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ABSTRACT

Concern over the under representation of women and minorities in the natural sciences and engineering led to the research reported in this document. The project surveyed a stratified sample of 1,651 college seniors who registered to take the Graduate Record Examination (GRE) and who were majoring in natural sciences, mathematics, computer sciences, and engineering (NSME). The goals of the survey were to identify some of the factors that may lead NSME majors to change fields for graduate school, analyze differences among ethnic groups remaining in NSME, and analyze differences between male and female NSME majors who plan to remain in NSME. This report focuses on the gender and ethnic differences in NSME majors planning graduate study in their fields. Results showed that the decision to leave NSME was uncorrelated with gender, race, or GRE scores, but was correlated with many questionnaire items. Detailed analysis of gender and ethnic differences among NSME majors planning to continue in their fields showed small to moderate differences on many dimensions. There were gender and ethnic differences in salary expectations, importance on making a contribution to society, and preferences for various job activities. Possibilities for further research and policy implications are suggested; and the GRE Background Questionnaires and survey instrument are included. Contains 65 references. (JRH)

GRE® RESEARCH

Gender and Ethnic Differences among Science and Engineering Majors: Experiences, Achievements, and Expectations

Jerilee Grandy

June 1994

GRE Board Research Report No. 92-03R
ETS Research Report 94-30

Educational Testing Service, Princeton, New Jersey

Gender and Ethnic Differences among Science and Engineering Majors:

Experiences, Achievements, and Expectations

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June 1994

This report presents the findings of a research project funded by and carried out under the auspices of the Graduate Record Examinations Board.

Educational Testing Service, Princeton, NJ 08541

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ABSTRACT

Concern over the underrepresentation of women and minorities in the natural sciences and engineering led to the research reported here. This project surveyed a stratified sample of 1,651 college seniors who registered to take the Graduate Record Examinations (GRE) General Test in December 1990 and who were majoring in natural sciences, mathematics, computer sciences, and engineering (NSME). The sample was stratified to contain all minorities and approximately equal numbers of White male and female U.S. citizens majoring in these fields. All were taking the GRE in the process of applying to graduate school.

The goals of the survey were threefold: (1) to identify some of the factors that may lead NSME majors to change fields for graduate school, that is, to leave the science/engineering pipeline directly after earning a bachelor's degree; (2) to analyze differences among ethnic groups remaining in NSME; and (3) to analyze differences between male and female NSME majors who plan to remain in NSME. Results of the first goal of the survey were reported earlier; this report focuses on the second and third goals of the study--gender and ethnic differences in NSME majors planning graduate study in their fields.

The survey questionnaire inquired about the students' undergraduate experiences, including enjoyment and difficulty of coursework, ratings of the quality of teaching and of the department, relationships with fellow students and instructors, and perceptions of themselves and others in relationship to their field of study. The questionnaire also asked students to rate themselves on a variety of skills and abilities, to rate various aspects of their chosen graduate fields of study, and to indicate their preferences for various job activities and characteristics. Finally, it asked a few questions about parents' occupations and whether each parent approved of the student's chosen field of study.

These data were then merged with GRE scores and background information supplied on the GRE registration form, which included parents' education, undergraduate grade averages, degree objective, honors and awards, hours worked, and hours spent in outside activities.

Results showed that the decision to leave NSME was uncorrelated with gender, race, or GRE scores, but was correlated with many questionnaire items. Detailed analyses of gender and ethnic differences among NSME majors planning to continue in their fields showed small to moderate differences on many dimensions, including grades, GRE scores, mother's education and occupation, out-of-class activities, degree objective, ability to perceive oneself as a scientist or engineer, perception of professionals in their field, perception of faculty, interaction with faculty, regard for other students in the department, and belief that they could make a real contribution in their field. Differences in undergraduate experiences included opportunities to assist professors in their research, ratings of teaching methods and evaluation procedures, intellectual environment, and the variety of advanced course offerings. Gender and ethnic differences also appeared in a number of self-ratings.

There were gender and ethnic differences in salary expectations, importance placed on making a contribution to society, and preferences for various job activities. Distinctive profiles emerged suggesting, for example, that Asian Americans had the least positive college experiences, Mexican Americans had the most stressful experiences, and African Americans had the most optimistic outlooks on their professional futures.

CONTENTS

INTRODUCTION

The present study reports the results of a survey of college seniors in mathematics, natural sciences, and engineering at a critical point in their development -- the transition from college to graduate school. The purpose of the study is to explore possible differences in the undergraduate experiences, skills and abilities, perceptions of the field of study, career plans and expectations, and family background between males and females and among seven racial/ethnic groups.

A considerable body of literature has grown over the past two decades in response to concern over the underrepresentation of women and minorities in science and engineering. This literature, combined with the many thousands of studies and dozens of theories on career decision making, make for a formidable task of providing a relevant and succinct research background for this study. We will therefore mention only some highlights of the literature because the thrust of this study is about people who have chosen science and engineering, who have succeeded in reaching their senior year of college, and who are sufficiently committed to their disciplines to be planning to continue their studies in graduate school.

BACKGROUND AND RELATED LITERATURE

Career Decision Making

Many factors affect career decision making. Numerous studies have found associations among family background, ethnicity, gender, school experiences, course-taking patterns, personality, attitudes, and other noncognitive variables and the decision to pursue a degree in the sciences or to choose (or switch to) other majors (e.g., Baker, 1982; DeBoer, 1984; Hewitt & Seymour, 1991Hilton & Schrader, 1986; and Hilton, Hsia, Solorzano, & Benton, 1989).

Weiss (1971) claimed that, all other things being equal, American students tend to select majors leading to the greatest monetary returns. Polachek (1978) found that students who place a high value on money tend to major in business or engineering, whereas those who are less concerned with the financial returns of their degree are more likely to major in social sciences or humanities. Hafer and Schank (1982) reported that a desire for prestige, job security, and financial security are important factors in major field selection.

Kirk (1990) found, in his survey of graduate students, that the variables most greatly affecting choice of a graduate major were opportunities for engaging in more fulfilling work, employment opportunities, and possibilities for advancement. Kirk went a step further. He found that student responses divided into two factors--opportunity and quality. He divided his respondents accordingly into two groups: "opportunity-oriented" and "quality-oriented."

The opportunity-oriented students appeared to see their degree as a means to an end; two thirds of that group were pursuing degrees in administration. Their choice of major was most heavily influenced by opportunities for employment, advancement, and financial reward. Compared to quality-oriented students, they showed a stronger preference for high status and traditional male occupations. They also engaged in more "self-monitoring"; that is, they more closely observed and controlled the images of self they projected to others. Snyder (1987) has found that self-monitoring is associated with a variety of career related factors. High self-monitors, for example, have a greater preference for high-status occupations (Mathwychuk & Snyder, 1982).

Kirk (1990) found that quality-oriented students, in contrast to opportunity-oriented students, selected major fields in accordance with vocational preferences and intrinsic rewards, such as helping others and academic success. Their strongest vocational preferences were for social occupations--vocations known better for their psychological rewards than for high salaries or status. Important to quality-oriented students were quality of instruction and earning high grades.

Roe (1953) identified personality factors associated with the decision to become a scientist, and suggested that there is a "scientific personality." Baker (1982) also studied the differences in personality, attitudes, and cognitive abilities of science and nonscience majors and found that science majors had higher mathematics scores, more positive attitudes toward science, greater spatial ability, and an intuitive-thinking-judging personality. Brown and Cross (1992) found significant differences in various personality dimensions between entering freshmen in engineering, students who persisted in engineering, and existing norm group descriptions of engineers and engineering students. They found no significant differences between genders or between Black and White subgroups.

Female Students in Science and Engineering

There has been considerable concern and research on the subject of the underrepresentation of women in science and engineering, ranging from early childhood influences on female career choices to the employment status of women scientists (e.g., Casserly, 1979; LeBold, 1987; National Research Council, 1983; and Vetter, 1981).

Differences in the attitudes and achievement of males and females toward mathematics and science emerge early in childhood. Data collected for the National Assessment of Educational Progress (NAEP) show that by fourth grade, nearly one quarter of school boys are "undecided," "agree," or "strongly agree" with the statement that "Math is more for boys than for girls" (National Center for Education Statistics, 1991).[1] Fewer girls, only 13%, gave these same responses. The girls who did believe that math is primarily a boy's domain scored lower than the boys on the NAEP math proficiency test. They also scored lower than the girls who denied that math is more for boys than for girls.

Even by fourth grade, therefore, the "chicken-and-egg" question has arisen: Does the performance of girls in math govern their belief, or does their belief govern their performance? Most likely, the answers to both parts of the question are "yes." Inferior performance reinforces the perception that girls are inferior, and their belief that they are inferior depresses their performance.

By grade 12, an even larger percentage (28%) of males believe (or are not sure) that math is more for boys than for girls. The percentage of females who accept that view declines slightly--from 13% to 10%--between fourth and twelfth grades (National Center for Education Statistics, 1991).

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[1]Reported statistics combined the three categories of undecided, agreed, and strongly agreed.

NAEP data also show that girls have far fewer early childhood experiences with hands-on scientific tools, such as electric meters and telescopes (National Center for Education Statistics, 1992). By fourth grade, 60% of boys and only 46% of girls report having done projects or experiments with electricity. By grade 12, these figures have risen to 82% and 63%, respectively. Only in the biological sciences do females possibly achieve a minuscule edge over males, with 85% of females and 84% of males reporting that they have done experiments with plants or animals.

This early pattern continues, in which greater numbers of boys gravitate toward numerical, electrical, and mechanical activities and equal or greater numbers of girls lean towards life sciences. The same NAEP reports also show that beyond the first-year math and sciences courses in high school--algebra, geometry, biology, and chemistry--more males than females take advanced courses in those areas, and many more males than females take physics.

Data from the files of the Scholastic Aptitude Test (SAT) show that even among high school seniors scoring above the 90th percentile in mathematics, only 15% of females plan to major in a mathematically demanding field, namely, physical sciences, mathematics, or engineering (Grandy, 1987, 1990). At the same time, 37% of the top-scoring males head for one of these fields. Despite national efforts to draw women into the more quantitative sciences, the numbers at the high school level rose just slightly between 1978 and 1984, then declined slightly.

Data on college freshmen from the Cooperative Institutional Research Program (CIRP) are consistent with the SAT data (Higher Education Research Institute, 1992). In 1991, for example, 16.2% of males and only 2.7% of females planned to become engineers.

Early decisions not to pursue mathematics, science, or engineering involve many complex issues pertaining to cognitive abilities and socialization that have been explored in depth by numerous investigators (e.g., Brush, 1991; Chipman & Thomas, 1987; Dix, 1987; Jacobs, 1989; Linn & Hyde, 1989; McIlwee & Robinson, 1992; Waite & Berryman, 1985).

Females leave the science/engineering pipeline in greater numbers than do men at every stage, from high school science and mathematics tracks through college (Alper, 1993). One study has shown that in the most selective colleges and universities, as few as 48% of female students initially interested in science persisted, compared with 64% of male students (Strenta, Elliott, Adair, Scott, & Matier, 1993).

Research on the sample of GRE test takers surveyed for this study suggests, however, that by the time students have reached their senior year of college and are seriously considering graduate school, the proportions of female and male science and engineering students planning to leave science or engineering for graduate study in another field may be about equal (Grandy, 1992a). However, among GRE test takers at large, females more than males plan to change fields for graduate school, regardless of their undergraduate majors (Grandy, 1992b).

The fact that females make more frequent major field changes may indicate a lack of satisfaction with the academic environment and/or difficulties with career decision making that affect women specifically. A survey by the Opinion Research Corporation showed that women, with or without children, leave or change jobs more frequently than do their male counterparts (Curtindale, 1990). The study concluded that women leave not because of conflicts between work and family, but because they cannot advance, their bosses treat them poorly, and they feel they cannot fulfill their career goals.

Recent estimates of the percentage of female engineers in this country range from 5% to 7% of the estimated 1.6 to 1.7 million engineers (Saigal, 1987). Culotta (1993) points out that in environments in which women are a small minority, as in engineering, they often feel isolated because they "stick out like a sore thumb" in the presence of male coworkers. Not only is the resulting isolation uncomfortable, but as outsiders, women are slow to learn the unwritten rules that lead to corporate success. Many women who become physicists still report continuing discrimination in the educational, professional, and social aspects of their lives (Brush, 1991). Similar feelings of isolation may be experienced by female science and engineering majors, especially among those in engineering and physics, where the percentages of women are especially low.

Unequal salaries for males and females are still evident at some levels of employment. For the most part, over the past decade, starting salaries in the sciences have become comparable for males and females. But among more experienced scientists, differentials still exist. In 1987, the median salary of Ph.D. physicists with seven or more years of experience in academia was $40,800 for females and $48,000 for males; for Ph.D. physicists in industry with the same experience, women earned an average of $56,700 and men earned an average of $63,000 (Babco, 1989). On the other hand, reports from the American Mathematical Society indicate higher salaries for women than men with Ph.D.s in mathematics. In 1989, male Ph.D.s with 12 months' experience in business and industry earned an average of $45,000 whereas female mathematics Ph.D.'s earned an average of $48,000 (Babco, 1989). There were similar salary differences in academic positions.

A recent salary survey conducted by the American Chemical Society reported that women were being recruited into chemistry in larger numbers than ever before, and that men and women with bachelor's degrees in chemistry and two to four years of work experience were earning comparable salaries (Heylin, 1992). Salary gaps were larger for chemists having more experience. Similarly, the median salaries of men and women Ph.D.s were about the same until about age 45; then the salaries of women tended to plateau, while the salaries of men continued to show further gains. The study showed that women are failing to move into management positions or into higher academic ranks in proportional numbers (Hoke, 1992). Explanations supported by the survey were difficulty in balancing career demands and family demands, and gender discrimination (but not harassment) in the workplace. The survey did not support a third hypothesis, namely, that there were differences between men's and women's commitments to their careers.

Some investigators have also turned their attention to the question of whether women actually *do* science differently from men (Keller, 1985). Barinaga (1993a) points out, with some striking examples, how the cultural context of science can influence not only what is studied, but the research results themselves. Barinaga (1993b) also cites anecdotes that women are less competitive than men and cites one study and additional anecdotes arguing that women choose an area of research not because it is a "hot topic" where there is a race for recognition and career advancement, but for its intrinsic merit Zuckerman and Cole (reported by Barinaga, 1993a) both question whether there is evidence to support this claimed gender difference or any other specifically female style of doing science. Further, they find that differences in research strategies correlate better with scientists' levels of success than with gender . The greater attraction of women to biological sciences and their greater success in primate research may be indicative of differences in research priorities or even possibly, as

Louis Leakey is claimed to have said: females are patient and singularly perceptive observers (Morell, 1993).

Whether or not women actually do science differently from men, women may do science for different reasons than men, and they may prefer different research topics. The survey reported here attempts to identify some of the differences, preferences, and priorities.

Minority Students in Science and Engineering

According to recent statistics, between 1975 and 1990, the percentage of all doctorates awarded to U.S. citizens in the physical sciences, life sciences, and engineering increased slightly for Native American, Asian American, and Hispanic citizens. The percentage awarded to Black citizens, however, increased only in engineering, and the increase was from 0.7% to 1.5%--figures that are far less than the proportion of Blacks in the U.S. college-age population. Furthermore, the percentage of doctorates awarded to Blacks in physical sciences and life sciences actually declined during that period (National Research Council, 1991). Data from the 1990 American Chemical Society Salary Survey reveal that Black chemists--both men and women--represented less than 2% of the membership who responded to their survey (Smith, 1991). Similarly, the Institute for Electrical and Electronic Engineers (IEEE) reported that only 1% of their members are Black (IEEE, 1991).

Reasons for the underrepresentation of minorities may be numerous. Pearson (1985) conducted an in-depth sociological analysis of Blacks in the American scientific community. He found that the four reasons given most frequently for Black underrepresentation in natural sciences were (1) lack of early encouragement and motivation, (2) lack of financial support and limited opportunities, (3) limited recruitment, and (4) institutional racism.

A longitudinal study by Hilton, Hsia, Solorzano, and Benton (1989) showed that among high-ability minority students, those who persisted in science in college were high in motivation and the highest in quantitative ability. What seemed to distinguish persisters most from the balance of the sample was their finding math, science, or engineering at the college level enjoyable, interesting, and rewarding, and their personal commitment to one of these fields for a career.

A survey by Powers and Lehman (1983) of undergraduate students planning to attend graduate school showed a significantly larger percentage of Black students intending to major in social sciences and a significantly larger percentage of White students planning to major in biological or physical sciences. Female students were more likely to major in education or a biological science; males were more likely to select physical sciences. These same observations are confirmed each year in the GRE database.

Consistent findings regarding the relationship of major field preferences to gender and race are reported by other investigators, such as Linhart and Yeager (1979) and Polachek (1978), and by statistical reports of doctoral recipients (National Research Council, annually).

Using the *Inventory of Affective Attributes of Scientists*, Young (1981) found more White than Black individuals having traits associated with scientists. These traits included interest in and understanding of natural phenomena, dedication/commitment to experimental requirements, philosophical/social perspectives, curiosity, and persistence.

Clark (1986) compared the personalities of science and nonscience majors and suggested that minority students who decide on scientific careers "may possess qualities that are congruent with the scientific personality." She added that "fewer blacks and white women tend to possess this personality than white men do."

Not all research findings are consistent, however. Using a sample of approximately 16,000 13- and 17-year-olds who participated in the 1981-82 National Assessment in science, Walker and Rakow (1985) found that Black students had the most positive attitudes toward science, and that White students had the most negative attitudes. White students, however, performed better in science. Consequently, when Black and White student data were combined, attitude toward science was negatively correlated with performance. Davis (1986) found similar results in student attitudes toward mathematics; Black students expressed more positive attitudes than their White classmates. The National Academy of Sciences (1987) found that Black and White students reported an equal interest in science, but because Blacks performed below Whites, the result again was a negative relationship between performance and attitude when both racial groups were combined. Although we can only speculate about the reasons for these results, it is important to keep in mind that attitudes and performance go hand in hand only when we control on important background variables like race.

For additional discussion of career decision making among minority students, refer to the *Career Development Quarterly*, Special Issue, vol. 39, 1990.

Survey of Natural Science, Mathematics, and Engineering Students

Much of the published research has focused on the reasons students have for selecting a major field--reasons that may be different for men and women, or for White and minority students--and reasons for choosing science or engineering. But little, if any, research indicates whether some females choose science (or reject science) for different reasons than males do. Similarly, some of the personal needs and aspirations of Black students may be quite different from those of White students or of Asian American students. It is reasonable to hypothesize that because of cultural, linguistic, and educational experiences, students in the sciences and engineering have a variety of different aspirations and expectations of their professions. To explore these differences, we reanalyzed the data from a survey recently reported (Grandy, 1992a).

The data for this project were collected for an earlier study to understand better the factors related to a student's decision to remain in NSME or to change to an entirely different field of study. The sample for that study was drawn from the December 1990 administration of the GRE General Test. When test takers register to take the GRE, the vast majority complete a background questionnaire (Appendix A). Based on responses to that questionnaire, we selected a sample of NSME majors for the survey. Appendix B specifies the particular fields that were included as NSME.

The sample was restricted to U.S. citizens with U.S. mailing addresses. The students had to have answered the questions on gender, ethnic identity, degree objective, undergraduate field of study, and intended graduate field of study. They had to plan to attend graduate school, not yet have graduated from college, and plan to earn a bachelor's degree in biological sciences, physical sciences, computer sciences, earth sciences, mathematics, or engineering. From an original GRE file of 121,982 records, 5,929 students satisfied these conditions.

The vast majority of students were White and were planning to continue in NSME. Ethnic minorities, females, and students leaving NSME were relatively small in numbers. Thus we stratified the sample on gender, ethnicity, and change of field. The resulting sample contained all students planning to change fields, all ethnic minorities, and two fifths of White females and one fifth of White males continuing in NSME. Questionnaires were sent to a total sample of 2,484.

Based on the literature reviewed, a seven-page questionnaire (Appendix C) was designed, assuming a model in which graduate school plans might be related directly or indirectly to any or all of the following factors:

1. Family Influences

   Father's occupation (whether in an technical, mechanical, or scientific field)
   Mother's occupation (whether in an technical, mechanical, or scientific field)
   Father's education
   Mother's education
   Parental approval and encouragement
   Feelings of responsibility or obligation to family

2. Undergraduate Experiences

   Enjoyment of coursework
   Difficulty of coursework
   Quality of classroom teaching
   Quality of the department or program in which enrolled
   Relationships with and encouragement from instructors
   Relationships with fellow students
   Personal identification with a profession

3. Skills and Abilities

   Verbal abilities
   Quantitative abilities
   Study skills
   Problem-solving skills
   Interpersonal skills
   Mastery of coursework (grades, awards, achievements)

4. Characteristics of Chosen Graduate Field of Study

   Skills demanded
   Feelings of commitment
   Career opportunities
   Opportunity to make a contribution in the field
   Prestige
   Income
   Demand

5. Career Plans and Expectations

Important job characteristics and activities
Expected income
Importance of income

Of the 2,484 questionnaires mailed, 1,651 (66.5%) were completed and returned.[2] Appendix C contains a copy of the cover letter and survey questionnaire. A followup postcard (Appendix D) was sent three weeks after the first mailing, and a followup questionnaire and a new letter (Appendix E) were sent to all remaining nonrespondents after another three or four weeks. Details of the survey procedure and nonresponse bias effects are discussed in the first report (Grandy, 1992a).

