses in biological sciences and mathematical sciences. Recruitment of other top students does not fully compensate for these losses. In addition, top women students' persistence rates are lower than men's in all fields.

3. Is there a change in the quality of talent flow into S&E graduate programs?

The GRE quantitative scores are decreasing slightly, but top S&E majors still score consistently higher than other fields.

4. Are top students still interested in doctoral programs?

Almost one-third of top S&E students pursue doctorates.

The majority of S&E majors go to graduate school including 67% of top biological science students. Nine years later, almost one-third of top S&E majors in the 1985 freshman cohort had doctoral degrees, doctoral plans, or medical degrees.

5. After graduation, do the top students in science fields persist in

science or pursue other employment?

Nine years after freshman year, employment was highest among top engineers and lowest among top biological science majors, who were more likely to be in graduate school. Engineers pursued engineering careers, while there was a great deal more changing to different fields among the other three majors. However, the potential pool of top talent who will eventually obtain their doctoral degrees and enter the academic or scientific workforce may be underestimated at this early point.

Related to Questions 4 and 5 is our finding regarding the flow of S&E talent into the professional schools, which resulted from the data presented at a workshop held during the study:

Except for many biology majors going into medicine, S&E are not losing top students to professional schools.

S&E majors are not choosing professional schools over graduate school and doctoral programs with the expected exception of biological science majors, the majority of whom pursue medical degrees.

Finally, our campus focus groups provided qualitative data, which resulted in the following finding:

S&E majors have a passion for the subject.

In general, the job market has had little or no effect on S&E majors' decisions to pursue or persist in these majors through graduate school. These students all expressed a passion for the subject matter.

However, is there still cause for concern? The answer is yes in light of the importance of S&E in producing a citizenry that is scientifically literate and globally competitive, and the importance of research. Consider these specific findings:

A number of concerns still need to be addressed.

- The numbers of women and minorities entering S&E are increasing, but only slightly.
- Biological science and mathematics departments are doing poorly at keeping top undergraduate students, who persist at rates of 33% and 24%, respectively.
- S&E departments are not retaining top women undergraduates. The proportion of top women who persisted in their S&E majors was lower than men in all fields.
- In engineering, only 29% of top undergraduate women persist,

while 82% of top undergraduate men do.

- Considering losses and gains during 1985-89, the number of top students majoring in mathematics dropped by one-half, and the total number of mathematics majors dropped by one-third.

In light of these results, much more needs to be learned, and there is much need for improvement, particularly in the area of nurturing our top undergraduates. Recommendations are presented in the next section.

Recommendations

The following are recommended:

- Longitudinal studies covering longer periods of time after college entry than currently available are needed to determine fully the extent of talent flow in academic and scientific sectors.

- At the same time, cross-sectional studies showing peaks and valleys in, for example, professional school admissions, should recognize external factors (such as popularity brought on by hit television programs and other cultural phenomena).

- Individual institutions should consider conducting focus groups and case studies to look at their retention of top talent and share lessons learned with other institutions.

Are U.S. citizens being displaced in graduate schools?

- The data used in this study did not enable the authors to contrast numbers or proportions of U.S. versus foreign citizens. At the undergraduate level, 97% of incoming freshmen are U.S. citizens (CIRP, 1996). However, at the graduate level, of the S&E doctorates (Ph.D.'s) awarded in 1995, only 53% were awarded to U.S. citizens (National Science Foundation, 1996). Therefore, it is important to determine the effect of the increasing numbers of foreign students entering S&E programs and the professional schools. Specifically, should displacement of U.S. citizens be of any concern?

- In addition to the citizenship composition of the S&E talent pool, the balance among other pools of talent based on sex and race/ethnicity should be monitored to ensure proportions that are appropriate, given considerations such as representation in the population at large.

- Data limitations are mentioned several times in this report. These limitations, that is, small cell sizes, were particularly

evident in our attempt to analyze trends by gender and race. We recommend that larger numbers of students be surveyed or that the study be designed differently to ensure sufficient data from which to discern a pattern.

In response to some of the specific findings:

Persistence issues need to be examined closely.

- Undergraduate biological science and mathematics departments must examine their programs to determine why the persistence of top students is so low, and what can be done to encourage top undergraduates to stay in their original field choice.

- Analysis of the factors causing top students to switch into an S&E discipline may produce insights into how to retain those who chose S&E at the outset.

- The persistence rates of top women in all the S&E fields, but particularly engineering, were low compared to top men. These disciplines need to examine their student advising programs, course offerings, and other factors to determine what can be done to improve on these numbers. Top women want to major in these fields, but something is keeping them from staying.

The number of minorities in S&E majors is still low.

- The numbers of minorities in some scientific disciplines are quite small. Similar to top women, those top minority students who do choose to major in S&E should be encouraged to stay.

- As expected, the potential for a rewarding career affects top students' choices, particularly at the graduate level. It was suggested at the December 1996 workshop that a graduate, faculty, and post-doctorate placement service be developed. The assistance in career placement currently given at this level needs to be examined as an avenue to improving the job market for S&E majors.

In conclusion, it is difficult to simply step in at one point in time and evaluate the status of top students and S&E. No matter the study field, to provide an accurate portrait of what fields are attracting and retaining students through career selection, we recommend periodic monitoring of key indicators such as those described in this study. Only by trending these data over time can we assess the educational and career paths of our nation's best and brightest students.

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1. Introduction

This report describes a study performed by the Commission on Professionals in Science and Technology (CPST) for the Alfred P. Sloan Foundation to assess whether top students are choosing science and engineering as an academic field and career path. This introductory chapter provides the background of the study, presents the study objectives, and describes the organization of the remainder of the report.

Background

The strength of the U.S. scientific and technical enterprise depends in part on the career choices of academically talented students. Who will educate the scientists and engineers of the next century? Will the quality and quantity of students already in the science and engineering (S&E) educational pipeline be adequate for training future scientists and engineers?

Ten years ago, there was major concern about a possible "brain drain" from science into other professions. The National Academy of Sciences commissioned Engin Holmstrom to examine the study field and career choices of top students interested in science and engineering. Her findings, using data through 1985, gave no indication of a brain drain, nor did they show any nationwide decline in the quality of science students (Holmstrom, 1987).

Since that time, significant changes have taken place, for example, in the labor markets for scientists and engineers. Therefore, it is useful to revisit the questions of what fields promising students are choosing and why, and, specifically, to determine whether science and engineering are attracting a larger or smaller share of these promising students than in the past.

These and related questions are explored in this study. Data were analyzed all along the educational pipeline from the choices of high school graduates, through college and graduate/professional school, and out into the labor force.

Study Objectives

The study focuses on the following five questions:

1. Is there a change in the quality of talent flow into S&E undergraduate programs? Are these programs attracting a larger or smaller share of top students now than in the past?
2. Do top students persist in science majors or switch to other majors?
3. Is there a change in the quality of talent flow into S&E graduate programs?
4. Are top students still interested in doctoral programs?
5. After graduation, do the top students in science fields persist in science or pursue other employment?

Report Organization

The remainder of this report is organized as follows:

- Chapter 2 describes the study methodology including definitions, data sources, and the types of analyses performed.
- Chapter 3 presents the study findings, organized by the five questions presented above.
- Chapter 4 discusses the findings and their implications and presents recommendations.
- The appendix contains the results of the study's literature review.

2. Methodology

This study focused on the most academically talented students, analyzing the most recent data available on the flow of top talent into and out of science and engineering fields at different points along the educational pipeline.

The study methodology steps may be summarized as follows:

- Determine data sources.
- Set definitions.
- Conduct initial analyses.
- Conduct campus focus groups.
- Conduct workshop.
- Conduct additional analyses based on workshop feedback.

The sections in this chapter describe each of these steps.

Data Sources and Points of Inquiry

An initial literature review was conducted to determine whether any similar studies have been performed. The results of this review are presented in the appendix. It was concluded from the review that rarely are academically talented students examined as a group, and that there have been no recent studies on the college and career paths of S&E top students.

After review of potential data sources, the following were selected for use:

- Cooperative Institutional Research Program (CIRP) of the Higher Education Research Institute at the University of California, Los Angeles (UCLA)
- National Merit Scholarship Corporation
- Educational Testing Service's Graduate Record Examination Program

CIRP

CIRP has collected data on entering freshmen since 1966. The following CIRP data were used:

- Freshman surveys of 1985, 1990, and 1995 classes (cross-sectional data)
- Follow-up surveys of the 1985 freshman class, taken in 1989 and again in 1994 (longitudinal data)

All the CIRP data are weighted by CIRP to represent the national population of college students (Astin, Panos, & Creager, 1966; Astin & Astin, 1992). The number of freshman surveys used varies each year, but as an example, the 1995 data are based on 240,082 surveys. The 1994 follow-up study includes more than 50,000 students who responded to the 1985 freshman survey, including 27,000 who responded to the 1989 follow-up survey.

National Merit Scholarship Corporation

Data on National Merit Scholars from 1982 through 1994 were obtained from the National Merit Scholarship Corporation (NMSC). This information was used to determine the intended college majors of these students.

Educational Testing Service

The Educational Testing Service furnished Graduate Record Examination (GRE) results from selected testing years (1988-89, 1991-92, and 1994-95). These data provided insights into the scores of students intending to pursue S&E fields at the graduate level versus the scores in other fields.

Points of Inquiry

As mentioned earlier, the study examined top S&E students at various points in a top S&E student's academic program and career. Figure 1 shows how the data sources just described relate to this timeline.

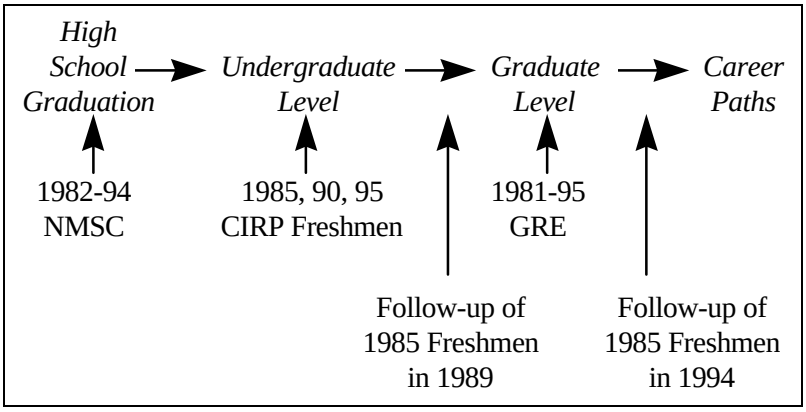

Figure 1. Points of Inquiry and Data Sources

The data provided by CIRP are of two types: cross-sectional and longitudinal. Figure 2 shows this concept. The cross-sectional data are "snapshots" of the freshman classes of 1985, 1990, and 1995. The longitudinal data consistently analyze the same 1985 freshman cohort four years later (1989) and nine years later (1994).

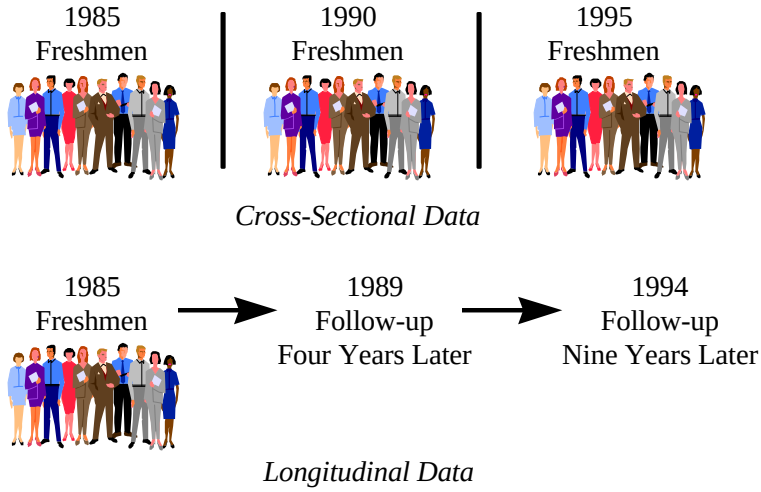

Figure 2. Cross-Sectional Data Versus Longitudinal Data

Definitions

The following definitions were established as part of the study design once the data sources were determined:

- **"Top students."** Academically talented students are termed "top" in this study. These students were defined as consistently as possible throughout the study.
  - At college entry, top students in the freshman class were defined as those with high school grade point averages (GPAs) of A-, A, or A+.
  - At the end of four years of college, "top" was defined as A or A+.
  - For the nine-year follow-up of 1985 freshmen, "top" was expanded (due to data limitations) to include B, B+, A-, A, and A+.
- **"Science and Engineering."** These fields were defined as follows:
  - **Engineering.** Aeronautical or astronautical, chemical, civil, electrical or electronic, industrial, mechanical, and "other"
  - **Biological Sciences.** General biology, biochemistry or biophysics, botany, environmental science, marine (life) science, microbiology or bacteriology, zoology, and "other"
  - **Mathematical Sciences.** Mathematics and statistics
  - **Physical Sciences.** Astronomy, atmospheric sciences (including meteorology), chemistry, earth science, marine science (including oceanography), physics, and "other"

These field definitions correspond with the categories used by CIRP.

Initial Analyses

The quality of talent flow into S&E was evaluated at high school graduation, college entry, and graduate school entry. The popularity of S&E among top students, that is, S&E's share, was also traced. Then, the study field and graduate degree choices of top students were traced through four years of college. Finally, graduate school attendance, doctoral degree rates, and employment status of top S&E students were examined nine years after college entry.

Campus Focus Groups

Focus groups were conducted on university campuses with the following groups of students:

- Undergraduate physics majors
- Undergraduate biochemistry students
- Graduate biology students

The purpose of these focus groups was to collect qualitative information on the students' knowledge of the current job market in S&E and its influence on their educational and career planning and decision making.

The following questions were posed to the groups:

- In what year are you, and what is your major or field?
- What are your immediate plans after graduation?
- What led you to pursue your major or field?
- Has your knowledge of the job market affected your educational and/or career planning?
- (For undergraduates only) What do you plan to do after all of your education is completed?

Workshop

The results of the initial analyses were presented at a workshop held by CPST on December 12, 1996, at the headquarters of the American Association for the Advancement of Science (AAAS). Experts and interested parties from education, government, business, industry, and professional societies attended and contributed to this workshop.

Following the presentation of the initial results, perspectives were provided from professional schools:

- Carl Monk, executive director of the Association of American Law Schools, discussed trends in law school admissions.
- Douglas Kelly, Associate Vice President for Biomedical Research of the Association of American Medical Colleges, presented data on the trends in medical school admissions and the medical degrees awarded.
- Frederic McHale, Director, Graduate Management Admission Test (GMAT), Educational Testing Service, discussed trends in the numbers and types of students taking the GMAT, which is generally a requirement for admission to graduate business schools.

Breakout groups were also held on two topics:

- Data and data needs
- Policy issues and recommendations

Jesse Ausubel of the Alfred P. Sloan Foundation closed the workshop with recommendations for further action.

Key findings and recommendations resulting from the workshop are presented in the remaining chapters of this report.

Additional Analyses

A recommendation from the workshop participants was that the CIRP data be reanalyzed by gender and race. CPST requested further data from CIRP that provided further breakdowns by race and by gender. Due to extremely small cell sizes in the race subcategories, it was not possible to perform analyses by racial subgroups such as African-Americans, Asians, and Hispanics. Therefore, the following race definitions were established for this series of analyses:

- White includes anyone who marked "white" on the survey.
- Nonwhite includes all other race categories (African-Americans, Asians, Hispanics, and others)

The majority of the initial analyses of the CIRP data were repeated, broken down by gender and by race. For example, changes in the gender composition of the S&E top talent pool were examined, as was the proportion of nonwhite students among top S&E majors.

Certain analyses were limited by the nature of the data. For example, a high number of respondents in the CIRP nine-year follow-up survey did not indicate race, resulting in questionable results for the career paths of top nonwhite men and women in the S&E fields.

The findings resulting from all the analyses described here are presented in Chapter 3.

3. Findings

This chapter presents our findings from the analyses described in the previous chapter. Supporting data are presented to illustrate these findings.

General Findings

Our general findings related to the study questions are as follows:

1. Is there a change in the quality of talent flow into S&E undergraduate programs? Are these programs attracting a larger or smaller share of top students now than in the past?

The quality of incoming freshmen is higher.

Of the available pool of freshmen, top students made up a larger percentage in 1995 than in 1985. Thus, of the students choosing S&E, more of them are top students, indicating that the quality is higher.

On the other hand, the S&E fields' share of the talent pool of top students has dropped in engineering and math. Biological sciences' share has increased, while the physical sciences' share has remained the same.

The number of National Merit Scholars choosing S&E majors is consistently higher than other majors.

2. Do top students persist in science majors or switch to other majors?

Many top freshmen do not stay in S&E.

There are some losses in all S&E fields with large losses in biological sciences and mathematical sciences. Recruitment of other top students does not fully compensate for these losses. In addition, top women students' persistence rates are lower than men's in all fields.

3. Is there a change in the quality of talent flow into S&E graduate programs?

The GRE quantitative scores are decreasing slightly, but top S&E majors still score consistently higher than other fields.

4. Are top students still interested in doctoral programs?

Almost one-third of top S&E students pursue doctorates.

The majority of S&E majors go to graduate school including 67% of top biological science students. Nine years later, almost one-third of top S&E majors in the 1985 freshman cohort had doctoral degrees, doctoral plans, or medical degrees.

5. After graduation, do the top students in science fields persist in science or pursue other employment?

Nine years after freshman year, employment was highest among top engineers and lowest among top biological science majors, who were more likely to be in graduate school. Engineers pursued engineering careers, while there was a great deal more changing to different fields among the other three majors.

Related to Questions 4 and 5 are our findings regarding the flow of S&E talent into the professional schools. Our review of the data presented at the December 1996 workshop resulted in the following general finding:

Except for many biology majors going into medicine, S&E are not losing top students to professional schools.

S&E majors are not choosing professional schools over graduate school and doctoral programs with the expected exception of biological science majors, the majority of whom pursue medical degrees.

Finally, our campus focus groups provided qualitative data, which resulted in the following finding:

S&E majors have a passion for the subject.

In general, the job market has had little or no effect on S&E majors' decisions to pursue or persist in these majors through graduate school. These students all expressed a passion for the subject matter.

The following sections provide detailed findings related to these statements.

The Talent Pool for Undergraduate Study

Finding

Of the available pool of freshmen, top students made up a larger percentage in 1995 than in 1985. Thus, of the students choosing S&E, more of them are top students, indicating that the quality is higher.

On the other hand, the S&E fields' share of the talent pool of top students has dropped in engineering and math. Biological sciences' share has increased, while the physical sciences' share has remained the same.

The number of National Merit Scholars choosing S&E majors is consistently higher than other majors.

Top and Total Freshmen, 1985 Versus 1995

As shown in Figure 3, between 1985 and 1995, the number of freshmen entering the nation's colleges and universities declined by about 11%, while the number of top students, that is, those with high school GPAs of A-, A, or A+, increased by 17%.

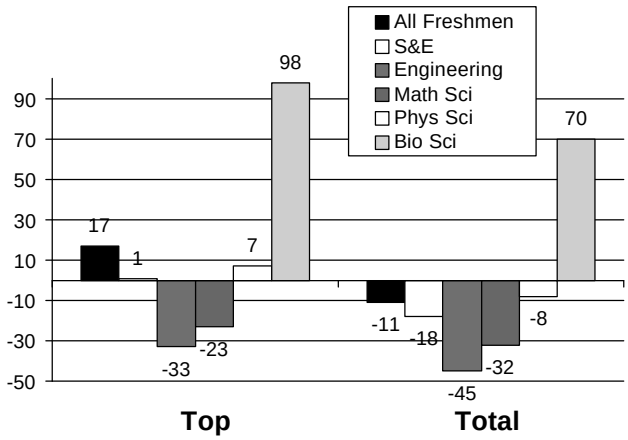

Figure 3. Percent Change in Number of Top and Total Freshmen from 1985 to 1995

To some degree, S&E fields reflected these national trends from 1985 to 1995:

With the exception of biological sciences, the popularity of S&E has declined among students in general.

- **Engineering**. Freshmen choosing engineering declined by 45%. Top talent flow into engineering also slowed with a decline of 33%.
- **Biological Sciences**. In contrast to other S&E fields, the popularity of biological sciences went up, with the freshmen choosing biological sciences increasing by 70% and the number of top students interested in biological sciences increasing by 96%.
- **Mathematical Sciences**. Freshmen interested in mathematical sciences declined by 32%. Similarly, the number of top students declined by 23%.
- **Physical Sciences**. Freshmen interested in physical sciences declined by 8%, while the number of top students increased by 6%.

Although the pool of freshmen interested in majoring in S&E programs was smaller in 1995 than in 1985, more academically able students were among the ranks of these S&E majors. In each case, there were proportionately more top students among S&E aspirants in 1995 than in 1985, as shown in Figure 4.

In 1995, S&E had proportionately more top students than ten years before.

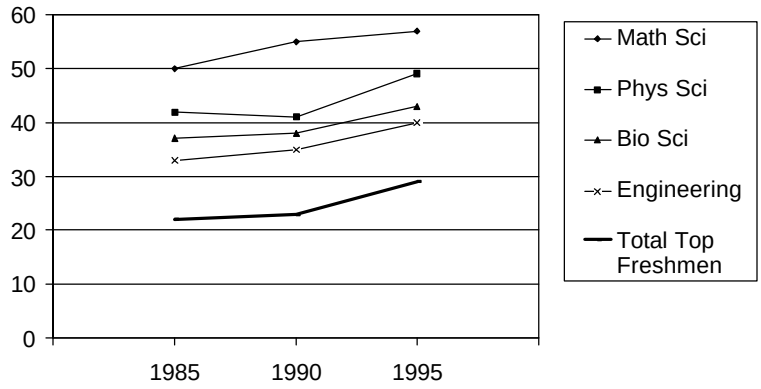

Figure 4. Percent of Freshmen Choosing S&E Majors Who Were Top Students

To specifically respond to one of the study objectives, S&E's share of top students was analyzed. The total S&E share of top students in 1995 was 24%, down from 29% in 1985. In the specific majors, the share of top students was as follows:

S&E's total share of top students declined from 1985 to 1995.

- Engineering's share of top students declined from 18% to 10%.
- Biological sciences' share of top students rose from 6% to 10%.
- Mathematical sciences' share declined from 2% to 1%.
- Physical sciences' share was stable at 3%.

Thus, the loss in share of top students in S&E overall appears largely due to the drop in share in engineering.

The following sections present our findings regarding the gender and racial breakdown of top students choosing S&E.