Of the 1,651 respondents, 143 planned to leave NSME. The remaining 1,508 constitute the NSME sample analyzed for this report.

Questionnaire data were merged with GRE General Test scores and information from the GRE background information questionnaire. To maximize reliability, 13 scales were created from the survey questionnaire. Appendix F specifies the variables that were used to construct each scale. The scales were entitled:

Course difficulty
Course enjoyment
Quality of instruction
Relationship to instructor
Relationship to students
Perception of self as a scientist
Quality of the department
Problem solving skills
Study skills
Verbal skills
Interpersonal skills
Career opportunities
"Will do it but don't like it" (indicating that they have selected this graduate field but do not really like it)

[2]Response rates ranged from 51% for Puerto Ricans to 73% for other Hispanics (i.e., Hispanics other than Puerto Ricans and Mexican Americans). GRE scores were higher for respondents than for nonrespondents. Thus, the sample was not completely unbiased. It represented higher scoring students and a slightly higher proportion of females than males.

DESCRIPTION OF SAMPLE

Among the test takers continuing in NSME, the survey sampling plan called for sampling all minorities plus one fifth of White males and two fifths of White females. The gender breakdown of the 1,508 respondents planning to remain in NSME was 51% male and 49% female (numbers were 771 and 737, respectively). Using the ethnic descriptors as they were presented in the GRE background questionnaire, the ethnic breakdown of the sample was as follows:

	Number	Percent
Native American or Alaskan Native[3]	40	2.7
Black or African American	220	14.6
Mexican American or Chicano	57	3.8
Asian or Pacific American[4]	225	14.9
Puerto Rican	37	2.5
Other Hispanic or Latin American	48	3.2
White (non-Hispanic)	881	58.4

There was a broad distribution of both undergraduate majors and intended graduate fields of study. The next four tables show intended graduate major field areas by ethnic group[5] for each gender[6]:

[3]Some students who identified themselves as Native Americans apparently interpreted this option to mean "born in America." We do not know how many survey respondents were misclassified in this manner.

[4]Although the background questionnaire disaggregated Hispanics into three groups, it did not disaggregate Asians and Pacific Islanders. For analysis purposes, therefore, we treated data in this category as belonging to a single ethnic group.

[5]For simplicity, ethnic group names have been shortened for these tables and for the remainder of the report.

[6]When interpreting the figures, keep in mind that the survey sampling fractions were different for males and females and that response rates were not the same for all groups. Percentages of subgroups in the sample, therefore, are not the same as percentages of the same subgroups in the GRE population.

Males: Number with Each Intended Graduate Major

	Biol Sci	Phys Sci	Comp Sci	Earth Sci	Math Sci	Engin	Other[7]	Total Number	Total Percent
Native American	6	3	4	0	2	8	1	24	3.1
African American	10	12	11	3	10	44	2	92	11.9
Mexican American	5	4	2	1	2	24	0	38	4.9
Asian American	23	9	13	5	6	90	2	148	19.2
Puerto Rican	1	2	2	0	1	10	3	19	2.5
Other Hispanic	4	2	2	1	3	13	5	30	3.9
White	88	65	29	22	30	174	12	420	54.5
Total Number	137	97	63	32	54	363	25	771	
Total Percent	17.8	12.6	8.2	4.2	7.0	47.1	3.2		100.0

Females: Number with Each Intended Graduate Major

	Biol Sci	Phys Sci	Comp Sci	Earth Sci	Math Sci	Engin	Other	Total Number	Total Percent
Native American	5	1	0	0	1	6	3	16	2.2
African American	33	8	9	4	8	46	20	128	17.4
Mexican American	4	2	0	0	3	6	4	19	2.6
Asian American	10	4	5	4	11	30	13	77	10.4
Puerto Rican	10	1	1	0	0	5	1	18	2.4
Other Hispanic	5	1	0	1	0	6	5	18	2.4
White	134	51	14	45	47	83	87	461	62.6
Total Number	201	68	29	54	70	182	133	737	
Total Percent	27.3	9.2	3.9	7.3	9.5	24.7	18.0		100.0

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[7] "Other" fields included secondary teaching, agriculture, and health and medical sciences. These fields are all common graduate-school tracks of individuals with undergraduate science degrees, so persons continuing in these fields were not regarded as leaving NSME.

Males: Number with Each Undergraduate Major

	Biol Sci	Phys Sci	Comp Sci	Earth Sci	Math Sci	Engin	Total Number	Total Percent
Native American	8	3	4	1	2	6	24	3.1
African American	10	20	12	2	12	36	92	11.9
Mexican American	5	4	2	1	2	24	38	4.9
Asian American	26	13	11	4	6	88	148	19.2
Puerto Rican	3	4	1	1	1	9	19	2.5
Other Hispanic	7	3	4	1	4	13	30	3.9
White	101	76	27	24	28	164	420	54.5
Total Number	160	123	59	34	55	340	771	
Total Percent	20.8	16.0	7.7	4.4	7.1	44.1		100.0

Females: Number with Each Undergraduate Major

	Biol Sci	Phys Sci	Comp Sci	Earth Sci	Math Sci	Engin	Total Number	Total Percent
Native American	8	1	0	0	1	6	16	2.2
African American	48	20	8	2	14	36	128	17.4
Mexican American	8	2	0	1	3	5	19	2.6
Asian American	22	4	3	4	13	31	77	10.4
Puerto Rican	11	2	0	0	1	4	18	2.4
Other Hispanic	10	1	0	1	0	6	18	2.4
White	219	62	12	31	62	75	461	62.6
Total Number	326	92	23	39	94	163	737	
Total Percent	44.2	12.5	3.1	5.3	12.8	22.1		100.0

As we might expect, not many people switch fields across the sciences. Therefore, the table of undergraduate majors is very similar to the table of intended graduate majors. There are striking differences in the fields selected by males and females, however, and in the distribution of ethnic groups across fields.

The percentage of females earning bachelor's degrees in biological sciences was more than twice as great as the percentage of males choosing majors in these areas (21% versus 44%). Engineering was exactly the reverse of biological sciences: 44% of males and 22% of females were earning degrees in engineering. Females were also more heavily represented in mathematical sciences, whereas greater proportions of males were in physical sciences and computer sciences.

There were also differences in major field representations by ethnic group, but the small numbers of non-Whites in each field did not permit serious comparisons of ethnic group by major field. Among females, it appears that Puerto Ricans and Asian Americans were the most different in terms of major field selections. Puerto Ricans were more heavily represented in biological sciences and underrepresented in engineering and mathematical sciences; Asian Americans were just the opposite. Among males, Mexican Americans were somewhat overrepresented in engineering, and African Americans were somewhat underrepresented in biological sciences.

Because the distributions of major fields across ethnic groups and between genders was uneven, apparent differences between males and females, or among ethnic groups, may be confounded by differences in major fields. Furthermore, well over half of the Black sample were female (due to the oversampling of females, a lower survey response rate on the part of Black males, and to the fact that fewer Black males than females take the GRE), and only about a third of Mexican Americans were female. Preliminary analyses, therefore, examined average differences across groups and then broke down the remaining analyses by broad field of study--biological sciences, engineering, and a combination of physical, computer, and mathematical sciences. It was not possible, because of the limited sample size, to break down the analyses three ways simultaneously--by gender, ethnic group, and major field. In all analyses, statistics were weighted by sampling fractions.

RESULTS

For all data analyses, we have reported statistically significant differences and indicated those differences in graphs. In most instances, the differences are significant at the 0.05 level of confidence. Nevertheless, the actual mean differences are sometimes quite small. For each gender and ethnic comparison, therefore, we have also computed effect size (**d**) as an indicator of the magnitude of the difference in means.[8] In this report we use effect sizes to maintain some perspective on the differences we are observing in mean responses to questionnaire items, and to point out which differences appear to be relatively larger than others.

Major Field Differences

With both genders and all ethnic groups combined and weighted in accordance with their sampling fractions, we compared means on the 13 generated scales. ANOVA statistics indicated that there were highly significant differences ($p < 0.0001$) in the scale scores of students having undergraduate majors in the six broad categories of biological sciences, physical sciences, computer sciences, mathematical sciences, earth sciences, and engineering.

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[8]The effect size is the difference in means of two groups divided by their pooled standard deviation. Thus, a **d** = 0.5 between males and females would indicate that their means differ by half a standard deviation. Cohen (1988) regards an effect size around 0.8 as "large," 0.5 as "medium," and 0.2 as "small." Perhaps because of the importance placed on minimizing gender and ethnic differences in education, some researchers refer to a gender difference of 0.2 standard deviation as "modest" (e.g., Wilder and Powell, 1989). Some argue that an attempt should be made to eliminate all measurable gender and ethnic differences, if possible. On the other hand, as Hyde and Linn (1988) state in their meta-analysis of verbal differences, "A gender difference of one tenth of a standard deviation is scarcely one that deserves continued attention in theory, research or textbooks Surely we have larger effects to pursue."

A copy of the tables showing means and effect sizes is available from the author upon request.

Students earning degrees in biological sciences, physical sciences, and engineering tended to rate the difficulty of their courses somewhat higher than did students in mathematics, computer sciences, and earth sciences. Those in biological sciences, earth sciences, and physical sciences rated course enjoyment the highest.

Quality of instruction was rated highest by students in physical sciences and lowest by students in engineering and computer science. Physical sciences and earth sciences earned the highest ratings for relationships with instructors and for relationships with other students. Lowest ratings for relationships with instructors were given by students in computer science and engineering; lowest ratings in relationships with other students were given by students in computer science and mathematical sciences. In their ratings of their department or program, earth sciences majors scored their department highest and computer science majors scored theirs lowest.

A scale that dealt with professional self image was scale 6: Ability to see oneself as a scientist or engineer. Students in mathematical sciences rated themselves lowest on this scale, probably because the wording of the items failed to include mathematicians specifically. Highest ratings were among students in the physical sciences and engineering.

Four scales were constructed from self-rating items. On problem-solving skills, engineering students rated themselves the highest and biological science majors rated themselves lowest. These differences should be kept in mind when interpreting gender differences because females are overrepresented among biological science majors, and males are overrepresented among engineers.

The self-ratings of study skills favored students in the mathematical sciences. Lowest self-ratings of study skills were among students in computer sciences.

The study found that average self-ratings of verbal skills for each major field area were rank ordered quite differently from verbal ability as measured by the GRE General Test. Highest mean self-rating was for students of earth sciences; lowest was for students of physical sciences. The GRE score averages would place earth science majors about average for our sample and physical science students in second place. We did not determine the correlation between GRE scores and self-ratings, but that computation could be made. It is possible that survey respondents interpreted "verbal skills" to refer to public speaking, debating, or simply to conversational fluency, none of which would necessarily correlate with the academic skills measured by the GRE.

Gender Differences

The unweighted sample broke down by gender into the following undergraduate major fields:

	Males	*Females*
Biological sciences	160	326
Physical sciences	123	92
Computer sciences	59	23
Earth, atmospheric, marine, and environmental sciences	34	39
Mathematical sciences	55	94
Engineering	340	163
TOTAL	771	737

We expected GRE scores, background information, and survey responses to differ not only by gender, but by major field. Students in engineering, for example, would probably have higher scores and greater interest in mathematics than biological sciences majors would. We therefore analyzed each variable, first by gender, for students in all NSME majors; then we reanalyzed each variable by gender for each of three groups: those with undergraduate majors in (1) biological sciences, (2) engineering, and (3) mathematics, physical, and computer sciences. Because of the large volume of statistics produced, we are reporting summaries of results.

Average GRE scores and statistics on selected background variables showed statistically significant differences by gender. Even when statistics were computed separately for students earning bachelor's degrees in biological sciences, engineering, and math, physical, and computer sciences, many differences were seen. The following table shows those variables for which males (M) obtained higher mean values, females (F) obtained higher mean values, or no significant differences were found (=).

GRE/BIQ Variable	*Entire Sample*	*Biological Sciences*	*Engineering*	*Math, Physical, Computer Science*
GRE verbal score	M	M	M	M
GRE quantitative score	M	M	M	M
GRE analytical score	M	=	=	=
Degree objective	M	M	=	M
GPA in major	M	=	M	M
GPA last two years	M	=	M	=
Overall GPA	=	F	M	=
Elected to an honor society	=	=	M	F
Received an award in science	=	F	=	=
Published an article	=	=	=	=
Hours per week worked for pay	F	F	F	=
Hours per week community service	F	F	F	=
Mother's education	F	=	=	=
Father's education	=	=	=	=

Differences in GPA, where they existed, were actually very small.[9] Within all groups, however, gender differences in quantitative score averages were quite substantial. In the sample as a whole, mean quantitative scores differed by 0.71 standard deviation. When viewed by major field, the differences were not quite so large, but ranged from 0.43 for students in math, physical sciences, and computer sciences to 0.62 for students in engineering. Differences in verbal score averages, though not as large, also favored males. Effect sizes ranged from 0.27 for students in math, physical, and computer sciences, to 0.31 for students in biological sciences. These mean gender differences

[9]Institutions often report that females earn higher grades than males do, on the average, and some College Board studies (e.g., Clark & Grandy, 1984) confirm those reports. We do not know from these data alone whether this sample was different from the norm for NSME majors.

may be kept in mind when interpreting differences in questionnaire responses later in this report. In particular, note that students in math, physical sciences, and computer sciences showed the fewest and smallest gender differences.

Differences in responses to the survey questionnaire were often small but statistically significant. The 13 scales created from those items showed some gender differences, a few of which were moderately large. An analysis of differences in means on the scales are shown in the following table, using the same notation as in the previous table.

Questionnaire Scale	*Entire Sample*	*Biological Sciences*	*Engineering*	*Math, Physical, Computer Science*
1 Course difficulty	F	F	F	=
2 Course enjoyment	M	M	M	M
3 Quality of instruction	=	=	M	=
4 Relationships with instructors	=	M	F	=
5 Relationships with students	F	F	=	F
6 Perceive self as scientist	M	M	M	M
7 Quality of department	=	=	M	F
8 Problem-solving skills	M	M	M	M
9 Study skills	F	F	F	F
10 Verbal skills	=	=	=	=
11 Interpersonal skills	F	=	F	F
12 Career opportunities	=	F	F	F
13 Will do, but don't like	M	=	=	=

For biological sciences majors, effect sizes were 0.25 favoring males for scale 8 (problem-solving skills) and 0.31 favoring females for scale 9 (study skills). For the other scales showing statistically significant differences, those differences were actually quite small (**d** < 0.20).

Among engineering majors, seven scales showed effect sizes greater than 0.2. Scales 6 and 8 (ability to perceive oneself as a scientist or engineer, and problem-solving skills) had effect sizes of 0.55 and 0.50, respectively, favoring males. The other five scales, showing effect sizes between 0.20 and 0.38, were course difficulty, study skills, and interpersonal skills (favoring females) and course enjoyment and quality of instruction (favoring males). In general, then, females in engineering reported finding their coursework more difficult and less enjoyable than did males. Although they rated their study skills higher, females rated their problem-solving skills much lower, and it may be this perception, combined with the lower quantitative GRE scores, that lay behind their having greater difficulty perceiving themselves as scientists or engineers.

Gender differences among students in mathematics, physical sciences, and computer sciences were much smaller. Only on scale 9, study skills, was the difference at all pronounced (**d** = 0.42), and females rated themselves higher than males did. The gender differences observed among engineers, who are also in highly quantitative and traditionally male-dominated fields, did not exist among students in the physical sciences, computer sciences, and mathematics.

Undergraduate Experiences. The first page of the questionnaire listed 28 statements about undergraduate studies, and students were asked to indicate the extent to which they agreed or disagreed with each statement on a 5-point Likert scale from "strongly agree" to "strongly disagree."

The first graph shows the mean responses, for males and females, with statements ordered from top to bottom by degree of agreement for both genders. Ahead of each abbreviated statement is an indication of whether males (M) or females (F) agreed more strongly with the statement, based on statistical significance at the 0.05 level of confidence.

Visual inspection suggests almost identical ratings by both genders. The statement showing the strongest agreement was, "I have enjoyed courses in my major better than most other subjects." The statement with which students agreed the least was, "The competition in labs has been so fierce that some students have sabotaged the experiments of others."

Although quite a few items showed statistically significant gender differences, only three items showed effect sizes greater than 0.2. Females agreed more strongly with these statements than males did:

> Coursework in my major has convinced me <u>not</u> to do graduate work in that field.[10]
>
> I have difficulty imagining myself as a scientist or an engineer.
>
> I have high regard for other students in my department.

Depending on the undergraduate field, however, there were greater or lesser gender differences. Among students in biological sciences, females agreed more strongly with these same statements. In addition, females more than males agreed that one or more professors had encouraged them to do graduate work in that field.

Among engineering majors there were greater gender differences. Males more than females enjoyed courses in their major better than in most other subjects and felt that they could make a real contribution to their field (**d** = 0.43). Males were more critical of the faculty, whereas females complained more that courses were different from what they had expected, homework took too much time, and they had enjoyed science more in high school than in college.

Patterns were different for students in physical sciences, computer sciences, and mathematics. Females did not indicate that they had more difficulty perceiving themselves as scientists than did males, nor was there a difference in their regard for other students in the department. Males did indicate, slightly more than females, however, that they enjoyed courses in their major better than in most other courses, but that many professors could not teach very well.

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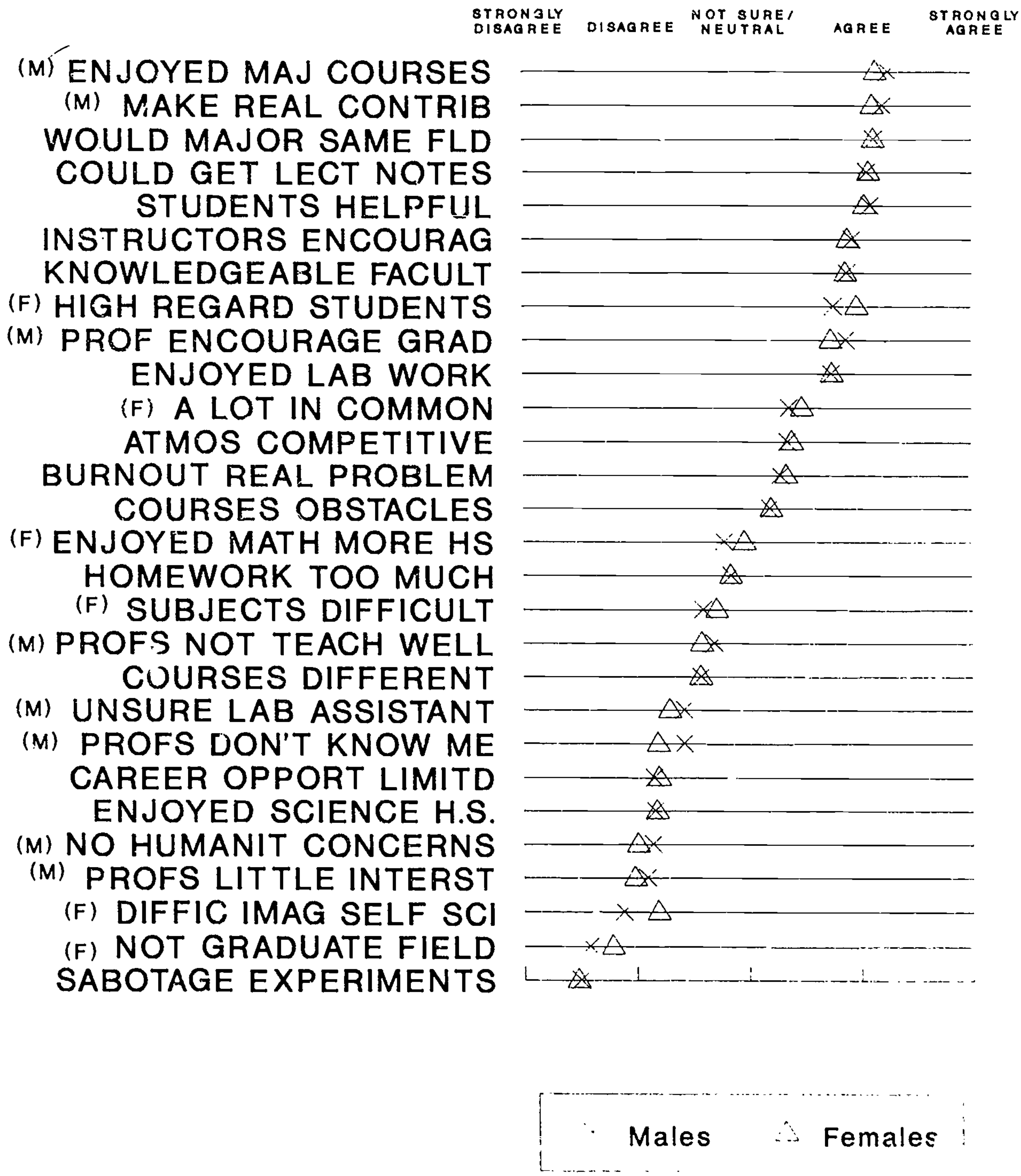
[10]All students in the sample were planning to continue in NSME, but they might be changing fields within that domain.