Gender Breakdown of Top S&E Majors

As shown in Table 1, the analyses of top freshmen by gender indicate that engineering's popularity has declined for both genders, especially men; biological sciences' popularity has increased; the mathematical sciences' share has declined, and physical sciences have remained relatively stable.

Table 1. Percent of Top Men and Women Freshmen Interested in S&E (1985 and 1995)

Major	Men		Women	
	1985	1995	1985	1995
Engineering	32%	20%	7%	4%
Biological Sciences	6	10	6	11
Mathematical Sciences	2	1	2	1
Physical Sciences	5	4	2	2

Numerically, most S&E fields lost top students from 1985 to 1995, as shown in Table 2. The only exceptions were biological sciences, where the number of both top men and women increased, and physical sciences, where only the number of top women increased.

Although the number of top students increased, engineering and math lost top students of both genders.

The losses of top students interested in engineering and mathematical sciences, as well as top men interested in physical sciences, are even more significant in view of the fact that from 1985 to 1995 the number of top students among both men and women increased by 8% and 24%, respectively.

Table 2. Percent Change in Number of Top Students Interested in S&E Among Men and Women Freshmen from 1985 to 1995

Major	Men	Women
Engineering	-33%	-34%
Biological Sciences	74	112
Mathematical Sciences	-20	-26
Physical Sciences	-11	33
Total Freshmen	8	24

Top women students consistently had better grades than men at the time of college entry.

One trend remained stable from 1985 to 1995: At the time of college entry, as a group, women choosing to major in S&E had better grades than men. For example, as shown in Table 3, top women made up the majority of female freshmen majoring in engineering (52% in 1985 and 62% in 1995). The difference between men and women is significant compared to the proportion of top students in the total freshman classes in both years.

Table 3. Percent of Top Students Among Men and Women Freshmen Interested in S&E Majors in 1985 and 1995

Major	1985		1995	
	Men	Women	Men	Women
Engineering	29%	52%	35%	62%
Biological Sciences	31	42	38	46
Mathematical Sciences	44	55	48	65
Physical Sciences	39	49	46	51
Total	18	24	24	32

Clearly, students are aware that better academic credentials are needed to enter S&E majors. Table 3 shows that in each year, the proportion of top students stating their preference for S&E majors is higher than the proportion of top students in the total freshman class.

Three out of five top students are women.

The data were also analyzed for changes in gender composition of the top students choosing S&E majors. As shown in Figure 5, women make up roughly 60% of all top students in 1985 and 1995. Their proportion among top students interested in biological and mathematical sciences remained more or less equal to their proportion in the total freshman classes in both years. In other words about three in five top students declaring their intentions to study biological sciences and mathematical sciences are women.

Engineering remains a male-dominated field.

On the other hand, engineering remains a male study field. Fully three-fourths of all top students interested in engineering at the time of college entry are men. The proportion of women among top students interested in engineering remains less than one-half of the proportion of women among top students in the 1985 and 1995 freshman classes.

In physical sciences, the composition of top students has changed over the past ten years, with more women indicating an interest in physical sciences: 47% of top women students in 1995 versus 37% in 1985.

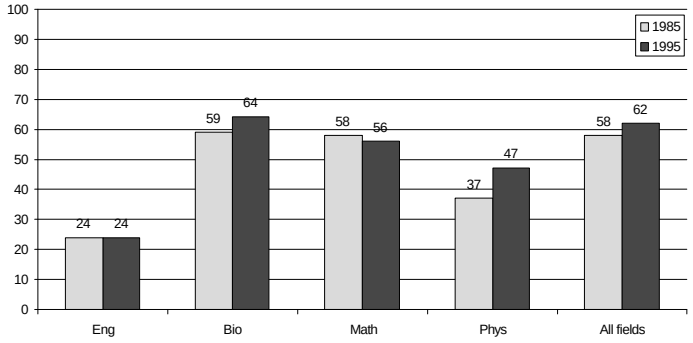

Figure 5. Percentage of Women Among Top Freshmen Interested in S&E (1985 and 1995)

Racial Breakdown of Top S&E Majors

For this study, the categories of white and nonwhite were used. The nonwhite classification refers to all minorities including Asians. Separate analyses by race (such as African-American, Hispanic, or Asian) were attempted, but no meaningful results could be determined from the small cell sizes.

As shown in Figure 6, there have been slight increases of minority students entering S&E fields.

Generally, the number of minority students entering S&E fields has increased slightly from 1985 to 1995.

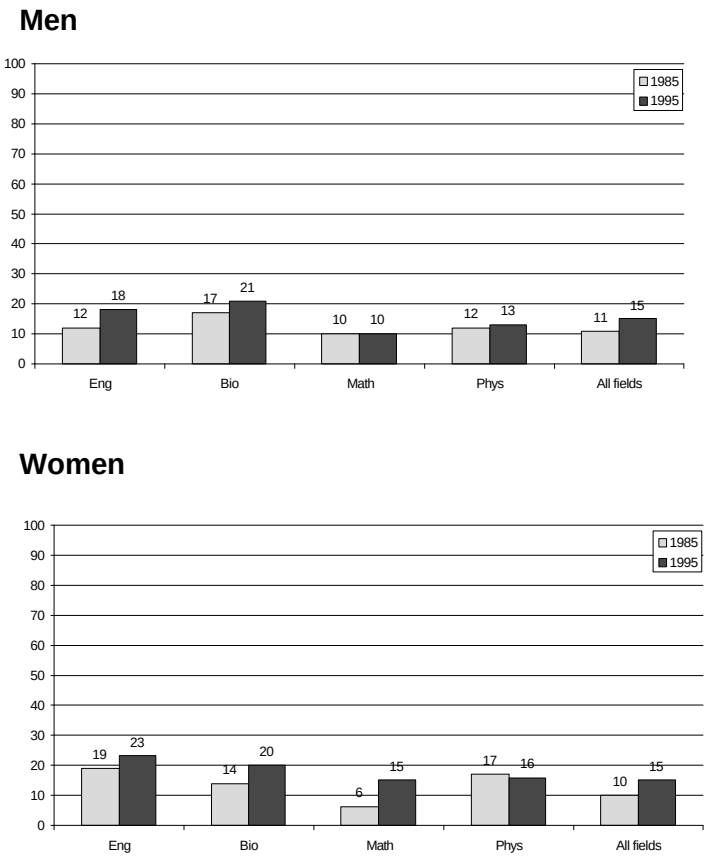

Figure 6. Proportion of Nonwhites Among Top Students by Gender (1985 and 1995)

Among top men students, the proportion of nonwhites has increased slightly among freshmen interested in engineering (up from 12% in 1985 to 18% in 1995) and in biological sciences (up from 17% in 1985 to 21% in 1995) but has remained about the same in mathematical and physical sciences.

Although the percentages of nonwhites show an increase, the actual numbers are very small.

Among top women students, all but physical sciences have registered slight increases in the proportion of nonwhites. The largest increase was in mathematical sciences from 6% in 1985 to 15% in 1995, but as seen in Table 4, the actual increase was from 247 to 432 students.

Table 4. Top Freshmen's Choices in 1985 and 1995 by Gender and Race

Top Students		1985	1995	% Change
Engineering				
Men	White	40,728	25,656	-37
	Nonwhite	5,632	5,581	-1
Women	White	12,161	7,526	-38
	Nonwhite	2,754	2,296	-17
Biological Sciences				
Men	White	7,189	11,934	66
	Nonwhite	1,437	3,108	116
Women	White	10,787	21,625	100
	Nonwhite	1,799	5,050	181
Mathematics				
Men	White	2,490	1,998	-20
	Nonwhite	274	222	-19
Women	White	3,607	2,427	-33
	Nonwhite	247	432	75
Physical Sciences				
Men	White	6,552	5,771	-12
	Nonwhite	872	866	-7
Women	White	3,605	4,903	36
	Nonwhite	749	899	20
Total Top Students				
Men	White	129,107	134,040	4
	Nonwhite	16,102	22,974	43
Women	White	181,694	212,776	17
	Nonwhite	20,255	37,649	86

Table 4 also shows that increases in top nonwhites are not being

accompanied by decreases in top white students in S&E fields. In fact, some fields show a decrease in top students in virtually all gender and race categories.

- **Engineering.** It was shown earlier in Table 1 that the percentage of top men interested in engineering had declined from 32% among 1985 freshmen to 20% in 1995. The number of top white men declined by 37%, from 40,728 in 1985 to 25,656 in 1995 (Table 4). The number of top nonwhite men declined by only 1% (from 5,632 to 5,581). The number of top white women declined by 38%, and nonwhites by 17%. Compared to the total freshman class where numbers of top students increased in all categories, the popularity of engineering among top students is down, but less so among nonwhite men. Nevertheless, the field remains dominated by white men.

- **Biological Sciences.** The popularity of biological sciences has increased, particularly among top nonwhite students.

- **Mathematical Sciences.** The popularity of math has decreased except among top nonwhite women.

- **Physical Sciences.** The popularity of physical sciences has decreased among top men but increased among top white and nonwhite women.

It appears that top nonwhite women compensate to some degree for the losses among top students in math, while top women in general compensate for losses in physical sciences.

National Merit Scholars

National Merit Scholars continue to prefer S&E fields.

Since National Merit Scholars represent the top 0.5% of the nation's high school graduates in terms of academic achievement, they provide a good indicator of the field preferences of top students. Over the years, these top high school graduates have consistently shown a stronger preference for S&E fields as a college major than for other programs. This trend continues as shown in Figure 7. In 1994, S&E fields still attracted larger numbers of National Merit Scholars than did business and health-related fields.

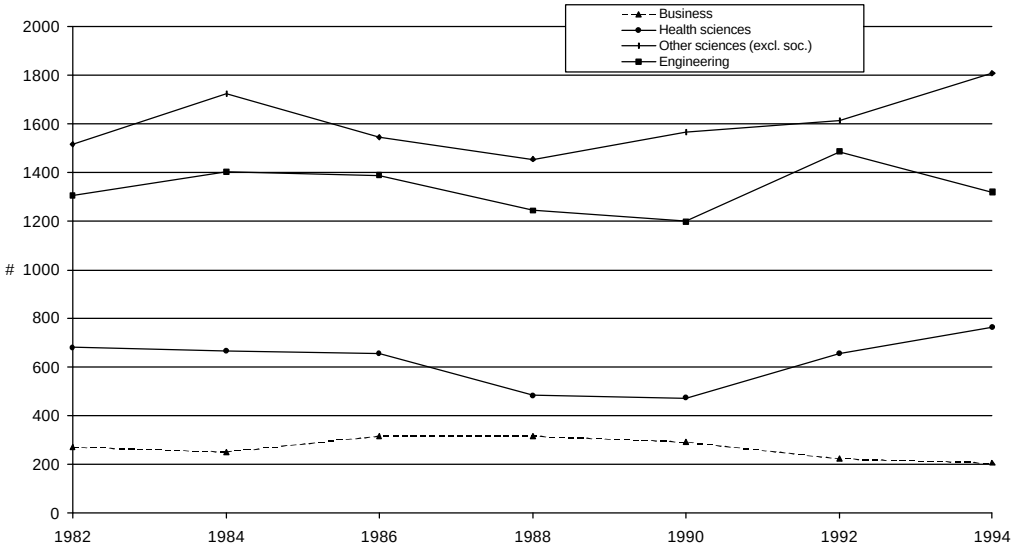

Figure 7. Number of National Merit Scholars Choosing S&E Majors Versus Other Fields (1982 through 1994)

Changes in Major Among Undergraduates

Finding

There are some losses in all S&E fields with large losses in biological sciences and mathematical sciences. Recruitment of other top students does not fully compensate for these losses. In addition, top women students' persistence rates are lower than men's in all fields.