Undergraduate Experiences



(M): Males agreed significantly more than females.
(F): Females agreed significantly more than males.

Ratings of Undergraduate Department or Program. Students gave high ratings, on the average, to nearly all aspects of their undergraduate program, and there were only very small gender differences in ratings. The very highest ratings, by both genders, were on "scholarly and professional competence of the faculty" and "accessibility of faculty members to undergraduates." The lowest ratings by both males and females--averaging from fair to good--were for "curricular and career advising." The next graph shows how very similar the average ratings were by males and females. Nevertheless, there were very small differences in means that were statistically significant, and two ratings that showed effect sizes greater than 0.2 for engineering majors.

The two items rated noticeably differently by males and females in engineering were "variety of advanced course and program offerings" (favoring males) and "opportunities to assist professors in their research" (favoring females).

Self-Ratings. Students rated themselves on a 5-point scale ranging from "well below average" to "well above average" on 13 skills. On the average, most students rated themselves as somewhat above average on all skills. The next graph shows that males and females had similar self-ratings on most skills. The statistically significant differences are indicated.

Effect sizes were greater than 0.2 for five skills areas. Males rated themselves higher than did females on the following skills:

Ability to think through problems
Math skills
Test-taking skills

Females rated themselves higher than did males on the following skills:

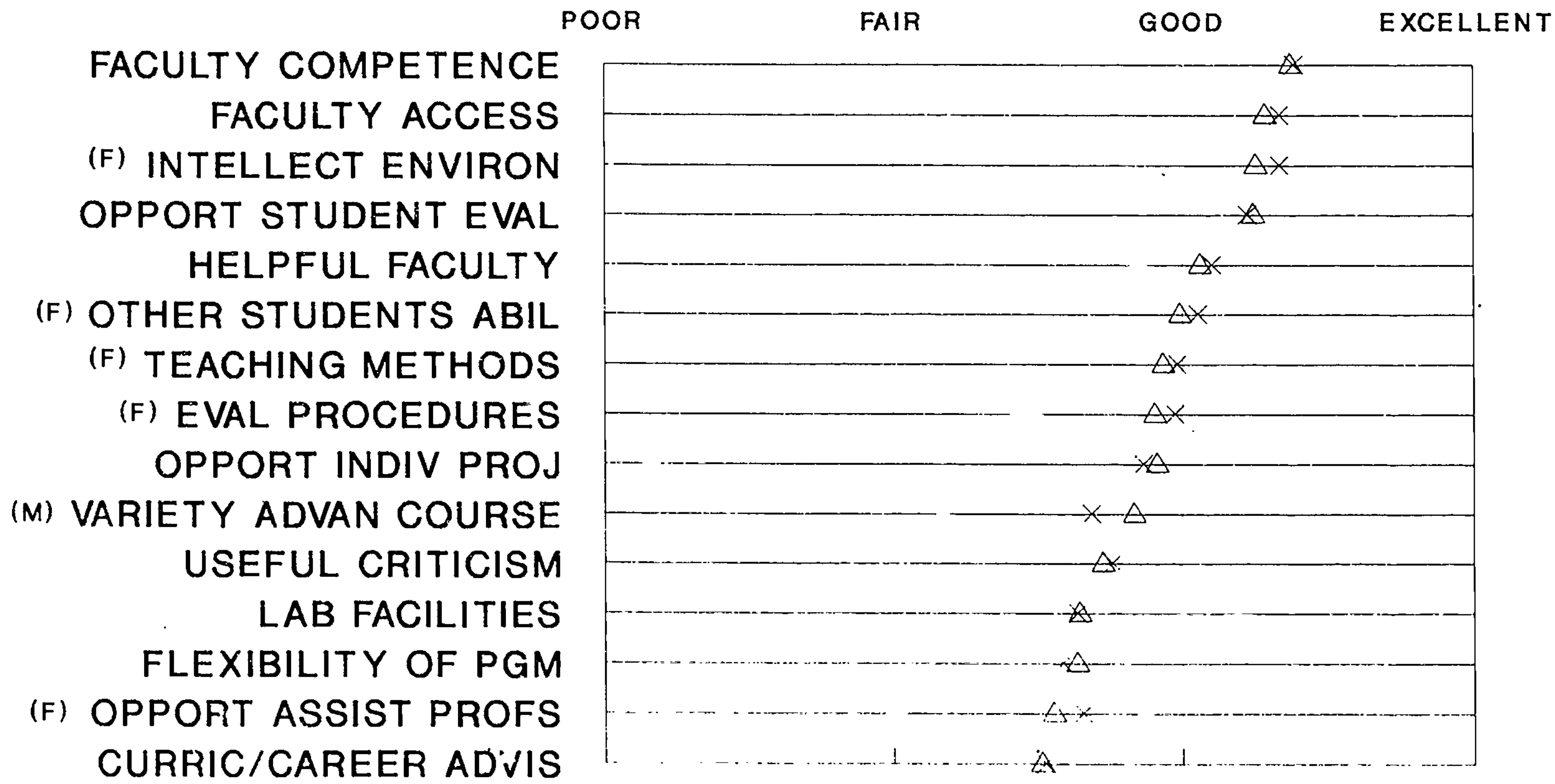
Ability to organize work
Time spent on homework

For engineering students, some effect sizes were moderate to large. Males rated themselves higher than did females on laboratory skills (**d** = 0.41), test-taking skills (**d** = 0.42), and ability to think through problems (**d** = 0.77). Males also rated themselves somewhat higher on speed in solving problems, and female engineering students did not rate themselves higher on ability to organize work, as they did within the total sample.

Among students in physical science, mathematics, and engineering, there were no gender differences in self-rated math skills or test-taking skills, but females did rate themselves somewhat higher than did males in relationships with fellow students.

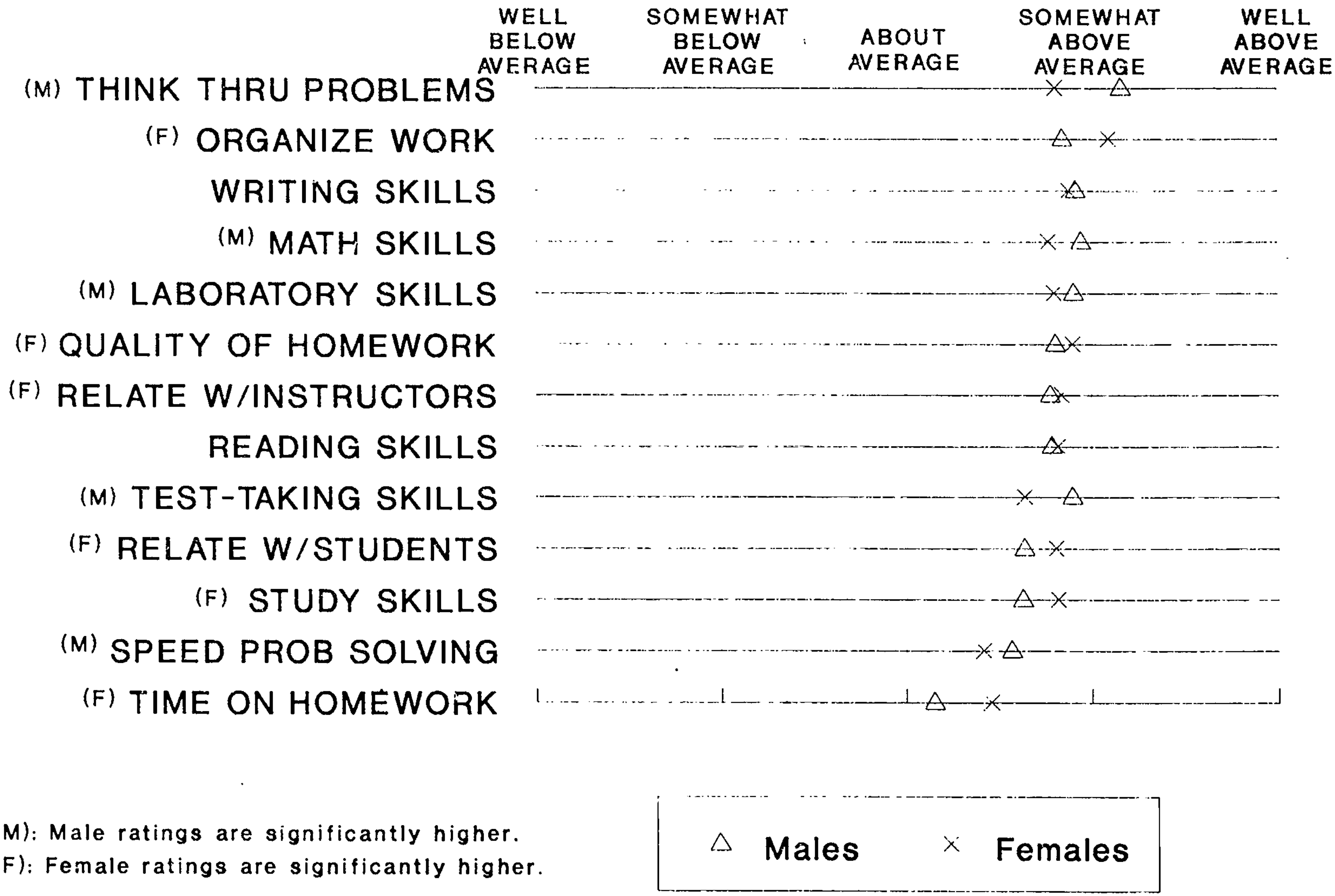
Career Plans and Expectations. The first question in this section asked students to assume that the current value of the dollar would not change, and to assume further that they would complete graduate school. Then, the question read, "Once you are out of graduate school and have become established professionally--in perhaps 10 or 15 years--about how much money do you expect to earn annually?"

Mean Ratings of Undergraduate Department or Program



(M): Males rated significantly higher than females.
(F): Females rated significantly higher than males.

Self Ratings



(M): Male ratings are significantly higher.
(F): Female ratings are significantly higher.

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Results showed that females expected to earn considerably less than males. In the next graph, note that in the $30,000 to $40,000 range, the proportion of females is more than twice as great as the proportion of males. In contrast, the proportion of males is more than twice as great as the proportion of females in the $75,000 to $100,000 range.

The greatest differentials in expected income were among students in biological sciences and engineering (**d** = 0.44 and 0.41, respectively). The gender difference in income expectation was smaller for students in the physical sciences, computer sciences, and mathematics (**d** = 0.23).

When asked how important it is to have an income at least as large as they predicted, males and females both answered most frequently "somewhat important." Males, on the average, gave income a slightly greater importance than did females.

The next question asked students to characterize, on five bipolar scales, the job they would most like to have. Differences in mean ratings on all five scales were statistically significant. Effect sizes were greater than 0.2 for the total sample on three of the five scales.

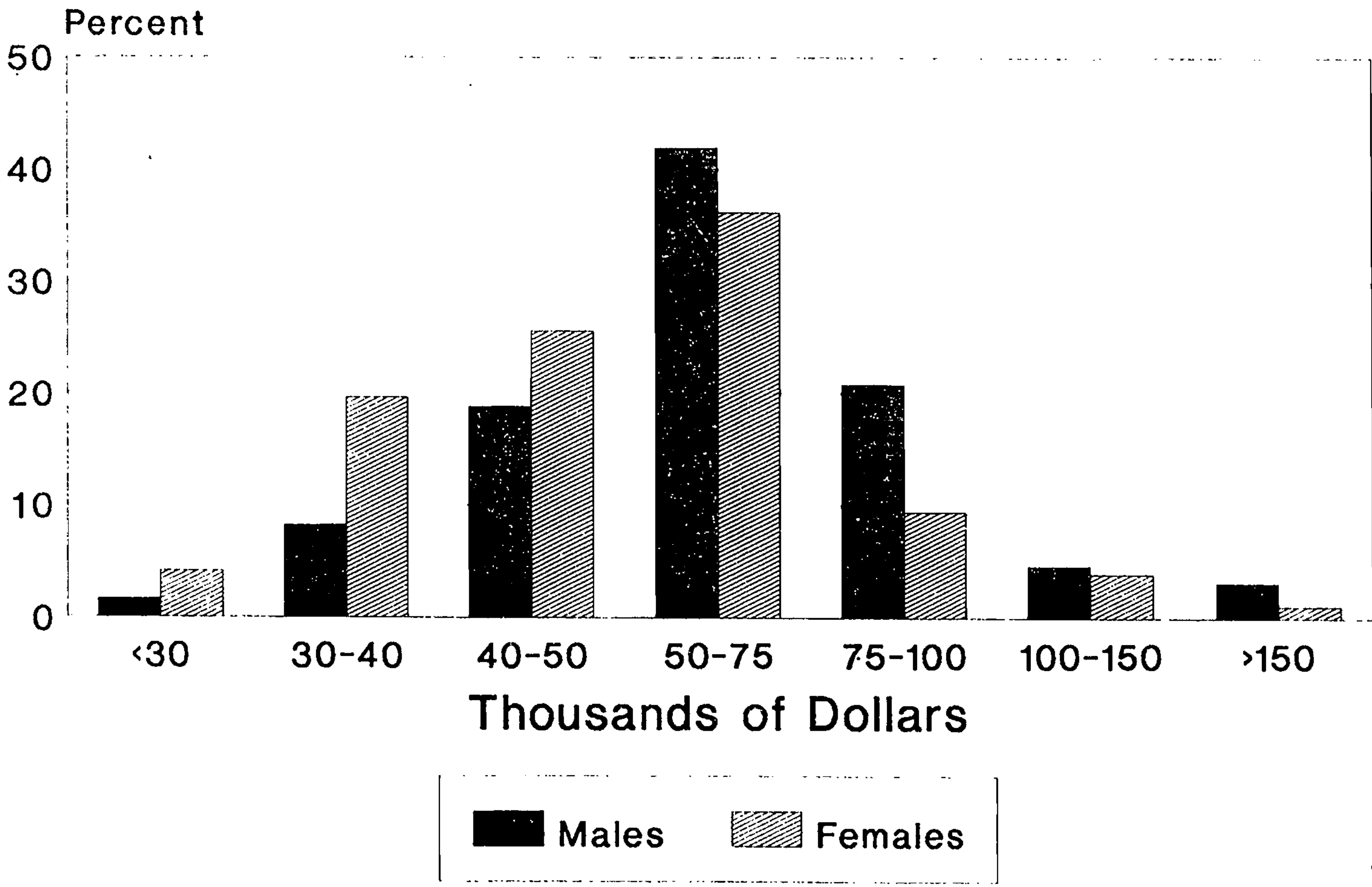
Both males and females tended to prefer a job that was somewhat more toward the practical and applied end of the spectrum than toward the theoretical side. The average for females was even more in the direction of practical and applied.

On the scale from "working with people" to "working with things," males, on the average, chose a balance exactly in the middle. The average for females was nearer to working with people. Among engineering students, the gender difference was moderately large (**d** = 0.55).

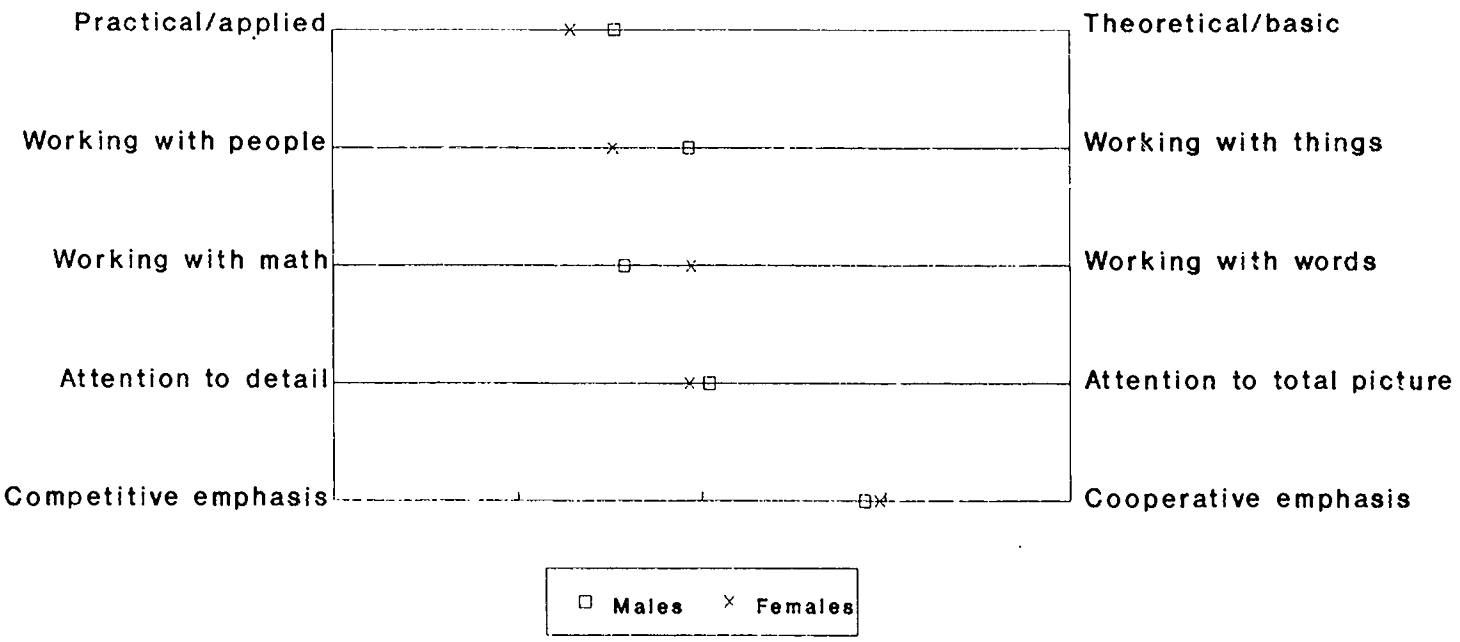
The third dimension on which males and females overall differed noticeably was "working with math" versus "working with words." Females, on the average, chose a point in the middle, preferring to work equally with both math and words. Males, on the average, chose a point slightly nearer to working with math. Analyses of major field subgroups, however, showed that the gender differences on this dimension were very small for students in engineering and math, and in physical and computer sciences. It was primarily among biological science majors that females showed a greater preference for working with words.

On the other two dimensions, males and females averaged very nearly the same choices overall, though the means differed for biological science students. Females tended to prefer "attention to detail" somewhat more than males did. On "competitive emphasis" versus "cooperative emphasis," both genders averaged virtually the same, at a point nearer to cooperative emphasis, but with females showing a slightly greater preference for cooperative emphasis. Although the female preference for cooperative emphasis is statistically significant, the effect size is only 0.09, which indicates that the difference is essentially negligible. Only among biological science majors does the effect size approach a level worthy of acknowledgment (0.23).

Expected Annual Earnings
(after 10 or 15 years,
assuming constant dollars)



Characteristics of Most Desirable Job



On a different type of scale, ranging from "not important" to "extremely important," students indicated the importance of each of nine job characteristics or opportunities. The next graph shows the means on each item for each gender.

Most important to both males and females was pleasant coworkers. Other items that averaged between very important and extremely important were job security, variety, and opportunities for advancement.

Females overall valued the following job characteristics higher than did males:

Pleasant coworkers
Contribution to society
Prestige/respect

The only characteristic valued more highly by males than by females was technical challenge.

The questionnaire then listed 22 job activities and asked students to what extent they wanted a job involving each activity. They responded on a 3-point scale from "not at all" to "possibly" to "definitely." Results for males and females are shown in the next graph. Those showing statistically different means are indicated.

Activities that both genders wanted most, on the average, were to develop ideas and to interpret and evaluate information. Activities that they wanted least were to persuade, negotiate, or sell; to keep records and catalog information; and to draw or draft.