Changes in Major Among All Top Students

During four or more years of undergraduate education, students often change their initial study field plans. By 1989, all the S&E fields experienced losses of the 1985 freshmen who had intended to major in S&E. At the same time, these fields differed in their ability to retain top talent (those with college GPAs of A or A+).

As shown in Table 5, the largest outflow of talent was from the

mathematical sciences, where the number of top students decreased by 38%, followed by engineering (-13%) and biological sciences (-7%). In contrast, the number of top students majoring in physical sciences increased by 64%.

Table 5. Four-Year Change in Major Plans of the 1985 Freshman Cohort

Major	A, A+	Total in Major
Engineering		
1985 Aspirants	9,563	158,877
1989 Majors	8,322	123,766
% Change	-13	-22
Biological Sciences		
1985 Aspirants	8,908	57,653
1989 Majors	8,260	63,652
% Change	-7	10
Mathematical Sciences		
1985 Aspirants	2,459	16,506
1989 Majors	1,516	12,429
% Change	-38	-24
Physical Sciences		
1985 Aspirants	2,260	28,255
1989 Majors	3,701	25,981
% Change	64	-8

Figure 8 shows the persistence rates among top students in their S&E majors, that is, the percentage who remained in their freshman

plans. Persistence was highest among physical science majors (78%), followed by engineers (69%), biological science majors (33%), and mathematical science majors (24%).

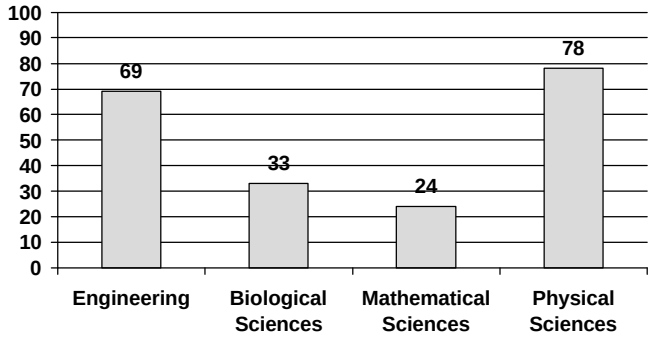

Figure 8. Percent of Top Freshmen Who Persisted in Their S&E Major

The inflow of top talent (those with college GPAs of A or A+) also differed among the fields. In 1989, 20% of engineering top students, 65% of top biological science students, 61% of top mathematical science students, and 52% of physical science top students had been recruited into the field during the four undergraduate years (Figure 9).

More than 50% of top students in biology, math, and physical sciences were recruited during their college years.

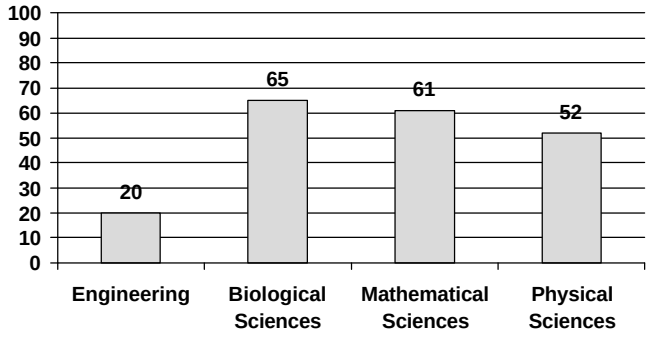

Figure 9. Percent Top Students Recruited by S&E Major

Table 6 shows the net result of the losses of top talent and the gains of new top talent between 1985 and 1989.

Table 6. Outflow and Inflow of Talent

Major	Changers	Recruits	Net Result
Engineering			
A, A+	2,942	1,701	-1,241
Total	71,687	36,575	-35,112
Biological Sciences			
A, A+	6,002	5,352	-650
Total	31,245	37,190	5,945
Mathematical Sciences			
A, A+	1,868	924	-944
Total	13,254	9,177	-4,077
Physical Sciences			
A, A+	485	1,926	1,441
Total	17,496	15,226	-2,270

With the exception of biological sciences, all S&E fields lost students during four years of college. With regard to top students, however, biological sciences, mathematical sciences, and engineering all experienced losses during four years of college; only physical sciences gained top students.

Top talent exchange was heaviest in the biological science programs, which lost two-thirds of their top students during four years of college but compensated for most of the losses by recruiting large numbers of top students from other programs.

The increase in top students in physical sciences reflects their ability to retain and

As stated above, physical science programs were unique in their ability to keep their top talent while at the same time managing to recruit top students from other programs. As a result, the number of

recruit top students.

top physical science majors increased by 64% after four years of college. Engineering programs also were successful, although to a lesser degree than physical science programs, in keeping their top students.

Mathematical sciences suffered a net loss of 40% of their top students.

In contrast, there was heavy traffic into and out of mathematical science programs. Fully three-fourths of top freshmen interested in mathematical sciences in 1985 had switched to other programs by 1989. After four years of college, 61% of top students majoring in mathematical sciences were recruits from other fields. But in the process, mathematical science programs lost nearly two-fifths of their top students.

In total, S&E majors lost nearly one-half of their top talent but compensated 88% of this loss by recruiting other top students. Just over 10% were recruits from other S&E fields. Nearly 90%, however, came from outside S&E disciplines.

Changes in Major by Gender and Race

The major finding of the analysis by gender and race is that top women's persistence rates are lower than men's in all S&E fields. See Table 7.

Table 7. Four-Year Persistence Rates of Top Women Versus Top Men

Major	Top Men Persisting	Top Women Persisting
Engineering	82%	29%
Biological Sciences	40%	22%
Mathematical Sciences	33%	25%
Physical Sciences	99%	31%

Engineering has not been able to retain top white women.

Figure 10 shows the persistence rates by race and gender in engineering. Top white men are the most likely to persist, followed by top nonwhite women. Top white women are least likely to persist in engineering as a major.

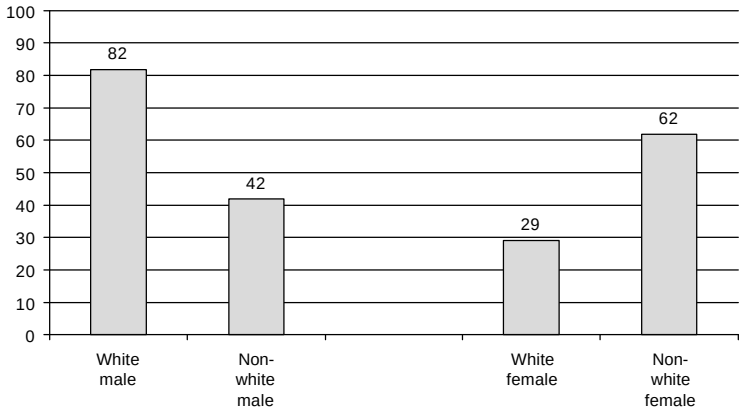

Figure 10. Persistence Rates in Engineering

Figure 11 shows the persistence rates in the biological sciences. Top nonwhite men are most likely to persist. Top white women and top white men are least likely to persist, but the white male persistence rate is double that of the white women.

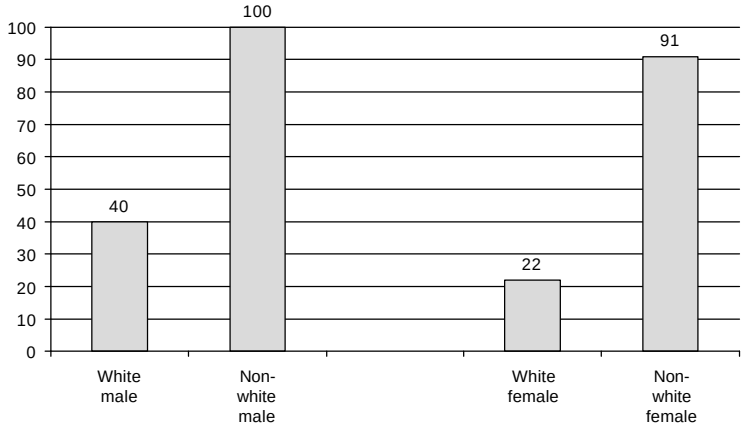

Figure 11. Persistence Rates in Biology

Mathematical sciences have the lowest persistence rate.

As shown in Figure 12, the overall persistence rate in math is lower than in other fields. Top white men are most likely to persist; top white women are less likely to persist. The top nonwhite data for both genders produced such small cell sizes that results are questionable and no conclusions on persistence rates can be drawn.

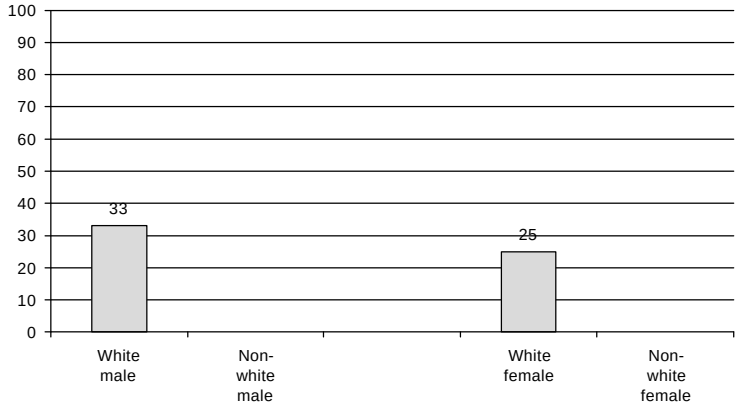

Figure 12. Persistence Rates in Mathematical Sciences

Figure 13 shows the persistence rates for physical sciences. Nearly all of the top white men persist, while only 31% of top white women persist. Similar to Figure 12, the top nonwhite data for both genders produced such small cell sizes that results are questionable and no conclusions on persistence rates can be drawn.

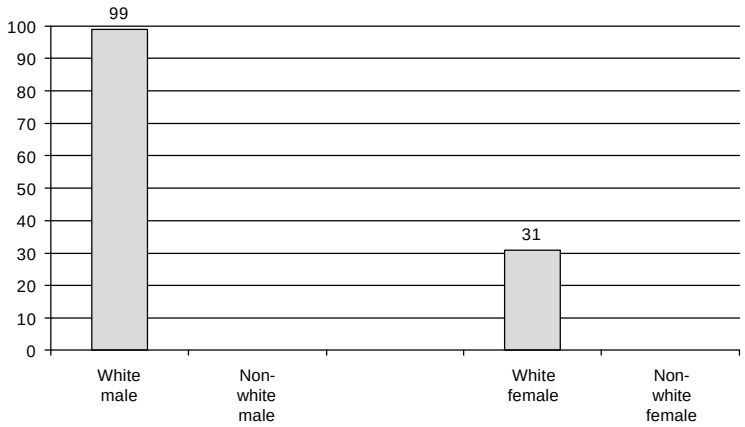

Figure 13. Persistence Rates in Physical Sciences

The Talent Pool for Graduate Study

Finding

The GRE quantitative scores are decreasing slightly, but top S&E majors still score consistently higher than other fields.

Graduate Record Examination (GRE) scores provide one measure of the potential ability of students planning to enroll in graduate programs. Historically, S&E test-takers have had relatively high scores on the GRE quantitative test. This trend continued, as illustrated in Figure 14, although recently the overall quantitative scores of the average student in most of the S&E fields has declined somewhat.