There were, however, some activities that one gender preferred to a greater or lesser extent than the other. Those activities with the largest effect sizes favoring males were as follows (effect sizes in parentheses):

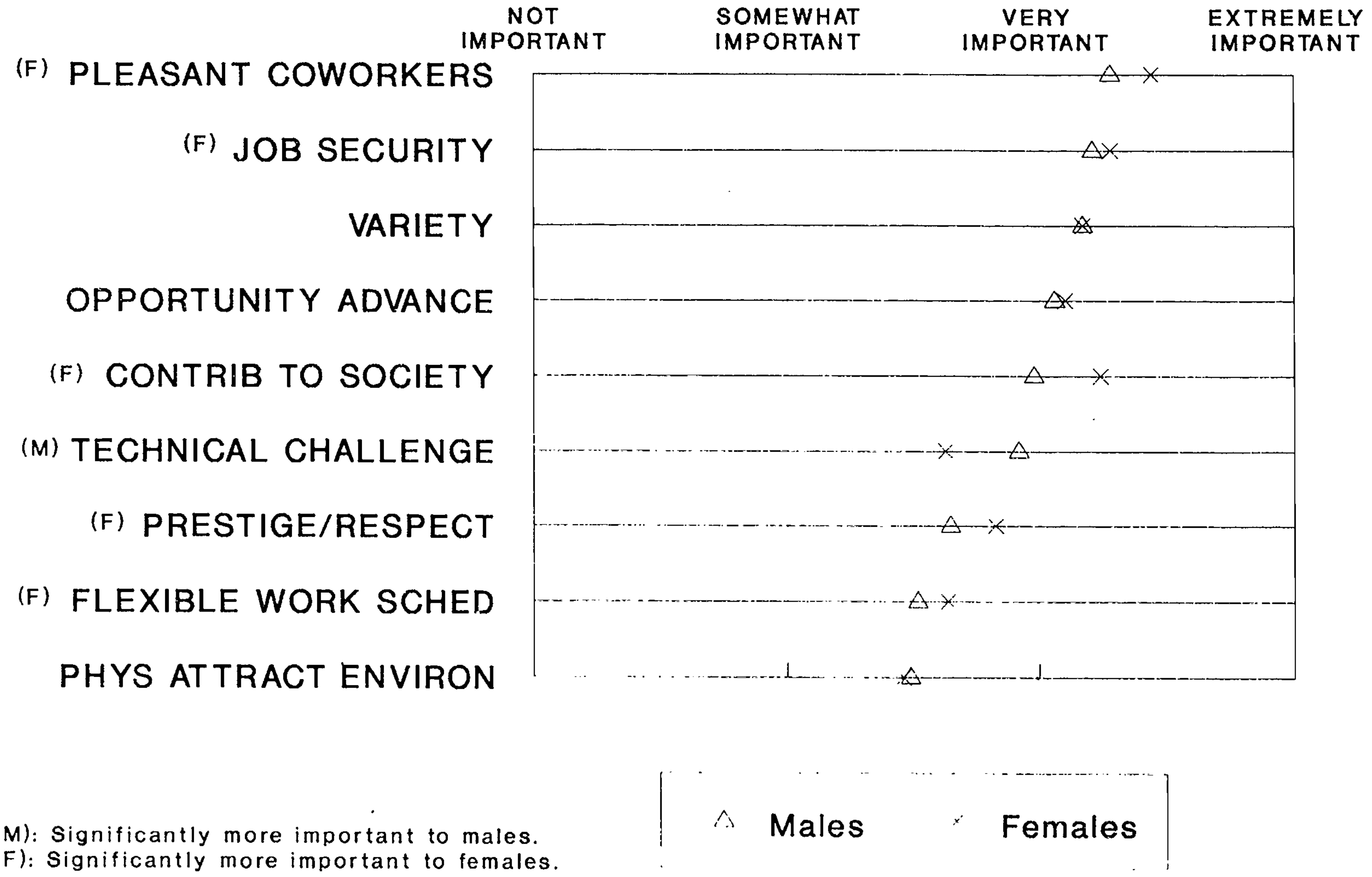
Develop ideas (0.31)
Work with computers (0.37)
Troubleshoot problems (0.39)
Reason mathematically (0.30)
Design instruments or equipment (0.57)

Although most females, like most males, indicated that they did not want a job keeping records or cataloging information, more females than males indicated they might want such an activity (**d** = 0.38).

Among students in mathematics and physical and computer sciences, there were no gender differences in preference for working with computers or reasoning mathematically, and a small male preference for reading extensively.

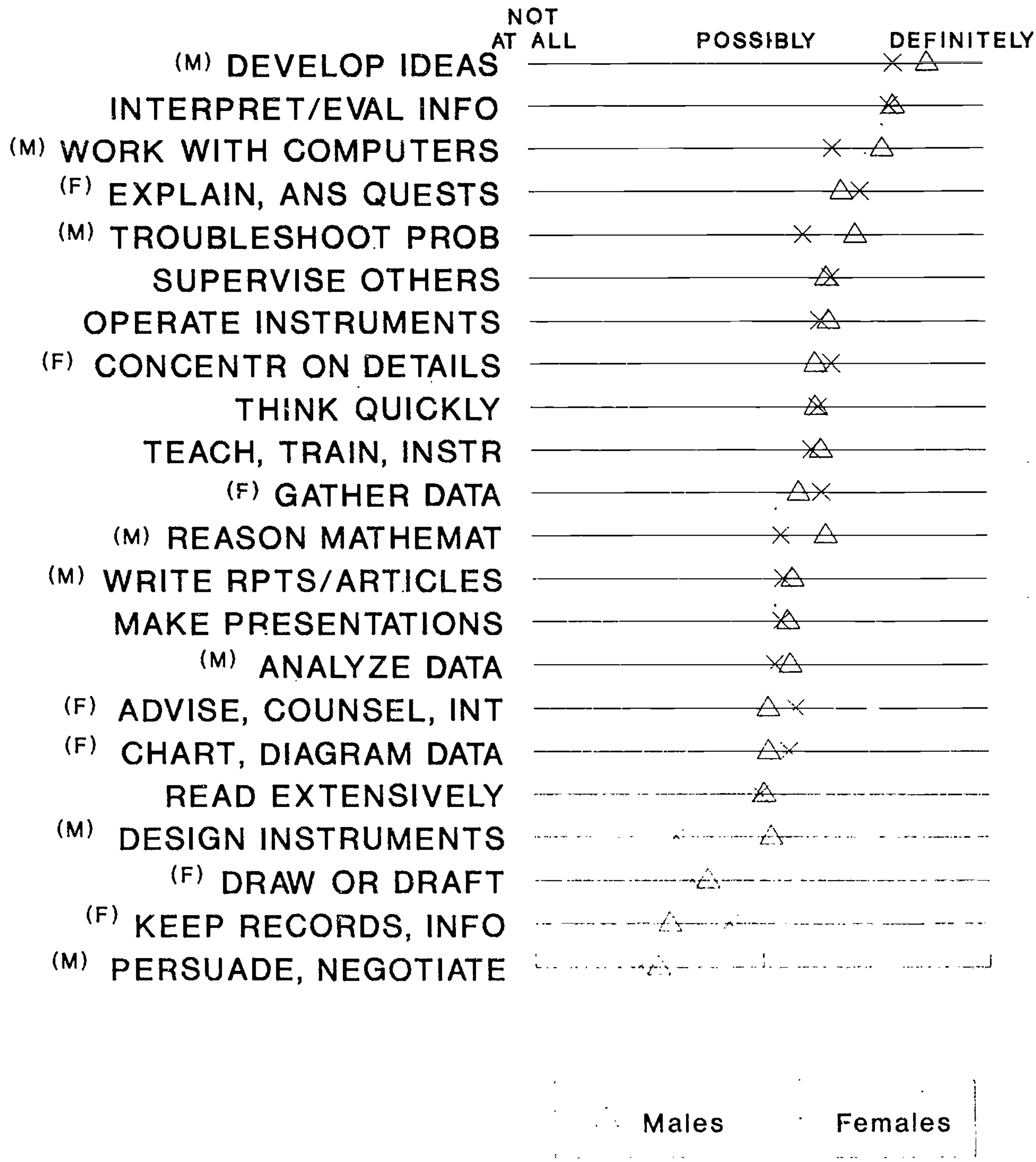
Among engineering students, there was no gender difference in the desire to reason mathematically. The male preference for developing ideas had a somewhat larger effect size (0.49), and there was a small female preference for gathering data.

Importance of Each Job Characteristic or Opportunity



(M): Significantly more important to males.
(F): Significantly more important to females.

Preferred Job Activities



(M): Preferred significantly more by males.
(F): Preferred significantly more by females.

Plans for Graduate Study. Survey results suggested that many males chose their graduate field of study earlier than females did.

The greatest number of students, both male and female, reported choosing their graduate field of study before college. It is also clear from the next graph that a greater proportion of males than females reported choosing their field of study before the sophomore year, and a greater proportion of females than males chose it after their sophomore year.

The questionnaire contained 17 statements referring to the intended field of study. It included statements of opinions and beliefs about the field as well as experiences with the field and with other people in it. Students responded on a 5-point Likert scale from "strongly agree" to "strongly disagree."

The next graph shows that there was extraordinary agreement between males and females regarding intended field of study. Statements with which both males and females agreed most strongly were:

> There are exciting new developments in this field.
> I truly love this field and want to learn as much as possible about it.
> In this field I will have an opportunity to make a significant contribution.
> Success in this field will require good technical skills.

They disagreed most strongly with the following statements:

> I am under pressure from my family to do graduate work in this field.
> This field really doesn't interest me much, but an advanced degree in it will be useful to my career.
> I expect my graduate courses to be less demanding than the undergraduate courses in my major.

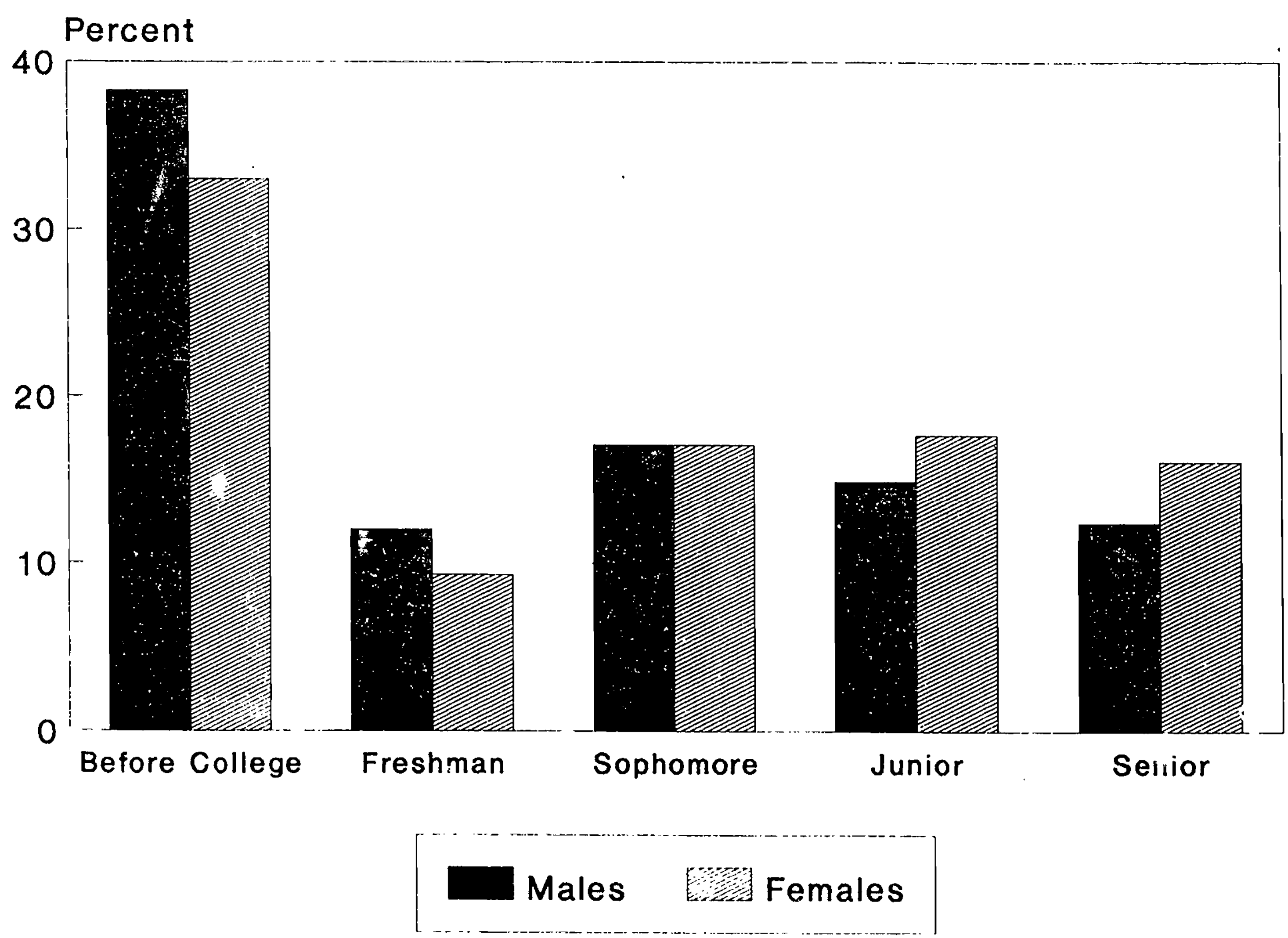
Eight items showed very small but statistically significant differences between males and females. Those items are marked on the graph, but the magnitudes of the differences are barely visible. Only one item, "Success in this field will require good technical skills," showed an effect size greater than 0.2, favoring males.

Among biological science majors, three more statements showed small gender differences ($d > 0.2$). Females agreed more than males with each of the following:

> Success in this field will require good interpersonal skills.
> In this field I will have an opportunity to make a significant contribution.

Students in physical sciences, computer sciences, and mathematics showed no gender differences on any statements regarding their field of study.

When Did You Choose This Field?



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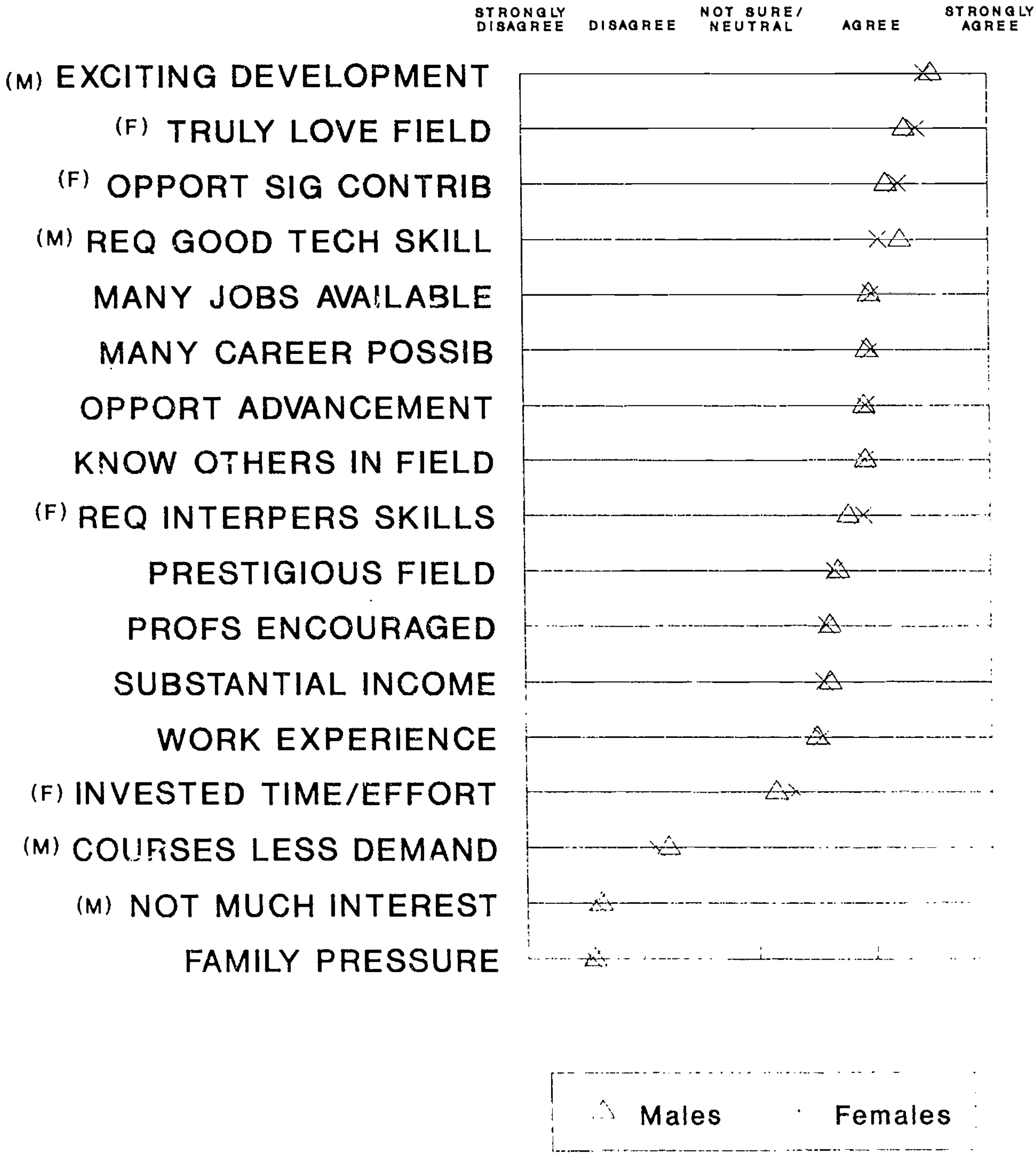
Statements about Intended Field of Study



(M): Males agreed significantly more than females.
(F): Females agreed significantly more than males.

A final set of questions asked about the occupations of parents, expression of parental approval for the major fields of study, and other experiences related to the field.

Nearly twice as many females as males (20.6% versus 11.5%) responded that their mother was in a technical, mechanical, or scientific occupation. There was no significant difference, however, between males and females in the percentages whose fathers were in those occupations.

More than 95% of all respondents indicated that their mothers and fathers approved of both their undergraduate and their graduate fields of study. Slightly more males than females, however, perceived each of their parents as approving both their undergraduate and graduate majors.

Among the total sample, no gender differences appeared in the responses to any of the following statements:

> I have had one or more professors who encouraged me to do graduate work in this field.
> I know personally one or more professionals in this field.
> I have had work experience in this field.

There were some small gender differences in responses to the statement on work experience, suggesting that among students in biological sciences, more females than males had work experience. In the physical sciences, computer sciences, and mathematics, the reverse was true--more males than females reported having work experience.

Gender Group Summary Profiles. The sample showed moderate to large gender differences in GRE quantitative score averages and in self-perceptions of some important skills and capabilities. Aside from these differences, the remaining gender differences--in undergraduate experiences, graduate school plans, and desired job activities--were generally quite small, though often statistically significant. The greatest gender differences were among students in engineering. Students in math, physical sciences, and computer sciences showed the fewest and smallest gender differences on all dimensions, including GRE scores and questionnaire responses.

Regardless of field of study, males scored higher than females on the GRE verbal and quantitative sections, but the differences were less pronounced among students within each field of study.

Among engineering students, females found their undergraduate coursework more difficult than males did. Males enjoyed their courses more and rated the quality of instruction better than females did. Males were considerably better able to see themselves as scientists or engineers than females were. Males judged their laboratory skills, ability to think through problems, speed in solving problems, and test-taking skills higher than females did. Females rated only time spent on homework higher than males did.

These findings are consistent with the results of other research on engineering students. Though the research applied to graduate school students, we might expect similar results for undergraduates. Baum (1989) discussed a Stanford University survey by Zappert and Stanbury (1984) in which a disturbing number of women expressed diminished self-esteem as a result of their graduate school experience. According to that study, much of women's self-doubt stems from difficulties in the adviser/student relationship and the reluctance of male faculty to accept them as professionals. Another explanation for the lower self-esteem of female engineering students was suggested by female students in an MIT survey cited by Baum (1989). Female students reported that foreign-educated faculty, many of whom are from cultures where women are not held in high esteem, pose problems for women in engineering graduate programs.

Although the female engineering students in our survey rated themselves lower on some skills, female students in math, physical sciences, and computer sciences did not. This finding contradicts the general view that physics, more than other sciences, is "unfriendly" to females (Brush, 1991). Our analyses did not single out physics majors specifically, but among physics, chemistry, mathematics, astronomy, and computer science majors combined, there were no gender differences suggesting dissatisfaction with the undergraduate experience or with personal achievement.

Perhaps consistent with the lower self-esteem of some female students are our findings that males expected to earn higher salaries than females. This difference in salary expectation may also be attributable to differences in job aspirations, which may reflect realistic expectations. Fewer women planned to earn Ph.D.s, and fewer women were in engineering, which pays higher salaries than biological sciences--the most frequently selected field for females.

Females showed a slightly greater preference for a job in which they would work with people more than with things, whereas males were fairly evenly split in their preferences. In biological sciences only, males had a preference for math, where females had a preference for words. This gender difference did not hold for students in the other majors. The apparent gender difference in preference for competition, as suggested by many female scientists and discussed earlier, was essentially not confirmed by the survey data, at least insofar as males and females were reporting these preferences honestly and accurately. Males admitted essentially no greater preference for competition.

Females, more than males, valued pleasant coworkers, ability to make a contribution to society, and prestige/respect as important job characteristics. Technical challenge was valued more highly by males than by females.

Preferences for job activities were rank ordered the same way for males and females, with developing ideas being highest on the scale. However, there were small gender differences in preferences for nearly all activities. Males showed a greater preference for developing ideas (especially among engineering students), reasoning mathematically (among biological science majors only), working with computers, troubleshooting problems, and designing instruments or equipment. Females were more willing than males to keep records and catalog information and, among engineering students, to gather data and to chart or diagram data. The pattern that seems to emerge is that females are more willing to do subordinate work. An alternative explanation, consistent with Spence's research on women's work motivation, may be that women tend to be motivated to work hard on all types of jobs (including more routine, menial ones), whereas men tend to be motivated by mastery, competitiveness, and liking a particular job (Spence & Helmreich, 1984).

Perhaps most interesting among the background statistics was the finding that nearly twice as many females as males indicated that their mothers were in technical, mechanical, or scientific occupations. There was no difference in the percentage whose fathers were in those occupations.

Ethnic Differences

Differences among the ethnic groups were larger than differences between genders, both in GRE scores and in questionnaire responses. In the following analyses, where effect sizes are reported, the comparisons were made between White students and the specific ethnic group under discussion.