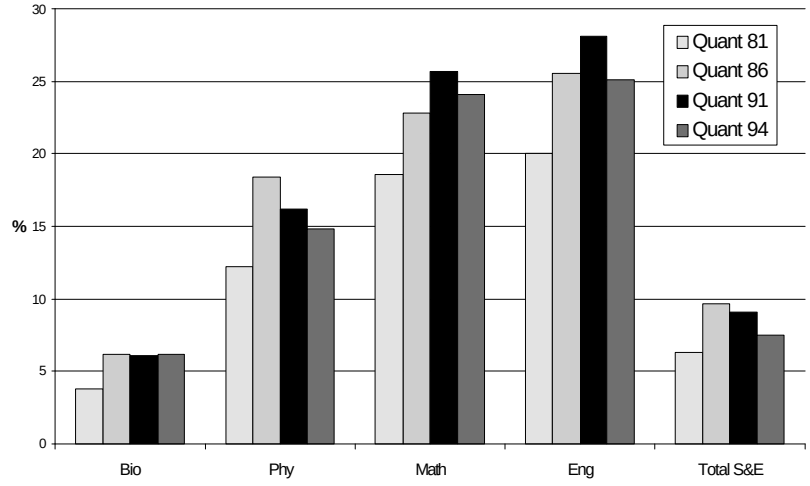

Figure 14. Percent of Domestic Examinees with 750+ on GRE Quantitative by Intended Graduate Major (1981, 1986, 1991, 1994)

Table 8 shows the mean GRE Quantitative scores by intended major in selected years. Table 9 shows the proportion of top-scoring students (also on the GRE Quantitative) by intended major in the same years. For this analysis, "top-scoring" is defined as scoring 750 or more.

Although quantitative scores have decreased, S&E majors continue to score higher than those in other fields.

As shown in Table 8, in 1995, the average scores of S&E students in the GRE Quantitative test remained much higher than the average for all examinees. Likewise, as shown in Table 9, the proportion of top students in S&E fields in 1994-95 was still five times more in engineering and mathematical sciences than in the total group, and three times more in physical sciences than the total group.

Table 8. Mean GRE Quantitative Scores of Domestic Examinees by Intended Graduate Major[1]

Major	1988-89	1991-92	1994-95
Behavioral Science	518	516	512
Social Science	487	485	476
Biological Science	587	588	586
Physical Science	643	631	622
Mathematical Science	664	662	650
Engineering	687	682	672
Art	493	494	500
Other Humanities	530	531	529
Education	472	472	470
Health Science	509	503	506
Applied Biology	528	523	520
Other	500	508	504
Undecided	535	532	527
No Response	514	510	530
Total	**532**	**528**	**524**

Table 9. Proportion of Top Students on the GRE Quantitative

[1] "Domestic examinees" are defined as U.S. citizens.

Among Domestic Examinees by Intended Graduate Major[2]

Major	1988-89	1991-92	1994-95
Behavioral Science	3.6	2.9	2.4
Social Science	2.1	1.8	1.3
Biological Science	8.2	6.1	6.2
Physical Science	20.5	16.2	14.8
Mathematical Science	26.7	25.7	24.1
Engineering	30.7	28.1	25.1
Total S&E	**10.9**	**9.1**	**7.5**
Art	2.3	2.0	1.9
Other Humanities	4.0	3.4	2.7
Education	1.7	1.6	1.6
Health Science	1.9	1.4	1.2
Applied Biology	2.9	1.8	1.5
Other	2.9	2.8	2.2
Undecided	6.9	5.7	4.6
No Response	5.4	4.8	5.1
Total Non-S&E	**3.7**	**3.0**	**2.7**
All Domestic Examinees	**6.7**	**5.6**	**4.5**

In summary, S&E fields experienced a slight decline in quantitative scores of students taking the GRE tests during the period from 1988 to 1995. This trend is not unique to S&E: During the same period, the average quantitative scores decreased from 532 to 524. Historically, however, S&E test-takers have scored consistently higher than those in other majors, and this trend continues.

[2] Top students are those with GRE Quantitative scores of 750 and above.

Talent Flow into Doctoral Programs

Finding

The majority of S&E majors go to graduate school including 67% of top biology students. Nine years later, almost one-third of top S&E majors in the 1985 freshman cohort had doctoral degrees, doctoral plans, or medical degrees.

All Top Students

Since the doctorate is a prerequisite for some scientific and most academic employment, it is important to study trends regarding the quality of students with such aspirations. The doctoral plans of top freshmen who entered the nation's colleges and universities in 1985 and in 1995 were first examined, followed by four-year changes in degree plans of top students in the 1985 freshmen cohort. Finally, using information from the 1994 follow-up of 1985 freshmen, the doctoral degree and graduate school status of top S&E students in the 1985 freshman cohort was reviewed.

Freshman Graduate Degree Plans

Both doctoral and medical degrees became more popular with freshmen from 1985 to 1995. During this period the total number of freshmen declined by 11%, while the number interested in doctoral degrees increased by 24% (129,679 to 161,114) and in medical degrees by 18% (88,564 to 104,420).

The number of top students interested in a doctoral or medical degree increased from 1985 to 1995.

Similarly, from 1985 to 1995, the number of top students in freshman classes increased by 17%, while the number of top students interested in doctoral degrees increased by 41% (from 50,710 to 71,484) and in medical degrees by 34% (from 41,878 to 56,322), suggesting that doctoral degrees had slightly more drawing power among top students than did medical degrees.

As shown in Table 10, the proportion of top students interested in doctoral degrees rose from 16% in 1985 to 20% in 1995, and the proportion of top students interested in medical degrees rose from 13% to 16%.

Table 10. Degree Aspirations of Top 1985 and 1995 Freshmen

Planned Degree	1985	1995
None	1%	<0.5%
Associate	2	<0.5
Bachelor's	28	19
Master's	34	37
Doctorate	16	20
Medical	13	16
Law	5	4
Divinity	<0.5	<0.5
Other	1	1
Total	100	100
(N) Top Freshmen	(320,219)	(361,985)
(N) Total Freshmen	(1,371,150)	(1,164,011)

Changes in Doctoral Degree Plans During Undergraduate Education

College students change their degree plans as they do their study field majors. Not surprisingly, many students among the 1985 freshman cohort made adjustments in their freshman degree plans during four years or college.

By 1989, the number of 1985 freshmen who planned to get a doctoral degree had increased by 34%. Among top students (those with college GPAs of A or A+), the increase was 53%. In contrast, the number of students interested in medical degrees had decreased by 48%; and for top students (those with college GPAs of A or A+), the decrease was 53% (Table 11).

Table 11. Changes in Doctoral and Medical Degree Plans

After Four Years of College

Degree	A, A+	B+, A-	B or Less	Total
Doctoral Degree				
1985 Aspirants	16383	42569	80433	139385
1989 Majors	24998	53073	108808	186879
% Change	53	25	35	34
Medical Degree				
1985 Aspirants	9013	24759	56492	90264
1989 Majors	4250	21680	21100	47000
% Change	-53	-13	-63	48

Graduate Degree Status Nine Years After College Entry

Using data from 1994 follow-up survey of 1985 freshmen, we examined the graduate school and degree status of top students who had majored in S&E fields. Note that in this section on the nine-year follow-up, the definition of top students was expanded to include those who had college GPAs of A+, A, A-, B+, and B because of relatively small cell sizes.

Top students are more likely to attend graduate school than other students in S&E fields.

By 1994, just over one-third of both S&E majors and others had attended graduate school. However, among top students, S&E majors were more likely to attend graduate school (55%) than were other students (40%). Graduate school attendance rates for top students were:

- Engineering: 52%
- Biological Sciences: 67%
- Mathematical Sciences: 50%
- Physical science: 46%

Among top S&E students, 2% had doctoral degrees, 17% masters degrees, and 8% medical degrees. However, among top students, 6% were already enrolled in a doctoral program, and 16% had plans to do so at a later time.

As shown in Table 12, top engineering majors were less likely to be interested in doctoral degrees than were other science majors, while

biological and physical science majors were more likely than other S&E majors to get medical degrees.

Table 12. 1994 Follow-up of Top Students' Graduate Degree Plans and Status (Percent)

Graduate Study Field	Degree Already Earned	Working Toward Degree	Highest Degree Planned
Engineering			
Ph.D., Ed.D.	1	3	10
M.D., D.D.S.	<0.5	2	2
Biological Sciences			
Ph.D., Ed.D.	2	9	19
M.D., D.D.S.	23	11	27
Mathematical Sciences			
Ph.D., Ed.D.	4	6	27
M.D., D.D.S.	0	<0.5	1
Physical Sciences			
Ph.D., Ed.D.	5	16	26
M.D., D.D.S.	5	2	5
Total S&E			
Ph.D., Ed.D.	2	6	16
M.D., D.D.S.	8	4	9
Total Others			
Ph.D., Ed.D.	<0.5	3	19
M.D., D.D.S.	<0.5	<0.5	1

Graduate Study Field Changes

Not all students who major in S&E programs in college persist in studying the same fields in graduate school. The persistence rate in S&E fields among top students was lowest among biological science

majors (21%) and highest among physical science (47%) and mathematical science (45%) majors. The rates and patterns of change varied:

- **Engineering:** 39% engineering, 49% business, 3% medicine, 9% other
- **Biological Sciences:** 21% biological sciences, 38% medicine, 19% other health, 12% education, 3% business, 7% other
- **Mathematical Sciences:** 45% math, 19% education (not college), 11% business, 9% engineering, 7% computer science, 9% other
- **Physical Sciences:** 47% physical sciences, 20% medicine, 8% engineering, 5% biological sciences, 5% business, 3% education, 3% other health, 9% other

Summary

Top students, and in particular those who had majored in S&E fields, were more likely to attend graduate school than were other students. As would be expected, very few of the 1985 freshmen had obtained their doctoral degree by 1994. Some were still enrolled in a doctoral program, and others planned to do so. Assuming these plans materialize, nearly one-half of top physical science majors, one-third to two-fifths of mathematical science majors, one-third of biological science majors, and one-tenth of top engineering majors may end up with a doctoral degree.

More than one-half of top S&E students enrolled in a different field in graduate school.

However, this does not mean that these doctorates will be in S&E fields. Among top students attending graduate school, less than half of the S&E majors persisted in their undergraduate fields. At this point, the largest talent outflow from S&E was in the biological sciences, where only one-fifth persisted. Three-fifths of top biological science majors who attended graduate school switched to medicine and other health-related fields.

To a lesser degree, there was top talent outflow from the physical sciences to medicine, with approximately one in ten obtaining a medical degree at some point.

Top Students by Gender and Race

Table 13 shows the percent graduate school attendance of top 1985 freshmen based on the nine-year follow-up. Only in the physical sciences do top white men not attend graduate school in proportion to top white women. In the other three fields, top white men are

attending graduate school to a proportionately greater extent. Consistent with these results, for sciences overall, the percentages who attended graduate school were 57% for top white men (n = 49,492) and 52.8% for top white women (n = 21,233).

The following can be stated based on the data shown in Table 13:

- Top biological science majors attend graduate school more than the other fields.
- Top men are more likely to attend than top women, especially in engineering (56% versus 30%). The exception is physical sciences (51% women, 43% men).
- Among top men, whites are more likely than nonwhites to attend graduate school, again except in physical sciences.
- Among top women, the results are mixed: Proportionately more nonwhites than whites attend graduate school in engineering and biological sciences. More top white women attend graduate school than top nonwhite women in math and physical sciences.