ANOVA results showed that average GRE scores and background questionnaire variables were all significantly different. The list below shows selected variables from the GRE test file and indicates which ethnic groups obtained the highest and lowest averages.

	Highest	*Lowest*
GRE verbal score average	White	Puerto Rican
GRE quantitative score average	Asian American	African American
GRE analytical score average	White	Puerto Rican
Degree objective	Native American	Asian American
Overall GPA	White	African American
GPA in major	White	African American
GPA last two years	White	African American
Hours/week worked	Native American	Asian American
Hours/week community service	African American	Asian American
Honors or awards in science	Puerto Rican	Asian American
Honor Society	Asian American	Other Hispanic
Father's education	Asian American	Mexican American
Mother's education	Asian American	Mexican American

Asian Americans came from families with the most formal education; Mexican Americans from the least. Sixty-five percent of the fathers and 52% of the mothers of Asian Americans had at least a bachelor's degree, whereas only 32% of the fathers and 21% of the mothers of Mexican Americans had that much education.

Community service consumed very little time among science and engineering students. Among Puerto Ricans, however, 8% reported spending more than 10 hours a week in community service. The figures were 6% for African Americans and 5% for Native Americans. At the lower extreme, fewer than 2% of Asian Americans or Mexican Americans spent time in this way. Time spent in community service, we hypothesized, may relate to some questionnaire responses indicating greater interest in humanitarian concerns and in working and interacting with people. Later in this report we note this relationship.

The same 13 questionnaire scales defined earlier were analyzed by ethnic group, with the following results:

		Highest	Lowest
1	Course difficulty	Puerto Rican	White
2	Course enjoyment	Native American	Asian American
3	Quality of instruction	Native American	Asian American
4	Relationship with instructor	Native American	Asian American
5	Relationship with students	White	Other Hispanic
6	Self as a scientist	Other Hispanic	Asian American
7	Quality of department	Native American	Asian American
8	Problem solving skills	Other Hispanic	Native American
9	Study skills	No difference	No difference
10	Verbal skills	Other Hispanic	Native American
11	Interpersonal skills	No difference	No difference
12	Career opportunities	African American	Asian American
13	Will do but don't like	Asian American	Other Hispanic

Results of the scale analyses seem to suggest that, of the seven ethnic groups, Asian Americans showed the least enthusiasm for their chosen field of study. They appeared to find their coursework more difficult (**d** = 0.53) and enjoy it less (**d** = 0.60), on the average, than did Whites or members of most other ethnic groups. They were the most critical of their undergraduate department, including quality of instruction (**d** = 0.35) and relationship with instructors (**d** = 0.71). They were somewhat less able to see themselves as scientists or engineers (**d** = 0.26) and far more likely than Whites to indicate that they planned to pursue their field but did not really like it (**d** = 0.61).

Native American students, on the other hand, showed the greatest positive attitude toward their subject and their undergraduate experiences, even though they rated some of their own abilities, including problem-solving skills (**d** = 0.53) and verbal skills (**d** = 0.51) lower than Whites and other groups did.

Puerto Rican students found their coursework considerably more difficult than did White students (**d** = 0.87) and somewhat more difficult than did other ethnic groups. Their other ratings, however, showed only small differences from other groups.

Other Hispanics were nearly identical to Whites in their apparent confidence in their skills and in their perception of themselves as scientists and engineers. They rated their relationships with instructors and other students, however, somewhat lower than did Whites.

These results suggest some patterns that we can understand more clearly by examining individual questionnaire item responses, the means of which differed significantly among ethnic groups.

The graphs presented for ethnic group comparisons are of the same format, basically, as the earlier graphs comparing genders. Because there were seven ethnic groups, seven symbols were used to plot mean ratings for each item. To avoid cluttering the graphs, however, only the symbols for the highest and lowest ethnic group averages are shown. Thus, for each item, the range of average responses is shown by identifying the two ethnic groups with the highest and the lowest mean ratings.

Undergraduate Experiences. The first page of the questionnaire listed 28 statements about undergraduate studies, and students were asked to indicate the extent to which they agreed or disagreed with each statement on a 5-point Likert scale. The next graph shows average responses for the highest and lowest ratings on each item.

There were statistically significant differences in the average ratings among ethnic groups for all but six statements. The statements about which there was essentially equal agreement or disagreement by all ethnic groups were the following:

If I missed a lecture, I could always get notes from someone else.
I have high regard for other students in my department.
I have enjoyed laboratory work.
Courses have sometimes been obstacles rather than vehicles for learning.
I have difficulty imagining myself as a scientist or an engineer.

Close examination of the graph shows that Asian Americans, on the average, tended to rate their experiences less positively than did members of other ethnic groups. Although they perceived their undergraduate experiences in a generally positive way, they agreed less than Whites did on 18 items showing effect sizes ranging from 0.23 to 0.64. Statements with which they agreed considerably more strongly than did White students were the following:

Homework has taken too much time. (**d** = 0.56)
I enjoyed science more in high school than I have in college. (**d** = 0.42)
Most of my professors have little interest in students. (**d** = 0.63)
Many professors in my department do not know me. (**d** = 0.46)
Coursework in my major has convinced me not to do graduate work in that field. (**d** = 0.45)[11]

Statements with which Asian Americans agreed considerably LESS strongly than did Whites were the following:

I have enjoyed courses in my major better than most other subjects. (**d** = 0.43)
If I were starting over again, I would major in this same field. (**d** = 0.59)
My instructors have encouraged me to continue in this field. (**d** = 0.64)
One or more professors have encouraged me to do graduate work in this field. (**d** = 0.47)

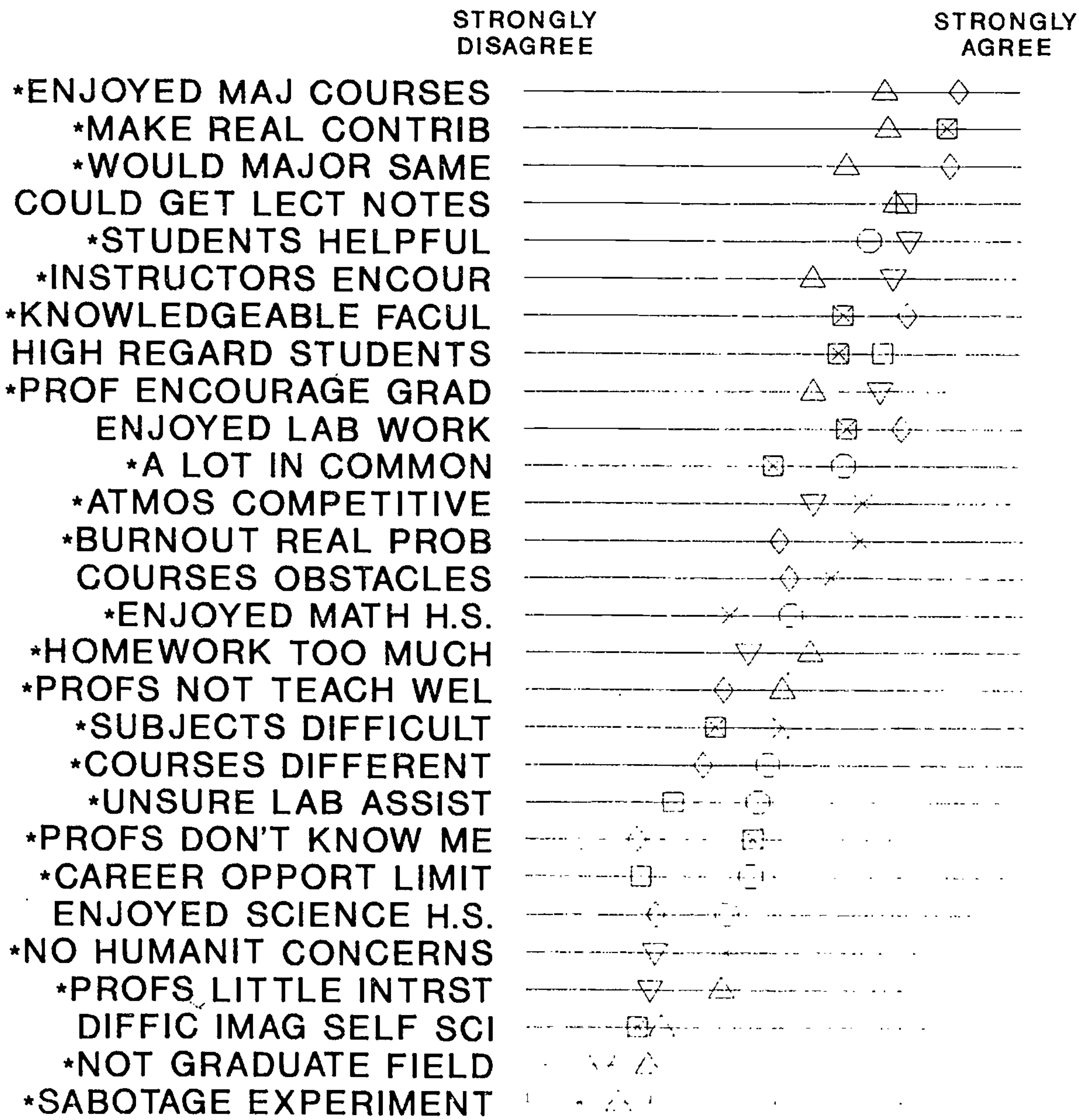
Native Americans tended to report especially positive experiences. In general, there were only small differences in the ratings of Native American and White students. Their mean ratings were significantly higher than the ratings of most other ethnic groups on the following items:

I have enjoyed courses in my major better than most other subjects.
If I were starting over again, I would major in this same field.
All important courses have been taught by knowledgeable faculty.

---

[11]None of the students in the sample was planning to leave NSME, but some were planning to switch to areas of NSME other than the field in which they were earning their bachelor's degree.

Ranges of Average Ratings of Ethnic Groups for Undergraduate Experiences



* $p < 0.05$

Native Americans were LEAST likely to agree with these items:

Many professors in my department do not know me.
Courses in my major have turned out to be very different from what I expected.
Many of my professors could not teach very well.
Burnout is a real problem for majors in my field.

Mexican Americans appeared to perceive their learning environment as somewhat more stressful than did other ethnic groups, on the average. They were more likely to have found their courses more difficult than they expected (**d** = 0.53), to view the atmosphere in their department as competitive (**d** = 0.39), and to agree that burnout was a real problem for majors in their field (**d** = 0.39). More Mexican Americans were also inclined to agree that people in their field had no real humanitarian concerns (**d** = 0.67), though in general, very few people held this view. Fewer Mexican Americans than Whites indicated that instructors had encouraged them to continue in their field (**d** = 0.43), and more felt that many professors in their department did not know them (**d** = 0.36).

The average Puerto Rican rating on the statement "Homework has taken too much time" was more than a full standard deviation higher than the average White rating (**d** = 1.05). More Puerto Ricans also reported enjoying science more in high school than in college (**d** = 0.50), and had found that their courses turned out to be different from what they expected (**d** = 0.47). They more frequently felt that their professors did not teach very well (**d** = 0.52) and showed little interest in students (**d** = 0.53). Finally, Puerto Ricans were having doubts about their chosen careers. More Puerto Ricans than Whites felt that career opportunities in their field were very limited (**d** = 0.60), and that most people in their field had no real humanitarian concerns (**d** = 0.46).

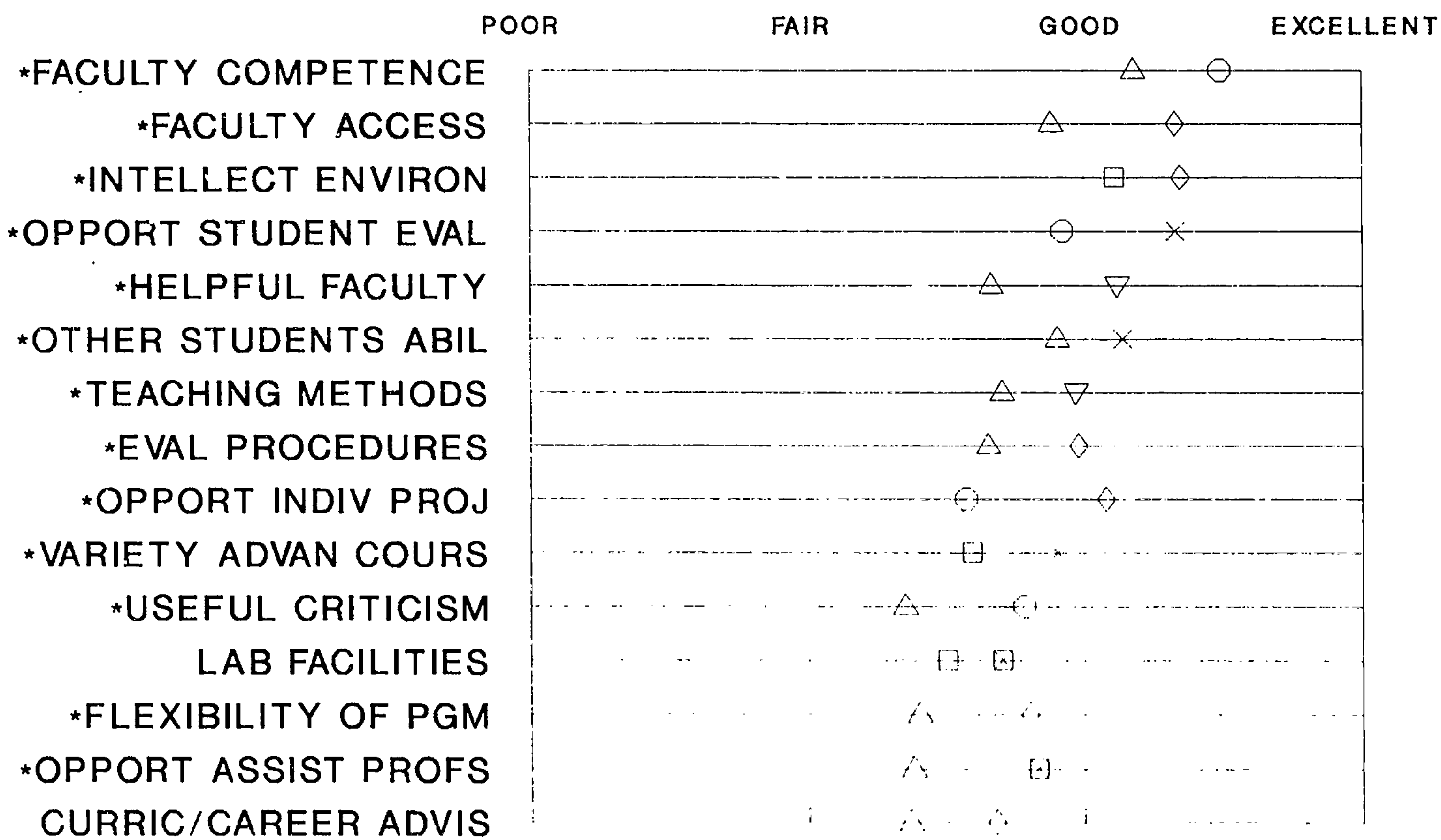
African American students' ratings of their undergraduate experiences did not differ markedly from White students' ratings.

From these profiles it appears that although student ratings of their undergraduate experiences were quite positive on the whole, there were enough differences among minority group responses that patterns were visible. Asian Americans had the least positive feelings about their experiences, especially regarding their choice of field of study and their relationships with faculty. Native Americans and Whites were generally the most positive. Mexican Americans seemed to have a somewhat more stressful, competitive, and academically difficult educational experience. Puerto Ricans may have suffered a harder transition from high school to college, as indicated by their responses to homework taking too much time and professors not being able to teach very well. They were also, perhaps, somewhat discouraged about job prospects.

Ratings of Undergraduate Department or Program. Students rated 15 different aspects of their department or undergraduate program. Mean ratings computed for each ethnic group are plotted in the next graph, again, for just the highest and lowest average group ratings.

There were no significant differences by ethnic group in the ratings of laboratory facilities or curricular and career advising. All other dimensions showed fairly small but statistically significant mean differences, the most pronounced of which was the Asian American response pattern.

Ranges of Average Ratings of Ethnic Groups for Undergraduate Department or Program



* $p < 0.05$

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Faculty competence and intellectual environment were given high ratings on the whole, but Asian Americans gave the lowest ratings of any ethnic group (**d** = 0.34 and 0.26, respectively). Asian Americans found the faculty least accessible to undergraduates (**d** = 0.56), less helpful in dealing with class work (**d** = 0.60), and providing the least useful criticism of class work (**d** = 0.50). Asian Americans were the most critical of teaching methods (**d** = 0.41) and opportunities for student evaluation of courses and instruction (**d** = 0.22). They were less satisfied with the flexibility of the program to meet individual needs (**d** = 0.25) and with opportunities to pursue individual projects (**d** = 0.32). Compared with the other ethnic groups, Asian Americans gave significantly lower ratings on 10 of the 15 undergraduate department rating scales.

African American students rated intellectual environment and scholarly and professional competence of the faculty somewhat lower than did White students (**d** = 0.31 and 0.33, respectively), but otherwise gave ratings not much different from those of other groups.

Puerto Ricans were slightly less satisfied with teaching methods (**d** = 0.21) and procedures used to evaluate students (**d** = 0.25) and with opportunities to evaluate courses and instruction (**d** = 0.40) and opportunities to pursue individual projects (**d** = 0.38).

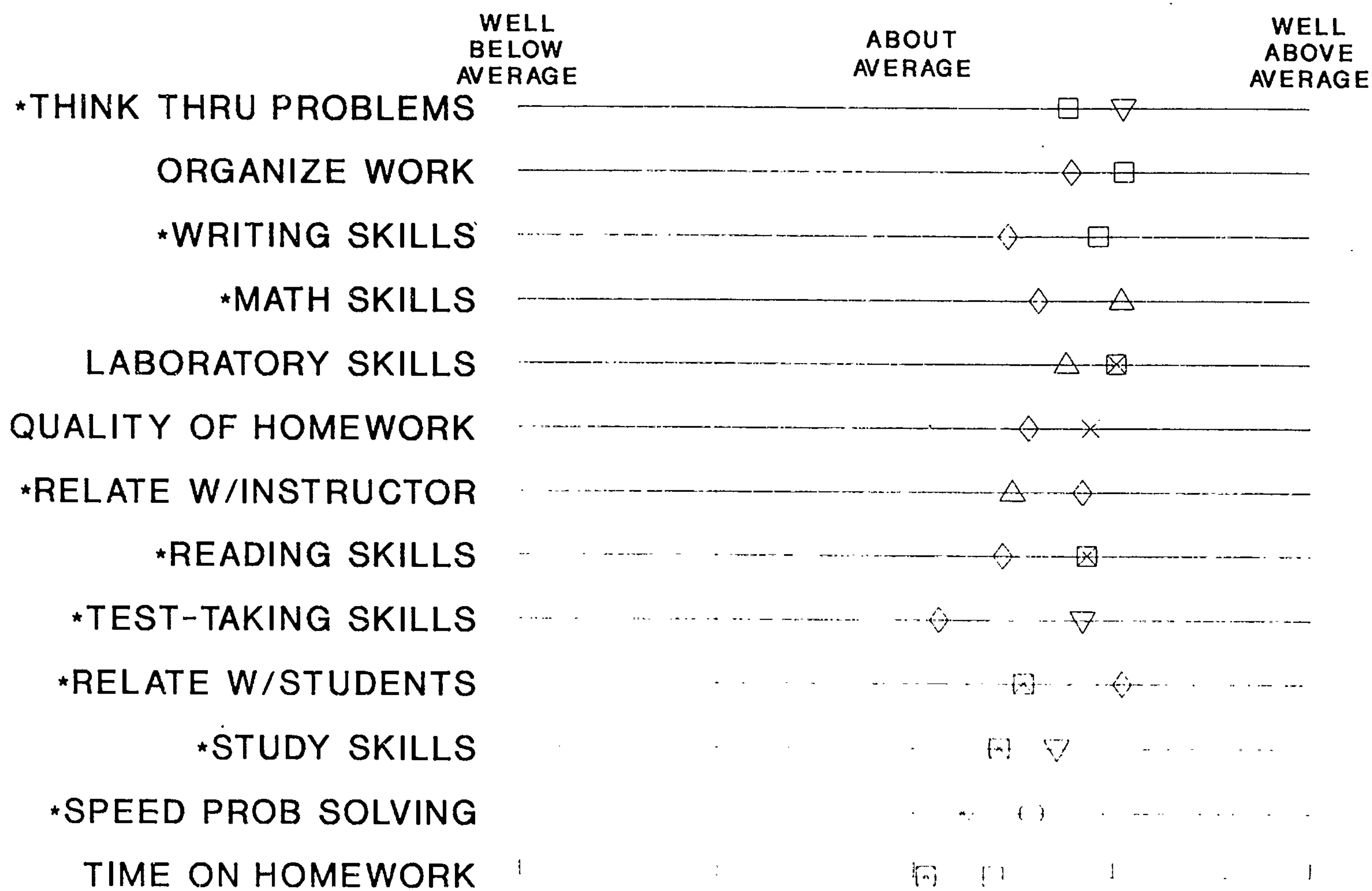
Self-Ratings. Students rated themselves on each of 13 different skills and abilities on a 5-point Likert scale ranging from "well below average" to "well above average." The next graph shows the ranges of mean responses.