Table 13. Top Students Attending Graduate School by Gender and Race

	Men			Women			Total		
Major	**White**	**Nonwhite**	**Total**	**White**	**Nonwhite**	**Total**	**White**	**Nonwhite**	**Total**
Eng	57	44	569	28	48	30	52	46	52
Bio	74	67	73	62	77	63	67	70	67
Math	63	11	61	57	43	42	60	44	50
Phys	39	92	43	73	19	51	45	12	46

Career Paths of S&E Talent

Finding

Nine years after freshman year, employment was highest among top engineers and lowest among top biological science majors, who were more likely to be in graduate school. Engineers pursued engineering careers, while there was a great deal more changing to different fields among the other three majors.

The findings presented here are based on the nine-year follow-up of the 1985 freshman cohort. These are relatively early career choices, as will be seen from the employment numbers.

Career Paths of All Top Students

Using data from the 1994 follow-up survey of 1985 freshmen, we determined the employment status of students who had majored in S&E programs in college. Regardless of the academic ability of the S&E majors, fully 90% of these students were employed full time nine years after college entry, and 85% of top students were employed full time by 1994.

Employment rates were highest among top engineering majors (95%) and lowest among top biological science majors (83%), who were more likely to be in graduate school than other S&E students.

Eighty-one percent of top engineering majors were employed as engineers, whereas the consistency rate was lower among other sciences, as shown in Figure 15. The following are additional details:

- **Engineering:** Some of the "other" fields chosen by top engineering majors were business (2%), computer programming (3%), and military (2%).
- **Biological Sciences:** The 36% for health careers includes 18% medicine.
- **Mathematical Sciences:** The 32% education shown in Figure 15 is noncollege-level teaching. The large percentage of "other" careers includes 5% engineering, 4% college teacher, 3% clerical, 2% research scientist, 2% military, and 2% statistician.
- **Physical Sciences:** The 30% for health careers includes 5% medicine. The "other" category includes 5% engineering, 3%

education (including college), and 3% computer programming.

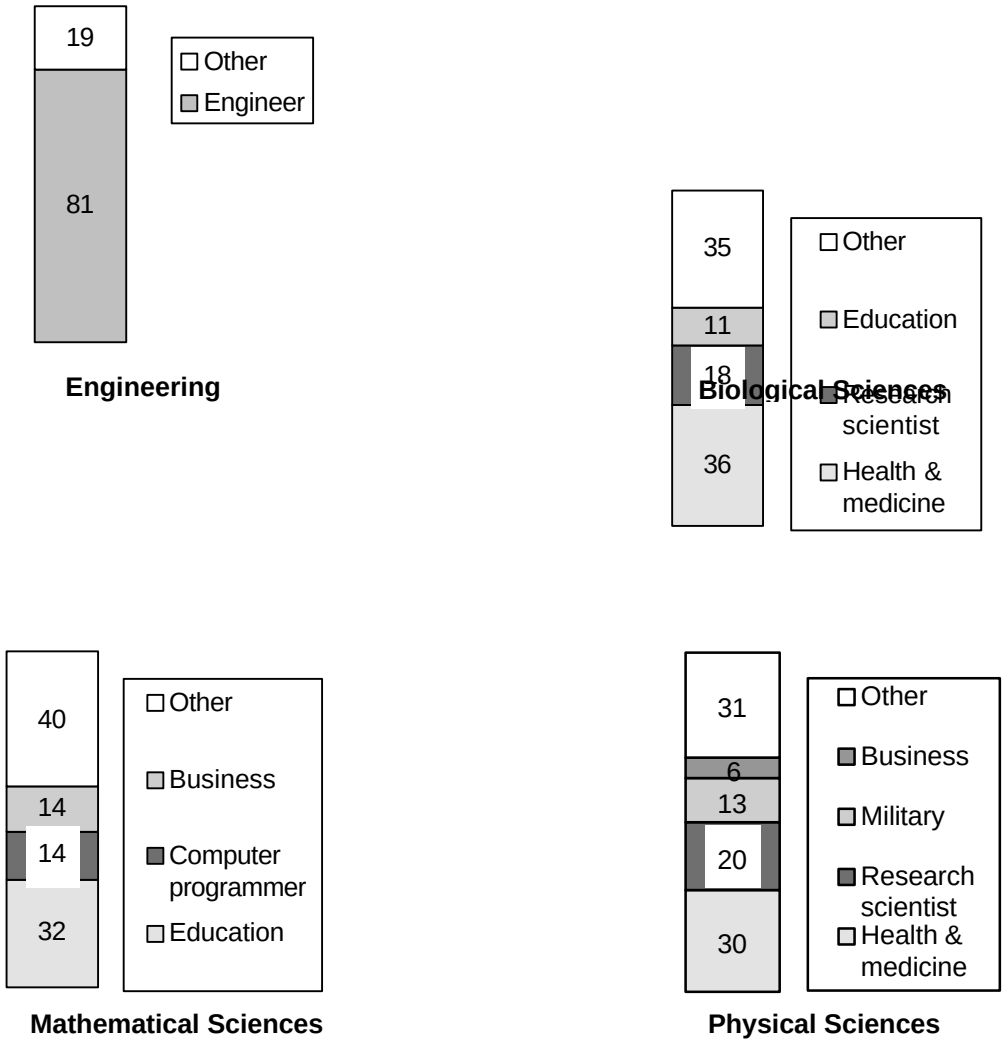

Figure 15. Career Choices of Top S&E Undergraduate Majors (Percent)

A certain pattern emerges for top S&E majors:

- Top engineering students study either business or engineering in graduate school, but most of them are eventually employed as engineers.
- Mathematical sciences steer their top talent to a variety of graduate school programs as well as employment settings, with about one-third teaching in secondary schools.
- There is quite an outflow of top talent from biological sciences and, to a lesser degree, physical sciences, to medicine and other health professions.

However, these findings are based on the graduate school experiences and career choices of college students only nine years after entering post-secondary schooling. The potential pool of top talent who will eventually obtain their doctoral degrees and enter the academic or scientific workforce may be underestimated at this early point.

Nine years may not be long enough to get an accurate picture of top students' final degrees.

In 1994, the proportion of top students employed in academic settings as "college teachers" was very small, while about one-fifth of top students who had majored in biological or physical sciences were employed as research scientists. With passage of enough time, many more may be expected to obtain doctoral degrees and be candidates for academic and scientific work at that degree level. Among top physical science majors, for instance, nearly one-half may end up with a doctoral degree. Similarly, as many as four in ten top mathematical science majors and three in ten top biological science majors may get a doctoral degree.

Top Students by Gender and Race

Due to the nature of the data, only limited analyses by gender and race could be performed. This section describes the results. Table 14 shows the percent of top white male and female 1985 freshmen who were S&E majors and entered one of the following fields: M.D./D.D.S., law, business, or research scientist.

Table 14. 1994 Employment Field of Top S&E Majors from the 1985 Freshman Cohort (Percent by Employment Field)[3]

Major	Top White Men		Top White Women	
Engineering	0.1	M.D., D.D.S.	0.6	M.D., D.D.S.
	0.7	Law	0.2	Law
	2.2	Business	1.2	Business
	1.5	Research Scientist	2.6	Research Scientist
Biological Sciences	28.5	M.D., D.D.S.	11.3	M.D., D.D.S.
	0.5	Law	0.3	Law
	8.1	Business	5.7	Business
	13.7	Research Scientist	21.1	Research Scientist
Math	---	M.D., D.D.S.	---	M.D., D.D.S.
	---	Law	0.4	Law
	14.2	Business	19.0	Business
	1.6	Research Scientist	2.6	Research Scientist
Physical Sciences	6.0	M.D., D.D.S.	3.7	M.D., D.D.S.
	---	Law	---	Law
	7.7	Business	7.7	Business
	25.3	Research Scientist	25.3	Research Scientist

For all science, the 1994 employment fields of top white men and women from the 1985 freshman cohort are shown in Table 15.

Table 15. 1994 Employment Fields of Top 1985 Freshmen (Percent)[3]

Employment Field	Top White Men	Top White Women
M.D., D.D.S.	4.6	6.7
Law	0.6	0.2
Business	3.9	5.8
Research Scientist	4.9	14.6

[3] Data are not shown for top nonwhite S&E majors because a high number of respondents to the original surveys did not indicate race, thus resulting in small cell sizes.

With respect to early career choices (in 1994 for 1985 freshmen), the following can be stated:

- In the biological sciences, 28.5% of top white men compared to 11.3% of top white women were M.D.'s or D.D.S.'s.
- In the sciences overall, 4.6% of top white men (4,021) and 6.7% of top white women (2,687) were M.D.'s or D.D.S.'s.
- While 14.6% of top white women were research scientists compared with 4.9% of top white men, many of the students who aspire to be research scientists were probably still in graduate school four years after college graduation.
- Among top white men, 0.6% were lawyers; among top white women, 0.2% were lawyers.
- Business was the career destination for 3.9% of top white men and 5.8% of top white women.

Perspectives from Professional Schools

Finding

S&E majors are not choosing professional schools over graduate school and doctoral programs with the exception of biological science majors, the majority of whom pursue medical degrees.

The data in this section were presented at the December 1996 workshop (see Chapter 2).

Law

Carl Monk, executive director of the Association of American Law Schools, provided data at the December 1996 workshop on law school admissions. During the past five years, law school admissions have been down 20%. The majority of the undergraduates who do enroll in law school have majored in the social sciences and arts and humanities: In both 1992-93 and 1994-95, 47% of applicants were social science majors, and 21% were arts and humanities majors.

Social sciences generally include political science and criminal justice

majors. At the same time, only 8% of applicants were S&E majors in 1992-93 and 9% in 1994-95.

In general, when reviewing a student's application, law schools consider several factors: performance on the LSAT, undergraduate GPA, and any outside experience. For example, a law school is more inclined to accept an applicant who has several years of experience working as a police officer with slightly lower scores on the LSAT than a student who has no employment experience but does have a high LSAT score. (The LSAT, like the GRE and the SAT, is only a predictor of a student's performance during the first year of school.)

As noted above, only about 9% of recent law school applicants were S&E majors.

The bottom line in law school admissions is to strive for a student body made up of many different types of students from a diversity of backgrounds. However, law schools do not generally make a specific attempt to recruit S&E undergraduates.

Even with the high cost of tuition, the 1990-91 school year saw a dramatic rise in admissions (99,327 applicants, 54,000 of whom were accepted, up from 38,070 admissions in 1986-87). Women accounted for a large portion of this dramatic increase, and it has been suggested that law school applications went up due to the popularity of the television series "LA Law."

In 1992-93, 42,996 were admitted, and in 1994-95, 42,151. The decrease in applications and admissions since 1990-91 may be due to rising tuition rates, a tight job market, and low starting salaries ($38,000-42,000 per year) compared with the extremely high debt burden.

The recent decrease in applications coupled with the low percentage of S&E majors applying to law school indicates that there are not large numbers of top S&E students applying to law school.

Medical

From Douglas Kelly, Associate Vice President for Biomedical Research of the Association of American Medical Colleges, who shared data at our December 1996 workshop (discussed in Chapter 2), we know that 1996 was a banner year for medical schools with 47,000 applicants applying for 16,200 slots. Forty-three percent of these applicants were women. However, a slight decrease in applicants of 8% is expected for 1997. The previous recent low figure for applicants was just eight years ago in 1988 when applicants numbered 27,000. Even earlier, there was a physician shortage in the early 1970s. Thus, during the 1970s and

1980s a doubling of applicants occurred.