There were significant differences in the mean ratings, by ethnic group, on all but four scales. Those scales were the ability to organize work, laboratory skills, quality of homework, and time spent on homework. In general, White students tended to rate their academic skills somewhat higher than did the other ethnic groups.

Native Americans rated themselves lower than did other ethnic groups on six of the scales, which included skills in reading, writing, mathematics, and test taking, as well as ability to organize work and quality of homework. Their lowest self-ratings, compared with those of White students, were in writing skills (**d** = 0.50) and test-taking skills (**d** = 0.75).

These comparatively low self-ratings were not consistent with Native American GRE scores and self-reported grades. It was, in fact, the African American sample who had the lowest average grades and quantitative scores and the second lowest verbal and analytical scores. However, African Americans rated themselves about the same as Whites did on writing skills, and higher on the average, than all other ethnic groups rated themselves. The skills on which African Americans rated themselves lowest, compared with Whites, were test-taking skills (**d** = 0.48) and ability to think through problems (**d** = 0.35).

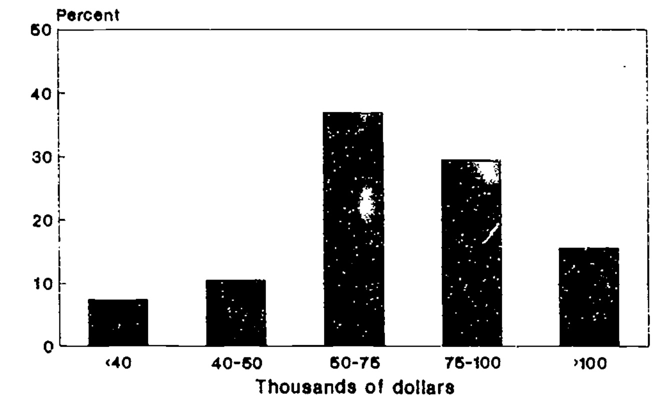
Ranges of Average Self Ratings of Ethnic Groups



* $p < 0.05$

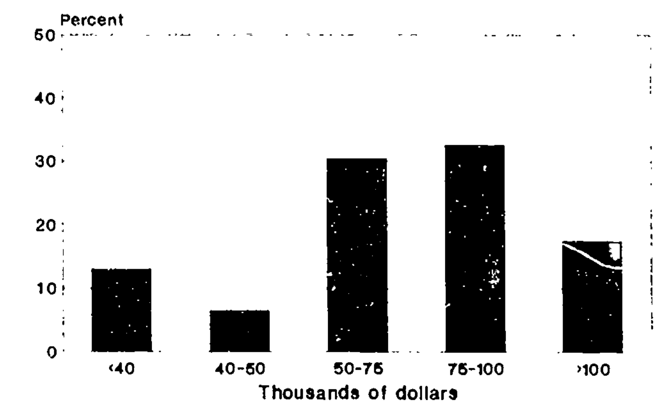
Expected Earnings. The questionnaire asked how much the person expected to earn annually, after becoming established professionally--in perhaps 10 or 15 years. Responses to this question revealed that many students, regardless of ethnic identity, had unrealistic income expectations. African Americans had the highest expectations, and Puerto Ricans had the lowest. The actual distributions of responses are graphed, for each ethnic group, to illustrate just how extremely different the expectations were. The following graphs are presented in order from highest to lowest median income expectation.

Expected Annual Earnings of African American Students Continuing in Science and Engineering (N = 217)



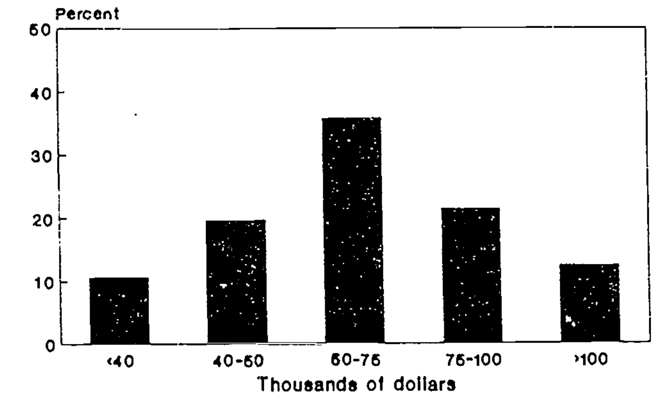
After 10-15 yrs, assuming constant $

Expected Annual Earnings of Other Hispanic Students Continuing in Science and Engineering (N = 46)



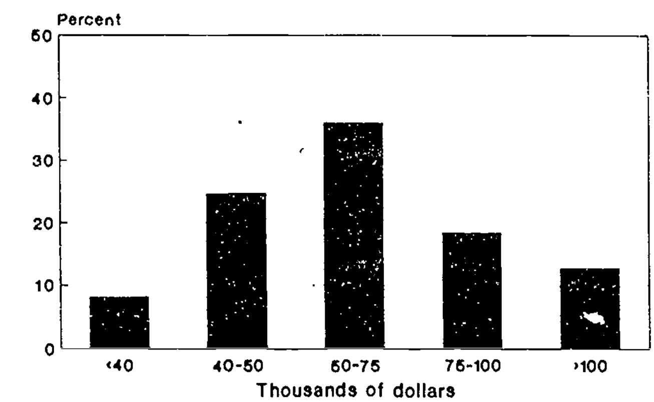
After 10-15 yrs, assuming constant $

Expected Annual Earnings of Mexican American Students Continuing in Science and Engineering (N = 56)



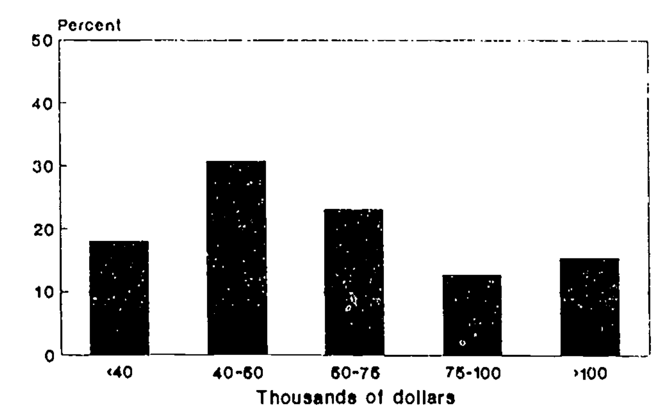
After 10-15 yrs, assuming constant $

Expected Annual Earnings of Asian American Students Continuing in Science and Engineering (N = 223)



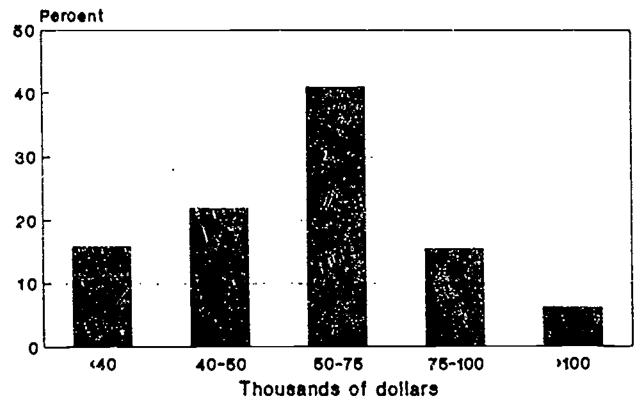
After 10-15 yrs, assuming constant $

Expected Annual Earnings of Native American Students Continuing in Science and Engineering (N = 39)



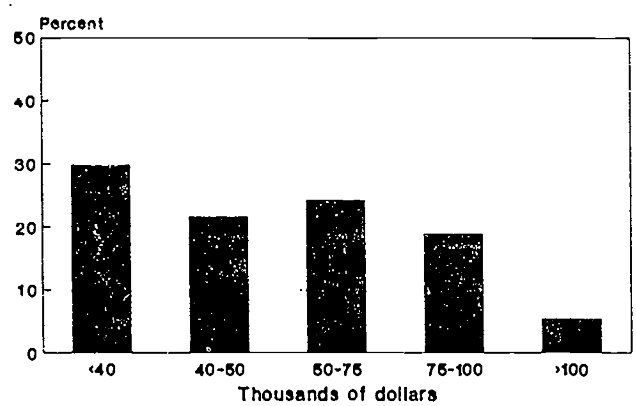
After 10-15 yrs, assuming constant $

Expected Annual Earnings of White Students Continuing in Science and Engineering (N = 881)



After 10-15 yrs, assuming constant $

Expected Annual Earnings of Puerto Rican Students Continuing in Science and Engineering (N = 37)



After 10-15 yrs, assuming constant $

The fact that Puerto Rican income expectations were lowest may realistically reflect lower pay scales within the Commonwealth, but the very high expectations of African Americans are out of line with published salary statistics. For example, 16% of the African Americans in the sample expected to earn more than $100,000 annually. We examined statistics for electrical engineers because they are among the more highly paid NSME professionals and because the Institute of Electrical and Electronic Engineers (IEEE) publishes salary statistics by ethnic group. In 1991, only 4% of IEEE members earned over $100,000 (IEEE, 1991). IEEE members who were African American earned considerably less, on the average, than members of other ethnic groups. The highest decile was $92,000 for Whites and only $65,200 for African Americans. Of course, these statistics included only IEEE members, and all educational levels and ages. It is possible that entry-level African American engineers are being offered higher salaries and are being promoted more quickly than they were in the past. Supporting statistics are not available, probably because the numbers of African American engineers are quite small. Even so, it seems very unlikely that the African American NSME students in the sample will be earning salaries as high as they predicted.

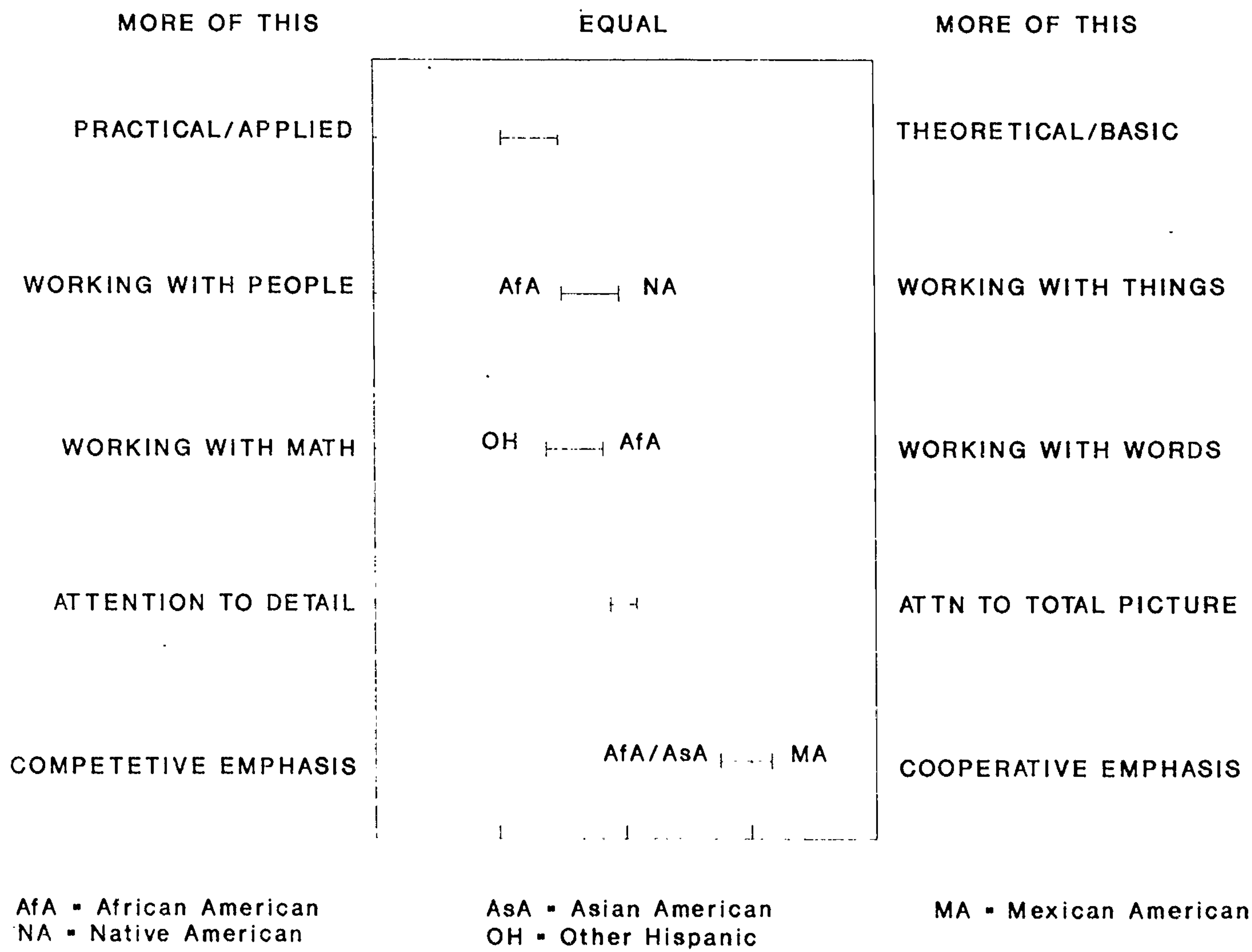
Desired Job Characteristics. The questionnaire presented students with five bipolar scales upon which they were to characterize the job they would most like to have. The next graph shows the range of mean ratings of ethnic groups. The means were significantly different on three of the five scales. The ethnic groups with the highest and lowest mean ratings are identified with the codes defined in the key.

All groups, on the average, favored job activities that were somewhat more practical and applied than theoretical and basic. There were also no significant ethnic group differences on the scale of "attention to detail" versus "attention to total picture." All groups averaged midway between the two. The other scales did show small ethnic differences.

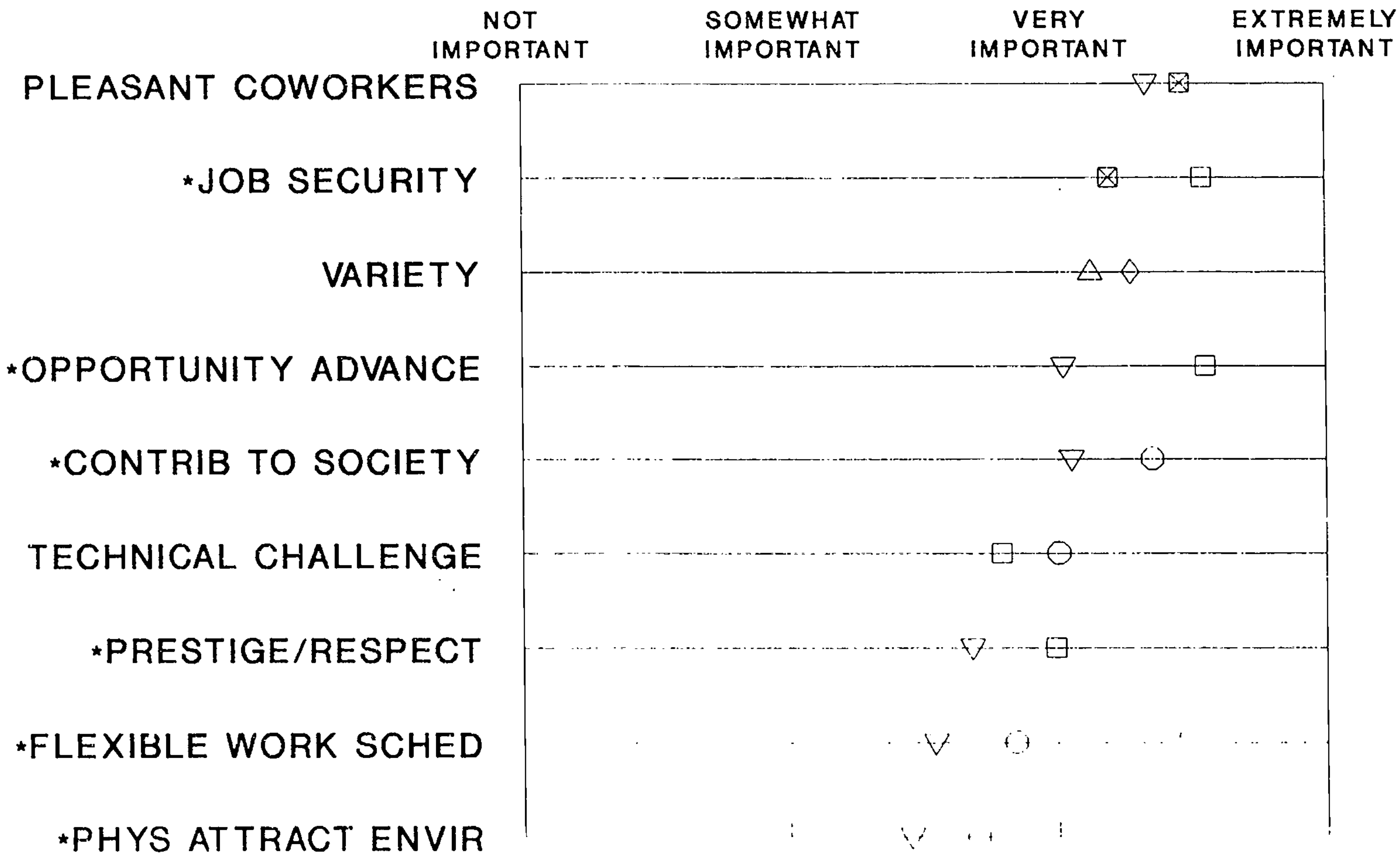
African Americans showed more of a preference for working with people than for working with things than did Whites or other ethnic groups ($\mathbf{d} = 0.28$). Mexican Americans and Other Hispanics preferred, more than others, to work with math rather than words ($\mathbf{d} = 0.25$ and 0.29. respectively). On "competitive emphasis" versus "cooperative emphasis," all groups, on the average, had a preference for cooperation. Mexican Americans showed a slightly greater preference for cooperative emphasis, and African Americans and Asian Americans showed some slightly greater preference for competition.

Some of these ratings, especially on the scales of people versus things and math versus words, further emphasize the African American student's somewhat greater interest in social interaction. This finding may be consistent with the greater number of hours African Americans reported spending in community service activities and in their higher self-report of writing skills.

Job Characteristics and Opportunities. This question listed nine job characteristics or opportunities and asked students to rate how important they regarded each one. The next graph shows that all groups, regardless of ethnic identity, rated "pleasant coworkers" at the very top, and there was no significant difference by ethnic group in the importance placed on coworker relationships. Variety and technical challenge were also very important job characteristics, and again, ones that were valued no more by one ethnic group than another.


MORE OF THIS
EQUAL
MORE OF THIS
PRACTICAL/APPLIED
THEORETICAL/BASIC
WORKING WITH PEOPLE
AfA
NA
WORKING WITH THINGS
WORKING WITH MATH
OH
AfA
WORKING WITH WORDS
ATTENTION TO DETAIL
ATTN TO TOTAL PICTURE
COMPETETIVE EMPHASIS
AfA/AsA
MA
COOPERATIVE EMPHASIS
AfA = African American
NA = Native American
AsA = Asian American
OH = Other Hispanic
MA = Mexican American

Ranges of Average Ratings of Ethnic Groups for Job Characteristics or Opportunities



* $p < 0.05$

White students tended to place less importance than did minority students on five of the nine job characteristics. These were opportunities for advancement, contribution to society, prestige/respect, a flexible work schedule, and a physically attractive environment. For three of these characteristics--contribution to society, flexible work schedule, and physically attractive environment--Puerto Rican students gave the highest ratings of any ethnic group (**d** = 0.35, 0.37, and 0.31, respectively). Puerto Ricans and Other Hispanics also placed greater than average importance on opportunities for advancement (**d** = 0.44 and 0.43, respectively).

African Americans placed a much higher than average importance on job security (**d** = 0.51), opportunities for advancement (**d** = 0.67), and prestige/respect (**d** = 0.41) than did most other minority groups.

Preferred Job Activities. Similar to the previous question, this one presented a list of job activities and asked students to indicate the extent to which they wanted a job involving each activity. They rated each activity on a 3-point scale from "Not at all" to "Definitely." The next graph illustrates the range of average ratings given by each ethnic group.

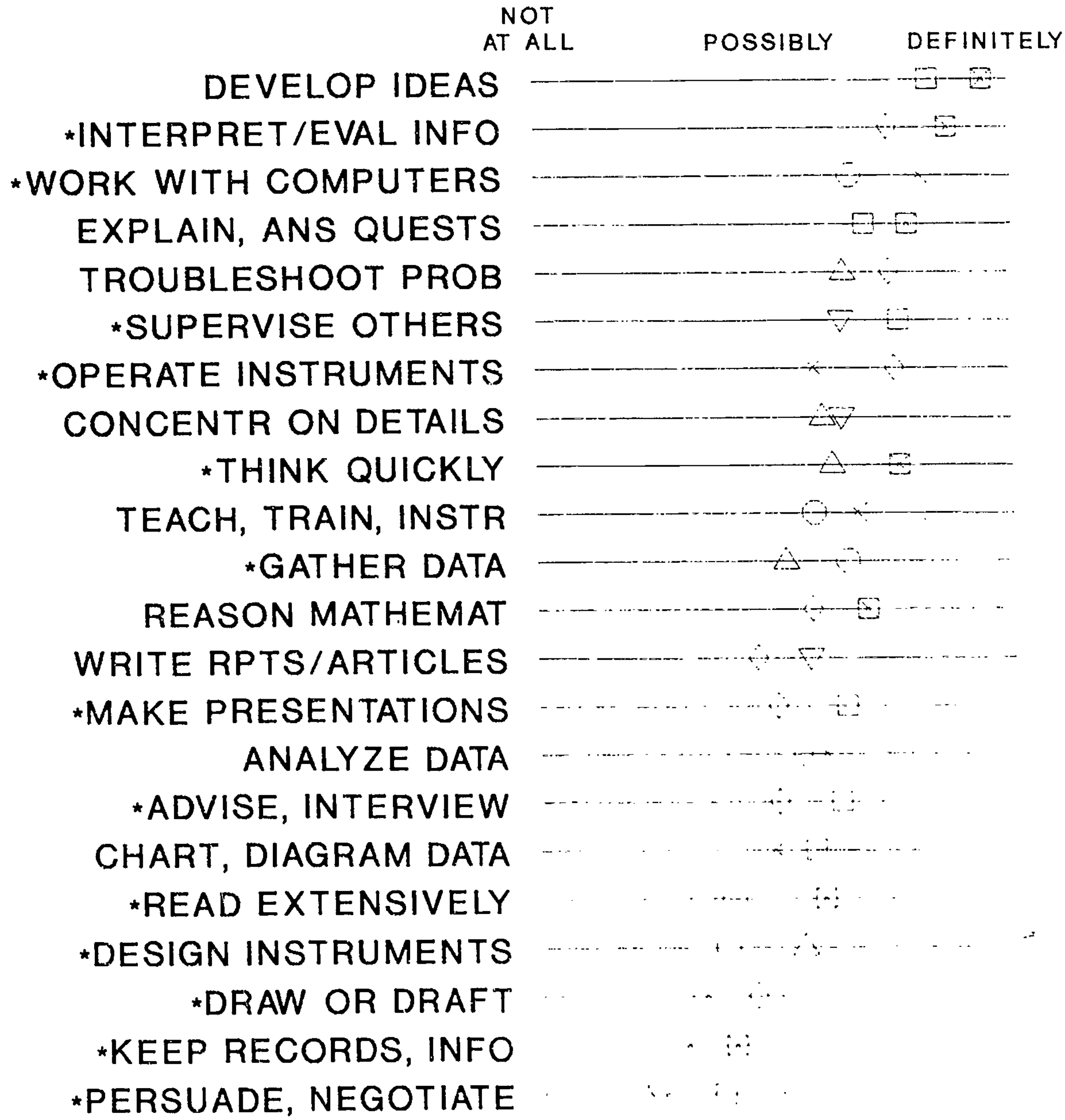
Members of all ethnic groups placed their highest priorities on developing ideas, and there was no statistically significant difference in the means. Six other activities were rated about the same by all ethnic groups. These were: explain and answer questions, troubleshoot problems, concentrate on details, teach, train or instruct, reason mathematically, write reports and articles, analyze numerical data, and chart or diagram data. The remaining activities were preferred, on the average, by some ethnic groups more than others.

The category of people designated as Other Hispanics showed greater than average preferences for eleven of the twenty-two items (effect sizes greater than 0.20 for each). These included interpreting and evaluating information, thinking quickly, reading extensively, advising, counseling or interviewing, and explaining or answering questions.

Mexican Americans tended to prefer, more than other ethnic groups, to work with computers (**d** = 0.27). They also showed a greater preference for reasoning mathematically and for explaining and answering questions. They had less interest than other groups in operating instruments, drawing or drafting, or keeping records and cataloging information. One characteristic that these tasks have in common is that they are generally the work of subordinates. Whether that is the reason the Mexican American sample found these activities less preferable may be worth exploring.

In contrast with Mexican American students, who showed the greatest preference for working with computers, Puerto Rican students had the least preference for working with computers (**d** = 0.20). Puerto Ricans also had less than average interest in reading extensively, writing reports or articles, or in designing instruments or equipment. Their relatively low verbal and analytical test scores may explain why they would rather not read extensively, since much of the reading in their field may be in English, and English is generally their second language. As for their less than average interest in working with computers, it is possible that fewer Puerto Ricans had ready access to computers, and may not have acquired sufficient skills to feel confident in their use.

Ranges of Average Ratings of Ethnic Groups for Preferred Job Activities



* $p < 0.05$

Consistent with their earlier questionnaire responses, African American students preferred, more than other groups, to supervise others (**d** = 0.43), make presentations (**d** = 0.28), advise, counsel, or interview (**d** = 0.30), and to persuade, negotiate, or sell (**d** = 0.42). All of these activities point to a greater need for social interaction than we see in members of other ethnic groups.

Except for an above average preference for designing instruments or equipment (**d** = 0.31), we see nothing so far in the profile of Asian Americans that makes them stand out from other ethnic groups or that might explain their relative discontent with their undergraduate program and field of study. On the next questionnaire item, however, we find that Asian Americans gave less than average positive ratings to a variety of aspects of their field of study.

Intended Field of Study. This question listed 17 statements referring to the person's field of study, and asked the extent to which they agreed or disagreed with each statement. Responses were on a scale of 1 to 5, from "strongly agree" to "strongly disagree." The next graph shows the ranges of mean ethnic group responses.

Nearly everyone strongly agreed that there were exciting new developments in their field. At the other extreme, very few people indicated that they were under pressure from their family to do graduate work in the field.

Differences in mean responses among ethnic groups were insignificant for five statements. They all agreed there were exciting new developments in their field, and that success in the field would require good technical skills. They all disagreed about equally that their graduate courses would be less demanding than their undergraduate courses. Ethnic groups reported having the same amount of work experience in their field, and the same numbers reported knowing personally one or more professionals in their field. The ethnic groups differed to a small but statistically significant degree on remaining twelve items.

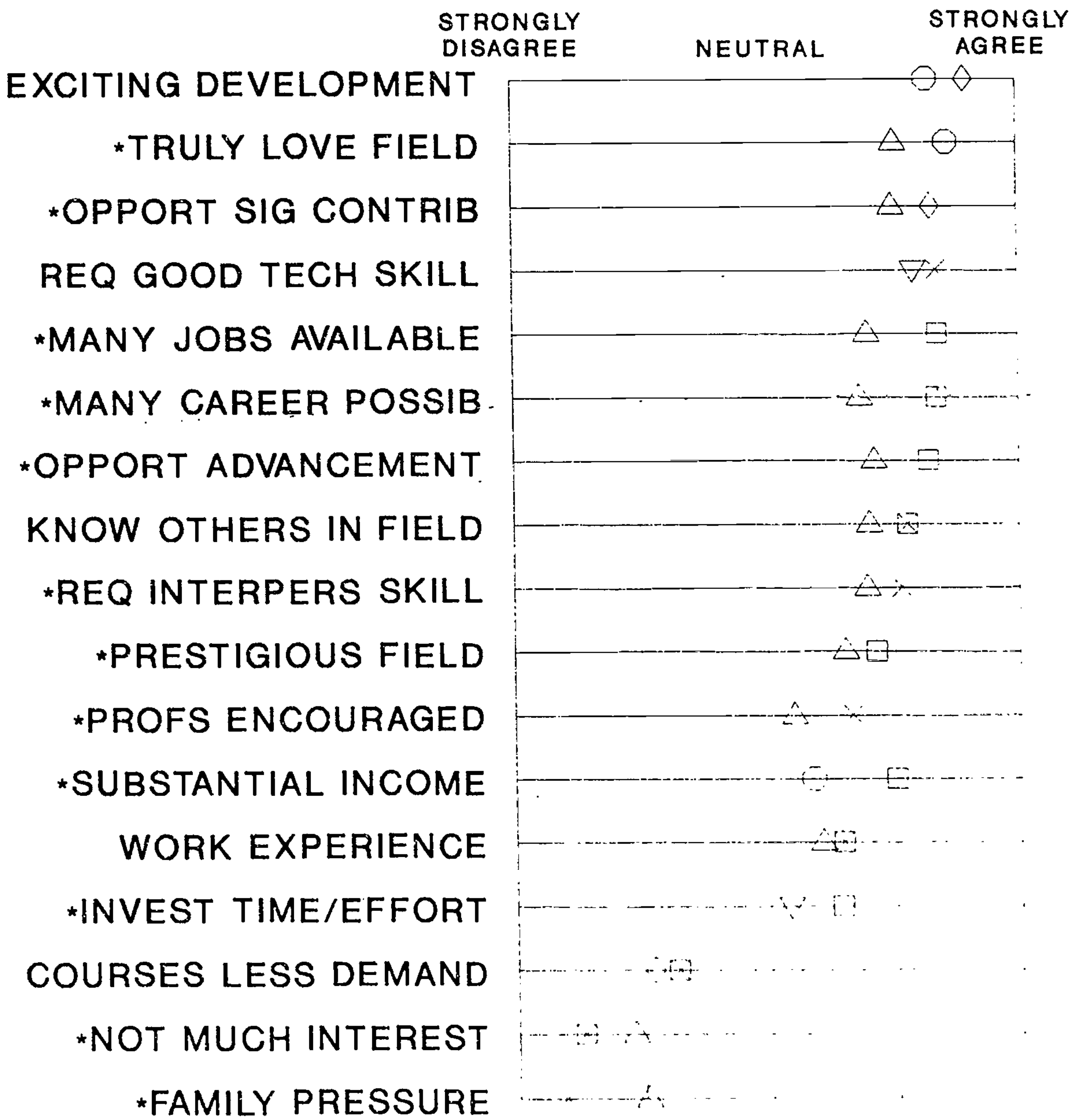
African Americans held a significantly more optimistic view of the career possibilities that lay ahead. Consistent with their anticipated higher earnings, African Americans agreed more strongly (**d** > 0.2) than other groups with the following statements:

> There should be many jobs available in this field when I complete graduate work (**d** = 0.42).
> A graduate degree in this field will prepare me for a number of different career possibilities.
> I expect this field to provide good opportunities for advancement (**d** = 0.50).
> This field provides many opportunities for a substantial income.

African Americans, more than others, also agreed that theirs was a prestigious field, that they had invested time and effort into the field and feel they must continue, and that success in the field will require good interpersonal skills.

In contrast to African American optimism was Asian American reluctance or pessimism. Asian Americans expressed the most negative views of any ethnic group on 11 of the 17 items, one of which was, "I am under pressure from my family to do graduate work in this field." (**d** = 0.54) For

Ranges of Average Responses of Ethnic Groups to Statements about Intended Field of Study



* $p < 0.05$

the most part Asian Americans disagreed with this item, but not as many disagreed, nor did they disagree as strongly as the other ethnic groups. It appear that while Asian Americans, for the most part, were interested in their field, they did not feel so strongly as the other ethnic groups, especially the African Americans whose views were most positive.

None of the other ethnic groups showed strikingly distinct profiles, though they did show some small differences. Mexican Americans, more than others, felt encouragement from their professors and felt that success in their field required good interpersonal skills. Recalling that Mexican Americans came from the most educationally disadvantaged backgrounds, and Asian Americans came from families with the most education, we may speculate that professors did support the Mexican American students most strongly and the Asian Americans least strongly because they were responding to their apparent relative needs.

Puerto Rican students also showed some small differences from other groups. They seemed to feel devotion to their field of study and, at the same time, the lowest income expectations.

Family Background and Approval. The last set of questions asks whether each parent was in a technical, mechanical, or scientific occupation, and whether each approved of the student's undergraduate and graduate fields of study.

The next pair of graphs show the percentages of fathers and mothers in technical, mechanical, or scientific occupations. Asian Americans (who also had the most highly educated parents) were at the top, with 54% of fathers and 28% of mothers. Lowest were Mexican Americans (whose parents had the least education) with 31% of fathers and only 9% of mothers in these related occupations.

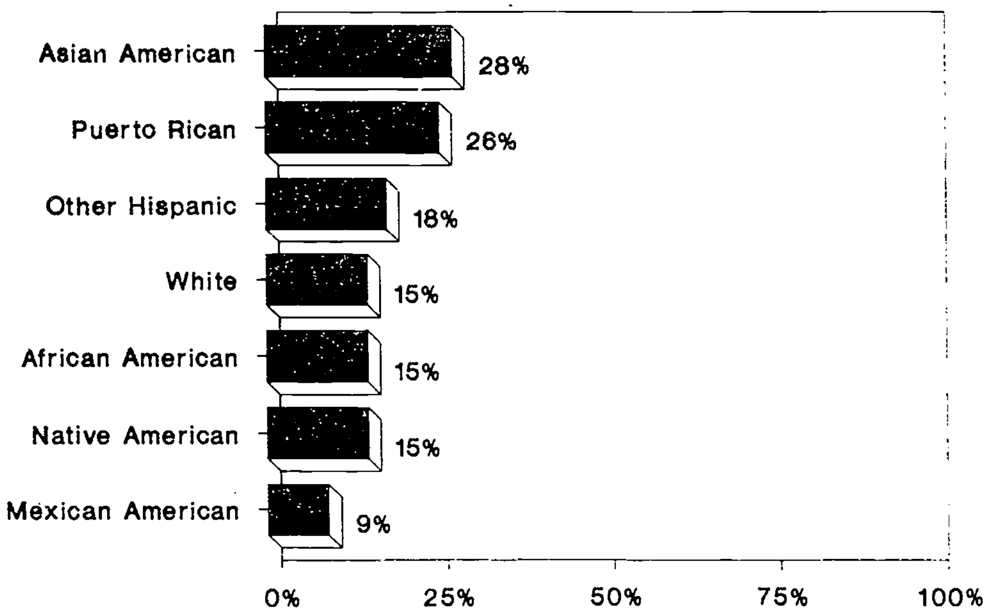
It is interesting to note that Puerto Rican students had a relatively high proportion of mothers in technical, mechanical, or scientific occupations, whereas fewer than the average number of fathers were in that type of work. The reverse pattern held for Native American parents. Native Americans had the second highest percentage of fathers in technical, mechanical, or scientific occupations and next to the lowest percentage of mothers. Among the other ethnic groups, father's and mother's rank orderings were about the same.

Nearly all respondents indicated that their parents approved of both their undergraduate and graduate fields of study. We found only the slightest difference among ethnic groups, and although the differences were statistically significant, they were quite small. They did, however, exhibit a pattern in which a slightly larger number of Asian Americans and Puerto Ricans indicated parental disapproval and slightly more Native Americans and Whites indicating approval. The differences among groups, though small, seem generally consistent with the relative discontent we observed among Asian Americans and the many positive responses reported by Native Americans.

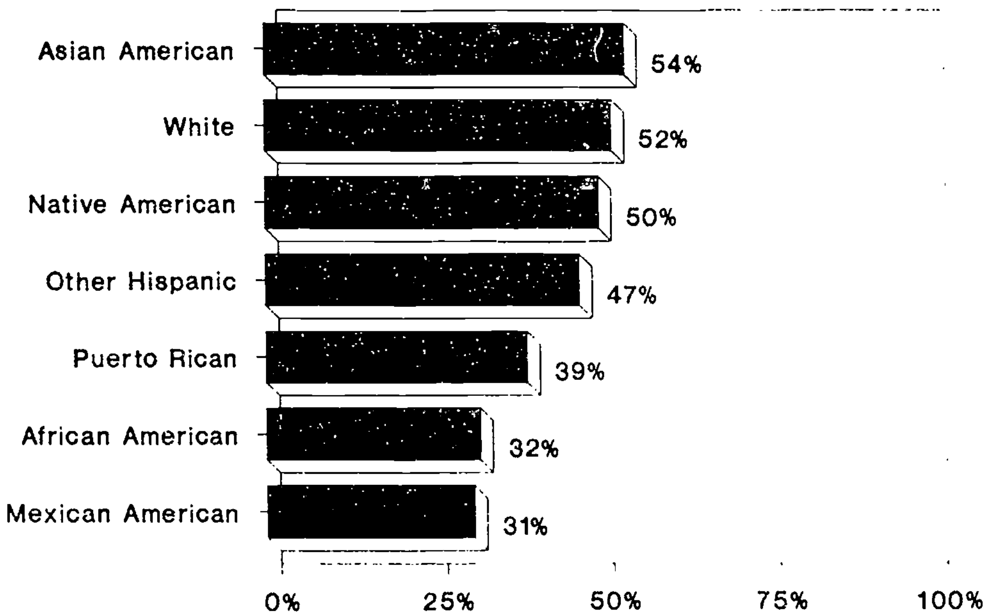
Ethnic Group Summary Profiles. Differences among the ethnic groups were more pronounced than differences between genders, though some ethnic groups stood out on only one or two characteristics.

Native American students had average GRE scores and grade point averages considerably lower than those of White students. Nevertheless, they reportedly enjoyed their coursework, including laboratory work, more than White students and did not find it more difficult. They rated essentially all of their academic skills considerably lower than Whites did. Nevertheless, they felt that their field offered many career possibilities and opportunities for advancement and a substantial

Mother Is in a Technical, Mechanical, or Scientific Occupation



Father Is in a Technical, Mechanical, or Scientific Occupation



income. Native Americans, more than most others, valued opportunities for advancement, prestige and respect, job security, and an opportunity to make a contribution to society.

Puerto Rican students indicated more than others did that homework had taken too much time, that coursework was more difficult than they had expected, and that their professors could not teach very well and showed little interest in students. They also seemed to be having more doubts about their chosen careers, feeling, more than others, that career opportunities were limited. Puerto Ricans also expected to earn the lowest salaries.

African Americans stood out in their expectation of the highest salaries. Consistent with that expectation was the confidence that there would be many jobs available to them, and that their field provided good opportunities for advancement and for a substantial income. They reportedly enjoyed their courses more than Whites did, but found the courses more difficult. African Americans had, on average, the lowest undergraduate grades, the lowest GRE quantitative scores, and the second lowest GRE verbal scores. This finding is consistent with the literature cited earlier, namely, that African Americans tend to have highly positive attitudes towards science (compared with Whites) yet low levels of achievement (compared with Whites).

African Americans showed the greatest preference for social interaction--the desire to work with people more than things and with words more than math. Consistent with that desire were their preferences for supervising or directing others, making presentations, advising, counseling, or interviewing, and persuading, negotiating, and selling. It is possible that their very high salary expectations were based on an intention to work in high levels of management, in a technical environment, and thus to earn higher salaries than the average Ph.D. scientist or engineer working in a laboratory. African Americans also reported having devoted the most time of any ethnic group to community and service activities while in college. This experience is consistent with their above average wish to make a contribution to society.

The Mexican American sample came from families with the least formal education, and they had lower GRE verbal scores and grade point averages than the White sample. They seemed to experience their undergraduate environment as more stressful than did the other ethnic groups, on the average. They found their courses more difficult, viewed their environment as more competitive, and their professors and fellow students as less supportive than did most other groups. They more often agreed that burnout was a real problem among students in their field and that people in their field have no real humanitarian concerns.

Mexican American students rated their reading, writing, and test taking skills lower than White students did. They showed the greatest preference for a job with a cooperative (rather than competitive) emphasis, and, more than most other groups, wanted a job using computers and mathematics. Mexican Americans valued, more than did Whites, a job offering prestige and respect, security, a physically attractive environment, and an opportunity to make a contribution to society. They were optimistic about career opportunities in their field, and felt, more than most others, that success would require good interpersonal skills.

Other Hispanics generally found coursework less enjoyable and more difficult than non-Hispanic Whites did. They rated quality of instruction lower as well as their relationships with instructors and with other students. Other Hispanics valued opportunities for advancement and having pleasant coworkers somewhat more highly than Whites did. Other Hispanics reacted more favorably than did Whites to most job activities, showing perhaps, a greater interest in and willingness to do a variety of activities.

Asian Americans had perhaps the most extreme profile of any ethnic group. Consistently, throughout the questionnaire, their responses were the least positive, whether referring to their undergraduate experiences, their own skills, or to their future and their career plans. Because their profile was so consistently different from the others, we have devoted some effort to explaining it.[12]

Blalock (1982) has developed the theory that if a minority is extremely small in comparison with the majority population, it is not likely to be noticed unless the majority finds its behaviors especially offensive. Minorities of a substantial size, he argues, may constitute a political and economic threat. In the case of Asian Americans, the White majority may resent the mathematical and scientific talent of their Asian colleagues, and view them as competition. Consistent with the view that Asian Americans are perceived as superior in science and mathematics (which is confirmed by GRE quantitative score averages) is the possibility that professors assume that they do not need the help and attention that other students need. Consequently, Asian Americans may interpret faculty confidence in their performance as neglect or indifference.

An additional explanation is that Asian American students may be under more pressure from family and feel that the demands on them are too great. This explanation is supported by their responses to the questionnaire item, "I am under pressure from my family to do graduate work in this field," to which they agreed far more strongly than did White students. In addition, the parents of Asian Americans had the most formal education and a large proportion were in scientific occupations. Ironically, a disproportionately high number of Asian Americans also indicated that their parents disapproved of their chosen field of study.[13]

In addition to the question raised by the Asian American profile, differences among ethnic groups were larger than the differences between genders. So we began a search for answers by attempting to identify possible differences in the undergraduate institutions attended by each ethnic group.