Mr. Kelly speculated that the increase in applicant numbers in the recent years leading up to 1996 may be due to the popularity of such television shows as "Chicago Hope" and "ER," which may be attracting undergraduate students to enroll in medical school. Changing demographics have also contributed to the recent increase in applicant numbers. While the number of white male matriculants has remained steady, the numbers of women and nonwhite men have increased.

Like law schools, medical schools take several factors into consideration when reviewing applications for admission: a student's GPA, MCAT score, and consideration of the undergraduate's nonacademic activities and experiences. Medical students on average are now older than ten years ago, and while many of the applicants are biology majors, diverse academic backgrounds are increasingly more common.

Some top students pursue Ph.D.'s in medical school.

Shifting to the Ph.D. side of medical-school-based education, approximately 4,000 biomedical Ph.D.'s are awarded per year; 60% of these are from medical school settings. There is also an M.D./Ph.D. combination degree. Approximately 300 students per year graduate with this dual degree. The number of students earning two degrees simultaneously is higher than it is for those who first earn a Ph.D. then an M.D., or those who earn an M.D. and then a Ph.D.

It was shown earlier in this report that a significant percentage of top biological science majors (and to a lesser extent physical science majors) are drawn into medical and health fields and specifically medical school. Since a decrease is predicted in medical school applications, and non-biological-science majors are becoming more common among applicants, the outflow of top S&E talent into medicine may be slowing slightly.

Business

Also at the December 1996 workshop, Frederic McHale, Director, Graduate Management Admission Test (GMAT), Educational Testing Service, provided an overview of undergraduate students who take the GMAT.

While the pool of applicants to medical schools was doubling, the number of GMAT test takers was declining. In 1990-91, there were

approximately 241,000 test takers; the number dropped to 198,000 by 1994-95 (Graduate Management Council, 1996).

Of those students taking the GMAT, the number with undergraduate S&E majors decreased in the last five years (1990-91, 1994-95), as did majors in other fields, as shown in Table 16.

Table 16. Undergraduate Majors of Students Taking the GMAT

Majors	1990-1991	1994-1995
Business	112,877	91,265
Science & Engineering	58,448	46,277
Social Sciences	38,556	33,742
Humanities	10,216	9,485

With about a 21% decrease in the number of S&E majors taking the GMAT over this time period, it is evident that there was no "brain drain" of top S&E talent to business schools.

Campus Focus Group Results

Finding

In general, the job market has had little or no effect on S&E majors' decisions to pursue or persist in these majors through graduate school. These students all expressed a passion for the subject matter.

The campus focus groups consisted of undergraduate physics students, undergraduate biochemistry students, and graduate biology students.

The undergraduate physics students' immediate plans were to attend graduate school. Most of them indicated that they chose this science

major because they had had a passion for science since childhood. In general, the job market had had little effect on their decision. Their career goals involved doing research. While many said they would prefer research in academia, they were willing to try other sectors.

Undergraduate biochemistry students intended to apply to medical school. They expressed diverse reasons for pursuing science, but most expressed a passion for neuroscience research. Generally, students planned to pursue an M.D., so that they could work with patients (and not just do research) and potentially have versatility in the job market. Students did concede that the job market could be very different six years in the future when they finish their education, but they were not worried about finding a job.

Graduate biology students' immediate plans were for post-doctoral positions in whatever sector had openings. They had diverse reasons for pursuing science, but all expressed enjoyment of the subject matter. Many noted that post-doctoral students in their labs had warned them about the paucity of jobs, which worried them somewhat. Several had switched to what they felt were more marketable specialties. They also made the point that career services on campus are targeted to undergraduate students, not graduate students.

The next chapter discusses key findings and presents recommendations.

4. Discussion and Recommendations

This final chapter highlights our findings, discusses their ramifications, and presents recommendations.

Review of Findings

Generally, S&E fields are not losing top students.

As our general findings stated in the previous chapter, although the pool of those students going into S&E appears to be shrinking, the supply of top students appears to be increasing. Thus, of the students choosing S&E, more of them are top students, indicating that the quality is higher. The S&E fields are not losing their share of top talent students except for slight decreases in engineering and math. In addition, the number of National Merit Scholars choosing S&E has been consistently higher than other majors.

Although S&E fields attract top students, their ability to retain them through their undergraduate years is generally lacking with the exception of physical sciences. There are large losses in biological sciences and mathematical sciences, and recruitment of other top students is high but does not fully compensate.

The majority of top S&E majors enter graduate school.

Top talent flow into graduate programs is strong. The majority of S&E majors go to graduate school including 67% of top biology students. Nine years later, almost one-third of top S&E majors in the 1985 freshman cohort had doctoral degrees, doctoral plans, or medical degrees.

As for career paths, nine years after freshman year, employment was highest among top engineers and lowest among top biological science majors, who were more likely to be in graduate school. Engineers were the most consistent in pursuing careers in their field. However, the potential pool of top talent who will eventually obtain their doctoral degrees and enter the academic or scientific workforce may be underestimated at this early point.

With the expected exception of biological science majors, the

majority of whom pursue medical degrees, S&E majors are not choosing professional schools over graduate school and doctoral programs. In addition, the current job market does not seem to have discouraged interested students from pursuing and persisting in S&E majors.

However, is there still cause for concern? The answer is yes in light of the importance of S&E in producing a citizenry that is scientifically literate and globally competitive, and the importance of research. Consider these specific findings:

A number of concerns still need to be addressed.

- The numbers of women and minorities entering S&E are increasing, but only slightly.
- Biological science and mathematics departments are doing poorly at keeping top undergraduate students, who persist at rates of 33% and 24%, respectively.
- S&E departments are not retaining top women undergraduates. The proportion of top women who persisted in their S&E majors was lower than men in all fields.
- In engineering, only 29% of top undergraduate women persist, while 82% of top undergraduate men do.
- Considering losses and gains during 1985-89, the number of top students majoring in mathematics dropped by one-half, and the total number of mathematics majors dropped by one-third.

In light of these results, much more needs to be learned, and there is much need for improvement, particularly in the area of nurturing our top undergraduates. Recommendations are presented in the next section.

Recommendations

The following are recommended:

- Longitudinal studies covering longer periods of time after college entry than currently available are needed to determine fully the extent of talent flow in academic and scientific sectors.
- At the same time, cross-sectional studies showing peaks and valleys in, for example, professional school admissions, should recognize external factors (such as popularity brought on by hit television programs and other cultural phenomena).
- Individual institutions should consider conducting focus groups

and case studies to look at their retention of top talent and share lessons learned with other institutions.

Are U.S. citizens being displaced in graduate schools?

- The data used in this study did not enable the authors to contrast numbers or proportions of U.S. versus foreign citizens. At the undergraduate level, 97% of incoming freshmen are U.S. citizens (CIRP, 1996). However, at the graduate level, of the S&E doctorates (Ph.D.'s) awarded in 1995, only 53% were awarded to U.S. citizens (National Science Foundation, 1996). Therefore, it is important to determine the effect of the increasing numbers of foreign students entering S&E programs and the professional schools. Specifically, should displacement of U.S. citizens be of any concern?

- In addition to the citizenship composition of the S&E talent pool, the balance among other pools of talent based on sex and race/ethnicity should be monitored to ensure proportions that are appropriate, given considerations such as representation in the population at large.

- Data limitations were mentioned several times in this report. These limitations, that is, small cell sizes, were particularly evident in our attempt to analyze trends by gender and race. We recommend that larger numbers of students be surveyed or that the study be designed differently to ensure sufficient data from which to discern a pattern.

In response to some of the specific findings:

Persistence issues need to be examined closely.

- Undergraduate biological science and mathematics departments must examine their programs to determine why the persistence of top students is so low, and what can be done to encourage top undergraduates to stay in their original field choice.

- Analysis of the factors causing top students to switch into an S&E discipline may produce insights into how to retain those who chose S&E at the outset.

- The persistence rates of top women in all the S&E fields, but particularly engineering, were low compared to top men. These disciplines need to examine their student advising programs, course offerings, and other factors to determine what can be done to improve on these numbers. Top women want to major in these fields, but something is keeping them from staying.

The number of minorities in S&E

- The numbers of minorities in some scientific disciplines are quite small. Similar to top women, those top minority students who

majors is still low.

do choose to major in S&E should be encouraged to stay.

- As expected, the potential for a rewarding career affects top students' choices, particularly at the graduate level. It was suggested at the December 1996 workshop that a graduate, faculty, and post-doctorate placement service be developed. Assistance in career placement at this level needs to be examined as a way to improve the job market for S&E majors.[4]

In conclusion, it is difficult to simply step in at one point in time and evaluate the status of top students and S&E. No matter the study field, to provide an accurate portrait of what fields are attracting and retaining students through career selection, we recommend periodic monitoring of key indicators such as those described in this study. Only by trending these data over time can we assess the educational and career paths of our nation's best and brightest students.

[4] In June 1997, CPST released *Postdocs and Career Prospects: A Status Report*, which was also funded by the Sloan Foundation and contains additional perspectives on career opportunities specifically for graduates holding postdoctoral positions.

References

Astin, A. W., & Astin, H. S. (1992). *Undergraduate science education: The impact of different college environments on the educational pipeline in the sciences.* Los Angeles, CA: Higher Education Research Institute, UCLA.

Astin, A. W., Green, K. C., Korn, W. S., & Schalit, M. (1985, December). *The American freshman: National norms for fall 1985.* Los Angeles, CA: Higher Education Research Institute, UCLA.

Astin, A. W., Korn, W. S., & Berz, Ellyne R. (1990, December). *The American freshman: National norms for fall 1990.* Los Angeles, CA: Higher Education Research Institute, UCLA.

Astin, A. W., Panos, R. J., & Creager, J. A. (1966). A program of longitudinal research in higher education. ACE Research Report 1(1). Washington, DC: American Council on Education (ACE).

Broch, E., & Schuppan, S. (1996). Special analyses based on selected data from the GRE database. Unpublished tables. Princeton, NJ: Educational Testing Service.

Graduate Management Council. (1996). *Profile of Graduate Management Admission Test candidates: Five year summary.* Princeton, NJ: Author.

Holmstrom, E. I. (1987). Quality of students in the sciences and engineering: Change or stability? Washington, DC: National Academy of Sciences.

National Merit Scholarship Corporation. (1996). Annual report. Evanston, IL: Author.

National Science Foundation (NSF). (1996). Selected data on science and engineering doctorate awards: 1995 (NSF 96-303). Arlington, VA: Author.

Sax, L. J. (1996). Special analyses based on selected data from the American Freshman Norms database and follow-up surveys, Cooperative Institutional Research Program. Unpublished tables. Los Angeles, CA: Higher Education Research Institute, UCLA.

Sax, L. J., Astin, A. W., Korn, W. S., & Mahoney, K. M. (1995, December). *The American freshman: National norms for fall 1995.* Los Angeles, CA: Higher Education Research Institute, UCLA.

Appendix:
Literature Review

Virginia V. Van Horne, AAAS

The majority of the references listed provide background information and data on undergraduate and graduate students in terms of S&E study field choices and academic performance. To provide a well-rounded listing, several references are included for informative purposes only—providing information on solutions to "brain drain," discussing top academic programs, and listing solutions to increase students' interest, as well as performance, in S&E careers.

- Adelman, C. (1994). The way we are: The community college in our lives, in *Lessons of a generation.* San Francisco: Jossey-Bass. Not only does this chapter discuss the role of the community college as a credentialing institution, but the chapter also examines the community colleges' credentialing function in the educational careers of high school graduates in the early 1970s. Of relevance to this project's discussion, the chapter provides a useful definition of high-academic resource students. Such students meet the following three criteria: top quartile of performers on a mini-SAT, top quartile of high school class rank, and "high" course work. The author defines "high" course work as more than five semesters of math, or more than five semesters of science, or more than five semesters of a foreign language. The author found that the principle sorting criterion was not the ability test, but the curricular thresholds. The chapter also discusses the merits of using transcripts in order to obtain accurate information, and to avoid misinterpretation when classifying students. For example, one student had listed engineering technology as a major; when reviewing the student's transcript, the student had taken only three courses in technical drawing.

- Adelman, C. (1995, October). Cross-currents: Changes in the undergraduate careers of minority women in science, mathematics, and engineering, 1972-1993. Unpublished paper presented at the National Research Council's conference on "Diversity in Science," held in Washington, DC, October 1995. This paper examines some of the basic parameters surrounding post-secondary course-taking, credit production, field, and degree attainment by reviewing data from transcript studies such as degree completion and majors, as well as enrollments, credit generation, and student participation rates. Of note is the fact that "changes in S&E field participation by bachelor's degree recipients of both sexes was over-shadowed by the rise of business and related fields." Paper uses a more current version and a different configuration of data from *The New College Course Map and Transcript Files* (see next description).

- Adelman, C. *The new college course map and transcript files: Changes in course-taking and achievement, 1972-1993.* Washington, DC: U.S. Department of Education.

Emphasizes the importance of transcripts and provides instructive information—empirical tables, clues on decoding transcripts, as well as information on trends. This report does not identify top performers.

- Anderson, B. T., Bruschi, B., and Pearson, Jr., W. Minority females and precollege mathematics and science: Academic preparation and career interests. *Equity & excellence in education* 27(2), 62-70. Provides useful information on SAT scores and Student Descriptive Questionnaire (SDQ) responses of females and minority students. In 1990, college-bound senior females indicated that business and commerce was their number one choice for major; engineering was either the first or second choice of minority males.

- Armstrong, J. (1994, Summer). Rethinking the Ph.D. *Issues in science and technology*, 19-22. Similar to the special Careers '95: The future of the Ph.D. section in Vol. 270 of *Science* magazine, this articles emphasizes the need for an evaluation and revision of Ph.D. programs—for example, stressing the importance of opportunities outside of the lab and academia—in S&E to ensure that the United States remains a leader in Ph.D. programs.

- Careers '95: The future of the Ph.D. *Science* 270(5233), 121-46 (Special Section), October 1995. To quote the magazine, "the future of the science doctorate goes under the microscope." The various articles vary from looking at foreign competition, building a better Ph.D., to examining the future university. Provides good background information as well as "food for thought."

- Committee on Science. (1995). *Hearing before the Subcommittee on Basic Research of the Committee on Science, U.S. House of Representatives, 104th Congress, (No. 19), July 13, 1995.* Washington, DC: U.S. Government Printing Office. This subcommittee convened a hearing to discuss the issues of graduate education and the movement of S&E individuals into private industry. Educators, policymakers, as well as business people testified. Dr. George Walker, Chair, Council of Graduate Schools and Vice President for Research and Dean of Graduate School, Indiana University, stated "market forces are, I believe, already at work in some disciplines. Council of Graduate Schools data shows that graduate enrollment is leveling off following a decade of increase."

- Grandy, J. (1990, September). Major field selections of high school seniors scoring above the 90th percentile in SAT mathematics. Unpublished report to the National Science

Foundation, Educational Testing Service. Grandy's study reviewed the major field choices of top-scoring high school seniors, those earning a score above the 90th percentile within their own race-by-gender group. In terms of S&E trends, "the percentage of top-scoring students planning to major in science or mathematics rose to a peak around 1982; the percentage of White females choosing to major in math or science has not changed over the past 13 years. Because White males have shown a declining interest, there is now a greater proportion of White females than White males planning to study science or math. Top-scoring Black students, both male and female, showed increasing interest in majoring in science and math." With respect to engineering, "the percentage of top-scoring students planning to major in engineering rose from 14% in 1977 to nearly 23% in 1987."

- Grandy, J. (1990, Summer). In search of the next generation of scientists: A new challenge for teachers. *The College Board review* (156), 2-8, 28. Article promotes the "glory" of science and emphasizes the duties of our Nation's science teachers to mentor and recruit students into the fold of science, hence producing more future scientists.

- Grandy, J. (1987, October). Trends in the selection of science, mathematics, or engineering as major fields of study among top-scoring SAT takers. Research Report RR-87-39. Princeton, NJ: Educational Testing Service. This research report examined how the highest scoring SAT examinees--those scoring among the top 10% on each part of the SAT within their race-by-gender group--have changed in their major field choices, with a focus on S&E majors. "The proportion of top-scoring examinees planning to major in math, science, and engineering increased until 1982 and then declined slightly; the number planning to study engineering has increased over the past decade, despite the apparent leveling off after 1982."

- Grandy, J. (1989, April). Trends in SAT scores and other characteristics of examinees planning to major in mathematics, science, or engineering. Research Report 89-24. Princeton, NJ: Educational Testing Service. "In terms of absolute numbers, a greater number of examinees planned to major in math, science, and engineering in 1988 than at any time over the previous eleven years." However, it is important to note that this figure is not as overwhelming as it may appear, since there was also an increase in the total number of SAT examinees during those same years. Test takers planning to major in S&E obtained higher verbal and math scores than the average for all test takers. Those students who excelled in math and verbal skills were predisposed to pursue many years of formal education.

- Hackett, G., and others. (1992, October). Gender, ethnicity, and social cognitive factors predicting the academic achievement of students in engineering. *Journal of counseling psychology* 39(4), 527-38. This article examines various support variables—self-efficacy, academic ability, etc.—to determine predictors of academic success for S&E majors.

- Hartnett, R. (1987, September/October). Has there been a graduate student "brain drain" in the arts and sciences? *Journal of higher education* 58(5), 562-585. In-depth study of this question. This article stresses that GRE trend studies have several problems: many

individuals who take the GRE do not enroll in graduate school; "trend data based on enrolling students is not particularly persuasive in the absence of relevant comparison information;" it is impossible to accurately answer the brain drain question by focusing solely on graduate student data; and one needs to know whether "the absolute number of the most highly talented students entering graduate school" has decreased. Rather than using GRE scores, the author examined trends in undergraduate admission test scores; the study was based on the scores of students who obtained advanced degrees; comparisons were made with students entering various professional fields; and both score distributions and mean scores were considered. Hence, an "apples to apples" comparison approach was used. To obtain these data, the author enlisted the support of graduate school deans. There was a high response from graduate schools but a low response from professional schools. The author discusses the possibility of an increase in the proportion of low scoring students in the arts and sciences, as opposed to a decline in the proportion of high scoring students, as well as the theory that graduate and professional schools were beginning to offer admission to candidates who previously had not been well represented, thus accounting for the increase in the percentage of low scorers. The author does not confirm or reject the brain drain theory due to a lack of sufficient data. The paper concludes with a call for an adequate database of good information on the graduate and professional school flow of talent.

- Holmstrom, E. (1987). Quality of students in the sciences and engineering: Change or stability? Washington, DC: National Academy of Sciences. This study examines whether our Nation's top students were opting to attend professional school as opposed to pursuing a Ph.D. Holmstrom concluded that research evidence did not support the contention that there was a nationwide decline in the quality of science and engineering students.

- Institute for Research on Higher Education, University of Pennsylvania. A transcript study containing demographic, academic, and institutional transcript data for all baccalaureates in a random probability sample of U.S. colleges and universities for the class of 1991. Data such as field of study, grades, and SAT and ACT scores were tabulated and analyzed.

- Mason, M., and Mason, W. B. (1991, March). Project S.C.A.M.P. (science, computer, and mathematics professions): A young scholars program for academically talented rural youth. *Reaching our potential: Rural education in the 90's, conference proceedings of the Rural Education Symposium* (Nashville, TN). Describes a year-long program at the University of Virginia designed to encourage the S&E talents and interests of gifted, rural junior and high school students.

- Massey, F., and Goldman, C. *The production and utilization of science and engineering doctorates in the United States.* Stanford, CA: Stanford Institute for Higher Education Research. Provides information on why more Ph.D.'s are being produced than are supposedly needed by the traditional employers in academic and industrial research.

- Mullins, D. W. (1988, July-August). Scientists for a summer. *Gifted child today* 11(4), 32-35. Interesting piece that looks at mentoring. Provides an example of how to prevent "brain drain."

- National Academy of Sciences. (1988, February). *The recruitment of the most talented students into graduate study in the sciences, mathematics, and engineering: Is there a problem?* Washington, DC: Author. The Steering Committee examined whether S&E graduate departments were losing students to professional schools. The committee sensed that there was a problem; however, since sufficient data was unavailable, the committee did not convene a workshop but recommended that further study be undertaken.

- National Academy of Sciences, Committee on Science, Engineering, and Public Policy. (1995). *Reshaping the graduate education of scientists and engineers.* Washington, DC: National Academy Press. The authors state that graduate education must be able to accommodate the needs of students who will not be pursuing a career in research, and make suggestions on how such training can be modified.

- National Merit Scholarship Corporation. (1994, 1995, 1996). Annual reports (1993-1995). Evanston, IL: Author. A portion of the annual report details the stated choice of tentative majors for National Merit Scholars. These students represent the top 0.5% of U.S. high school graduates in terms of academic achievement.

- National Science Board. (1993). *Science & engineering indicators, 1993.* Washington, DC: U.S. Government Printing Office. National Merit Scholars' data on planned college majors show that 40% of the 1992 Merit Scholars were interested in majoring in either science (excluding the social sciences, which have relatively high enrollments) or engineering.

- Sax, L. J. (1994). Retaining tomorrow's scientists: Exploring the factors that keep male and female college students interested in science careers. *Journal of women and minorities in science and engineering* 1, 45-61. Although this article does not focus on top performers, it provides information as to why some students decide not to pursue a career in science, even though they chose science as a career at the point of entering college. Of particular interest are the differences in responses given by male and female students for not pursuing science. For example, many men opt out of science due to financial concerns, opting for a career that will bring them more money. Women, on the other hand, opt out of science due to their concern with the "social good" of their career choice.

- Senate Subcommittee on Immigration. (1995). *U.S. Senate, 104th Congress, September 1995*. Congressional testimony from the Association of American Universities stated that, due to problems in graduate education and employment, "...We are especially concerned that some of the most talented American students have chosen to attend professional schools...rather than obtaining a Ph.D."

- Subotnik, R. F., and Steiner, C. L. (1993, February-March). Adult manifestations of adolescent talent in science. *Roeper review* 15(3), 164-69. After winning the talent search, 74 out of 98 of the 1983 Westinghouse Science Talent Search winners continued on the S&E path. The article examines career choices, mentors, and the impact of the Westinghouse "label."

- Subotnik, R. F. (1982, Summer). Talent developed: Conversations with masters of the arts and sciences. Master at the mind's work: An interview with Dr. Frank Wilczek. *Journal for the education of the gifted* 15(4), 370-81. The author interviews a physicist at the Institute for Advanced Studies. The interviewee provides interesting and insightful information about teaching gifted, young children and their path to science.

- U.S. Department of Education, National Center for Education Statistics. (1995). *The condition of education, 1995*. Washington, DC: Author. Provides useful background data.