Attending Institutions. The ethnic analyses had shown some striking differences among groups; the group that stood out most from the others was Asian Americans. Because their ratings of their undergraduate experiences tended to be less positive than the ratings given by other ethnic groups, we examined the undergraduate institutions that members of each ethnic group were attending to see if the apparent ethnic differences might actually be reflections of institutional differences. For example, if Asian Americans attended large research institutions and Native Americans attended small private colleges, we might hypothesize that Asian Americans received less individual attention and encouragement than did Native Americans because of the type of institution they attended.

A count of undergraduate institutions showed that the sample of 1,508 students represented a total of 555 different colleges and universities. In fact, the number of institutions attended by each

[12]The questionnaire may have failed to ask important questions such as family and peer group influences on career decision making, questions that might have distinguished Asian Americans from others.

[13]For a general view of the career aspirations of Asian American students, refer to Leong (1985)

ethnic group was remarkably high, suggesting that the sample was quite representative of a variety of undergraduate environments. The exact number of institutions represented by each ethnic group was as follows:

	Number of Students	*Number of Institutions*
Native American or Alaskan Native	40	36
Black or African American	220	133
Mexican American or Chicano	57	39
Asian or Pacific American	225	108
Puerto Rican	37	19
Other Hispanic or Latin American	48	38
White (non-Hispanic)	881	430
All Ethnic Groups Combined	1,508	555

We listed the most frequently attended institutions for each ethnic group and did informal (i.e., non-statistical) comparisons to see if there were obvious differences that might explain differences in undergraduate experiences. It would have been possible to do a more rigorous comparison of attitudes and experiences by institutional type, size, and other characteristics, but such an extensive analysis had not been proposed for this project. Future research could examine these relationships.

Among Native Americans, there were nearly as many institutions represented as students, and they were colleges and universities that were attended by other ethnic groups as well. Therefore, the relatively positive experiences reported by Native Americans could not easily be explained by their having attended a specific institution or type of institution.

The relatively negative experiences reported by Asian Americans could not be explained entirely either. However, 40% of Asian Americans in the sample attended five institutions. These top five were University of California at Los Angeles, University of Michigan, Massachusetts Institute of Technology, University of Illinois, and University of California at Berkeley. These are all large research universities, and one might make the case that students receive less individual attention there, but such a claim remains to be demonstrated.

African Americans, not surprisingly, attended historically Black colleges and universities (HBCUs) in fairly large numbers. In fact, the top ten institutions did not include any institution attended by members of other ethnic groups. This observation suggests that the very optimistic view of employment opportunities and salary expectations may be a function of the Black college atmosphere. A hypothesis that Black science and engineering students attending HBCUs have higher career and salary expectations can be tested by further analysis of these data.

The 57 Mexican American students in the sample were fairly evenly spread over 39 institutions. No single institution contained more than two members of the Mexican American sample.

Forty-three percent of the Puerto Rican sample attended the University of Puerto Rico and therefore had a different undergraduate environment than the majority of other ethnic group members. Their questionnaire responses, however, did not suggest an unusual pattern of experiences, attitudes, or expectations, other than an anticipated lower salary and a suggestion that college was somewhat more demanding than they had expected.

The group identified as Other Hispanics also attended a large variety of institutions, including large research universities, and their questionnaire profiles were not unusual.

Possible Response Set for Asian Americans. We explored informally yet another hypothesis to explain why Asian Americans might have appeared less than enthusiastic about their field and their undergraduate experiences. Because many students marked extreme responses such as "strongly agree," we hypothesized that the Asian American sample, perhaps for cultural or other reasons, tended to respond less extremely to questionnaire items. They may, for example, simply "agree" with a statement, believing that "strongly agree" should be reserved for much more intense feeling.

In reviewing the Asian American questionnaire responses, we could not confirm this hypothesis from questionnaire data because there were some items Asian Americans rated very highly, such as their own math skills. But these items were rare.

We were unable to find literature suggesting that Asian Americans tend to interpret items differently or that they are more reserved in their evaluations. However, O'Neill found in his survey of students in twelve university-based divinity schools that Asian students consistently rated their program and their experiences less positively than did Black, Hispanic, or White students (personal communication). The greatest proportion of Asian students in that study were Korean, and the sample contained a mixture of U. S. born and foreign born. A typical question was, "The faculty support my vocational goals." On a 5-point Likert scale from "strongly disagree" to "strongly agree," only 47% of the Asian sample agreed or strongly agreed compared with 72% of the White sample. Using this method of scoring--combining both positive responses--collapses the scale and should reduce whatever effects there might be from a tendency toward "conservative" evaluation. The differences between the Asians and other groups were quite large, which suggests that the differences may be real--i.e., not a result of a conservative response set.

Results of our study and the O'Neill study suggest that research on scale differences across cultures is most important to do. If some groups are more reserved or more conservative in their ratings, we are erroneously attributing the differences between their mean responses and the mean responses of other groups to true differences in attitude. Psychometrically, what we may be observing is an instance in which the units of measurement are different for two different groups. To investigate this possibility would require some very careful and sophisticated psychometric exploration. As a beginning in such research, we could ask the same questions, allowing the 5-point Likert scale responses with half of a group and allowing only a binary response, "agree" or "disagree" with the other half. The binary response format should eliminate whatever scale differences there might be across cultures.

Until further research can be conducted to explain the relatively negative Asian American profile, we must be hesitant to draw conclusions based on survey data. At this point we have two competing hypotheses: either Asian Americans tend to be more conservative in their ratings, or, Asian Americans may be genuinely more critical and discontent with their educational experiences. If the latter is true, we need to search deeper to see if, perhaps, faculty are giving less support and attention to Asian American students, leaving them feeling somewhat neglected.

FUTURE RESEARCH

The findings from this study point to at least three areas in which future research might be conducted.

First, because the sample for this research was limited to GRE test takers from a single test administration, similar research should be conducted on new samples of students. The numbers of Puerto Rican, Mexican American, Other Hispanic, and Native American students were quite small. Furthermore, we know that the designation of "Native American" probably includes people other than American Indians. For this reason, we should be cautious in generalizing our findings based solely on these samples.

Second, we must continue to find an explanation for the relatively low test scores and grades achieved by African Americans and the extremely high positive attitudes towards science and optimism regarding careers in science and engineering.

Third, further research on this data base could shed some light on the relationships between types of undergraduate institutions attended by NSME students and their relative satisfactions, dissatisfactions, attitudes towards science and engineering, and perceptions of their future careers.

Fourth, there are sufficient numbers of African American students in this sample that we could explore differences between those who attended HBCUs and those in other types of institutions to determine whether the apparent optimism regarding the future salary and career potential is related to the type of institution attended. From these data, other values, attitudes, expectations, and undergraduate experiences could also be compared. Similarly, we could compare Puerto Rican students attending the University of Puerto Rico with those attending other colleges and universities.

Fifth, if we are to continue conducting attitudinal research across ethnic groups, we must explore further whether members of some cultures respond differently to ordinal questionnaire scales. The question of whether Asian Americans are truly less positive in their attitudes and experiences or whether they respond to questions in a more conservative manner must be resolved in order to interpret the Asian American profile correctly. This is important to understand, not only to clarify the results of this survey, but to interpret correctly any attitudinal research conducted on Asian Americans.

Sixth, the questions raised regarding Asian Americans could be investigated in greater depth, exploring family and peer influences on major field choice and pressure to achieve. This work could be done both with surveys and with in-depth interviews, comparing Asian Americans with students of other ethnic backgrounds.

Seventh, further research on Asian American students should collect information on country of origin, both of the student and of the parents. The present study combines people of Japanese, Chinese, Korean, Indian, and other very different cultures. Although the Asian Americans in this study indicate that they are U. S. citizens, we do not know whether they were born in the United States or elsewhere and where they received the bulk of their education. This information may be highly relevant to the interpretation of survey findings.

POLICY IMPLICATIONS

Our findings for each ethnic group could help to sensitize faculty to the different needs of students. Asian Americans, if in fact they are feeling neglected, could be given more attention by faculty. Faculty and counselors could look more carefully for signs of stress in Mexican American students. Information about salaries and job opportunities could be directed to African American students who seem to have unrealistically high salary expectations, and who are likely to be disillusioned when they begin applying for jobs. But perhaps more important than directing information or forms of support to specific groups, it would be more valuable to direct that support to all NSME students.

By responding to a profile that typifies any particular group, we run the risk of stereotyping that group. For this reason, it is important to emphasize that for nearly all variables, males and females and all ethnic groups provided the full range of responses. There were some females who preferred to work only with things and not with people; there were African American students with very high GRE scores and grades; and there were Asian American students who were enthusiastic about their undergraduate experiences. Some Mexican American students had highly educated parents, and some African American students expected to earn low salaries.

It is essential to realize that among NSME students, there are a wide range of abilities, experiences, attitudes, values, and job preferences. Each person essentially has his or her own profile. In an ideal employment world, each student could be matched with the job that best fits that individual profile. At this point in history, the job-seeking process is still rather haphazard. Students often attempt to tailor their own skills and personalities to fit what they believe employers want.

Perhaps one of the most valuable outcomes of this research is the realization that people in NSME are extremely variable, whether we focus on differences between individuals or differences among groups. For these people to find career satisfaction, they will eventually have to match their own profiles with the activities and requirements of specific jobs. We have seen from the question on salary expectation that many people have unrealistic expectations Undoubtedly, they have equally unreal expectations of other job and career characteristics.

The undergraduate science and engineering curricula are "densely packed" with technical coursework that must be covered in four or five years. There is little space for nonessential courses. Yet many students are graduating having little realistic knowledge of their career options and the vast variety of employment environments available to them. Many may be operating, to some extent, on stereotypes perpetrated by the media. Communication specialist George Gerbner, dean of the Annenburg School of Communications at the University of Pennsylvania, argues that television entertainment programming encourages hostile public conceptions of science (Gerbner, 1987). In a *Science* editorial, Abelson (1990) commented, "For most of the public, the word 'chemical' now elicits antipathy and fear." Also, it has become evident that a large segment of our society no longer glorifies science, and events such as Earth Day highlight the public perception of scientists as makers of problems, not solvers of problems.

One move that colleges and universities could make would be to organize seminars on jobs in NSME. Speakers could be from industry and government, and their purpose would be to discuss the realities of the workplace. Emphasis should be placed on the many possibilities for scientists and engineers, and every attempt should be made to avoid stereotyping the professions. Some of us attended college at a time when the message was, "This is the way you have to be if you want to be a scientist," and, "If you like people, don't be a physicist." Stereotyping jobs can serve only to reduce the variety of types of people aspiring to those jobs. Again, the emphasis could be on variety of jobs available and the variety of people needed for those jobs. It is only through education and improved communications that students will learn to match their abilities and personalities to appropriate careers.

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Appendix A

GRE Background Questionnaire

GRE®

GRADUATE RECORD EXAMINATIONS
GRADUATE STUDENT LOCATER SERVICE
MINORITY GRADUATE STUDENT LOCATER SERVICE

REGISTRATION FORM OCT. 1, 1990 - SEPT. 30, 1991
INTERNATIONAL ADMINISTRATIONS

PAGE 1

GENERAL DIRECTIONS:
This form will be machine processed and may be returned to you if it is not completed properly or if the correct fee is not enclosed. For your information to be recorded accurately, please use a **No. 2 soft-lead pencil** (not ink) to print information in the boxes. **Completely fill in the ovals** corresponding to the letters and numbers you printed. **Check the accuracy of the ovals** you filled in, and **erase any errors completely.** Be sure to **complete page 4.** To avoid delay, do not enclose a letter.

1. IMPORTANT: I AM USING THIS FORM TO REGISTER FOR (fill in all that apply)

Please read the registration instructions in the **Bulletin** before completing all four pages of this form.

- O GRE test(s)
- O Graduate Student Locater Service
- O Minority Graduate Student Locater Service

LOCATER SERVICE: The registration deadline for the **last** 1990-91 search is May 7, 1991.

2. NAME

Omit spaces, apostrophes, and Jr., II, etc.

Last Name (Family or Surname) - first 15 letters | First Name (Given) - first 12 letters | MI

3. TEST DATE

Fill in only one oval.

- 1 O Oct 13, 1990*
- 2 O Dec 8, 1990
- 3 O Feb 2, 1991
- 4 O Apr 13, 1991*
- 5 O June 1, 1991 (General Test Only)

*General Test is not available in New York or other states with test disclosure laws.

4. DATE OF BIRTH

Month: O Jan O Feb O Mar O Apr O May O June O July O Aug O Sept O Oct O Nov O Dec | Day | Year

5. U.S. SOCIAL SECURITY NUMBER

See the Bulletin.

6. TEST CENTER

FIRST CHOICE | SECOND CHOICE

Enter at least one test center code and fill in the corresponding ovals

PLEASE PRINT.
FIRST CHOICE - Name, City, State or Province, Country

SECOND CHOICE - Name, City, State or Province, Country

7. TEST(S) TO BE TAKEN

O **I am registering for the GENERAL TEST.**
General Test is not available in October or April in New York or in other states with test disclosure laws

I am registering for one SUBJECT TEST as marked below. (Indicate which test by filling in the appropriate oval. These are not major field codes; fill in an oval below only if you are registering for a Subject Test.) No Subject Tests are given in June

- *B22 O - Biochemistry, Cell and Molecular Biology
- B24 O - Biology
- C27 O - Chemistry
- C29 O - Computer Science
- E31 O - Economics
- E34 O - Education
- E37 O - Engineering
- G47 O - Geology
- H57 O - History
- L64 O - Literature in English
- M67 O - Mathematics
- **M72 O - Revised Music
- P77 O - Physics
- P79 O - Political Science
- P81 O - Psychology
- S87 O - Sociology

*B22 offered Oct. & Dec. only
**M72 offered Oct. & April only

8. SEX

- 1 O Male
- 2 O Female

9. SEATING

Would you prefer left-handed seating if available?

- O YES
- O NO

10. CURRENT EDUCATIONAL STATUS

- 2 O Sophomore (second year)
- 3 O Junior (third year)
- 4 O Senior (fourth or final year)
- 5 O First-Year Graduate Student
- 6 O Second-Year Graduate Student
- 7 O Unenrolled (College Graduate)
- 8 O Unenrolled (Master's Degree)
- 9 O Other

11. UNDERGRADUATE INSTITUTION

INSTITUTION | DEPT. | R

Using the Institution Code List in the Bulletin, enter the code for your current or most recent undergraduate institution.

GRE REGISTRANTS:

IF YOU WANT YOUR GRE SCORES SENT TO THE *GRADUATE* SCHOOL AT THIS INSTITUTION, ENTER THE CODE AGAIN IN ITEM 12

Complete only if registering for the tests. If you do not indicate otherwise, both General and Subject Test scores will be sent to this institution.

- 1 O Both General and Subject scores
- 2 O General scores only
- 3 O Subject scores only
- 4 O No scores

12. SCORE REPORT RECIPIENTS

(Refer to registration instructions in the **Bulletin**). Both General and Subject Test scores will be sent if you do not indicate otherwise.

1 INSTITUTION | DEPT. | R
2 INSTITUTION | DEPT. | R
3 INSTITUTION | DEPT. | R
4 INSTITUTION | DEPT. | R

SEND THE FOLLOWING SCORES FROM MY CUMULATIVE GRE RECORD

- 1 O Both General and Subject scores
- 2 O General scores only
- 3 O Subject scores only

BEST COPY AVAILABLE

13. BACKGROUND INFORMATION

If you are registering for a Locater Service, it is to your benefit to respond to these questions.

a. What is your current citizenship status?

1 United States citizen
2 Resident alien ("permanent resident") in the United States
3 Neither a United States citizen nor a resident alien

b. Find your country code from the list in the **Bulletin** and enter it in the boxes and fill in the corresponding ovals. Enter 000 if you are a U.S. citizen.

c. In the State and Territories Code List in the **Bulletin**, find the code number for the state or U.S. Territory you consider your permanent residence.
(U.S. citizens and "permanent residents" only)

d. How do you describe yourself?
Fill in only one oval (U.S. citizens only)

1 Native American or Alaskan Native
2 Black or African American
3 Mexican American or Chicano
4 Asian or Pacific American
5 Puerto Rican
6 Other Hispanic or Latin American
7 White (non Hispanic)
8 Other

e. Please indicate any permanently disabling conditions you have
(Fill in only one oval.)

1 None
2 Blindness or other visual impairment
3 Deafness or other hearing impairment
4 Physical handicap
5 Learning disability
6 Multiple handicaps
7 Other

f. What is (are) your reason(s) for taking the GRE Test(s)? (Select all that apply.)

	General Test	Subject Test
1 Admission to graduate school	O	O
2 A fellowship/scholarship application requirement	O	O
3 An undergraduate program exit requirement	O	O
4 An external degree program	O	O
5 Practice	O	O
6 A graduate department requirement	O	O
7 Other	O	O

g. Do you plan to attend (or if enrolled, are you attending) graduate school full time or part time?

1 Full time
2 Part time
3 Undecided

h. What is the highest educational level you will have attained by the date of the test or Locater Service Search for which you are registering?

1 Still an undergraduate
2 Earned bachelor's degree
3 Graduate credit not toward a degree
4 Graduate credit toward a master's degree
5 Earned master's degree
6 Graduate credit toward a doctoral degree
7 Earned doctorate

i. In what calendar year did you receive or do you expect to receive your bachelor's degree?
(Fill in completely the ovals that correspond to the last two digits of the year.)

1 9

j. Referring to the Major Field Code List, find your undergraduate major field of study.

k. What is your eventual graduate degree objective?

1 Nondegree graduate study
2 Master's (M.A., M.S., M.Ed.)
3 Intermediate (such as Specialist)
4 Doctorate (Ph.D., Ed.D.)
5 Postdoctoral study
6 Not currently planning graduate study

l. Referring to the Major Field Code List, find the field in which you plan to do your graduate work. If you are undecided, use: 0000.

m. What is or was your **overall undergraduate** grade point average?

1 D or lower
2 C-
3 C
4 B-
5 B
6 A-
7 A

n. Indicate how many courses you have taken as an undergraduate in each of the following subject areas, including courses being taken currently. (Use the course definition at your undergraduate institution.)

Subject Area	None	1-2	3-6	7-9	10+
A. SCIENCE					
1 Architecture	O	O	O	O	O
2 Biological Sciences	O	O	O	O	O
3 Chemistry	O	O	O	O	O
4 Computer Science	O	O	O	O	O
5 Engineering	O	O	O	O	O
6 Geology	O	O	O	O	O
7 Mathematics	O	O	O	O	O
8 Physics	O	O	O	O	O
9 Statistics	O	O	O	O	O
10 Other Science	O	O	O	O	O
B. BUSINESS AND COMMERCE					
1 Accounting	O	O	O	O	O
2 Management	O	O	O	O	O
3 Marketing	O	O	O	O	O
4 Other Business and Commerce	O	O	O	O	O
C. HUMANITIES					
1 English	O	O	O	O	O
2 Fine Arts	O	O	O	O	O
3 Foreign Language	O	O	O	O	O
4 Philosophy	O	O	O	O	O
5 Other Humanities	O	O	O	O	O
D. SOCIAL SCIENCE					
1 Anthropology	O	O	O	O	O
2 Economics	O	O	O	O	O
3 Education	O	O	O	O	O
4 History	O	O	O	O	O
5 Political Science	O	O	O	O	O
6 Psychology	O	O	O	O	O
7 Sociology	O	O	O	O	O
8 Other Social Science	O	O	O	O	O
E. OTHER					
Other Subject Areas	O	O	O	O	O

o. Do you communicate better (or as well) in English than in any other language?

Yes No

p. Have you applied for a National Fellowship?

Yes No

q. What is your native (or best) language of communication? Use the list in the **Bulletin**. The languages are arranged in alphabetical order for your convenience. If your native language is English use code 422. If you do not find your native (or best) language listed, use code 000.

r. Indicate the highest level of education completed by your father or male guardian and your mother or female guardian. (Select only one in each column.)

	Father	Mother
1. Grade school or less	O	O
2. Some high school	O	O
3. High school diploma or equivalent	O	O
4. Business or trade school	O	O
5. Some college	O	O
6. Associate degree	O	O
7. Bachelor's degree	O	O
8. Some graduate or professional school	O	O
9. Graduate or professional degree	O	O

s. As of the GRE test or Locater Service Search date for which you are registering, how many years of full-time work experience and/or active military service will you have had?

1 None
2 Summer(s)
3 Less than one year
4 One year or more but less than three years
5 More than three years but less than five years
6 More than five years but less than seven years
7 More than seven years

t. Have you ever written a book or an article that appeared in a professional journal or other national publication?

Yes No

u. Have you been elected to membership in any national academic honor society (e.g., Phi Beta Kappa, Sigma Xi)?

Yes No

v. Have you applied or do you plan to apply for financial aid at any graduate school?

Yes No Not sure

w. Is your enrollment or continuing attendance in graduate school dependent upon your receiving financial aid?

Yes No Not sure

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x. Indicate how you prepared or are preparing for the GRE test(s). (Select all that apply.)

	General Test	Subject Test
1. By studying the sample questions in the **GRE Information Bulletin** and/or GRE Subject Test Descriptive Booklet(s)	O	O
2. By working through an actual GRE test published by ETS	O	O
3. By using a book on how to prepare for the GRE Test(s) not published by ETS	O	O
4. By attending a test preparation or coaching course	O	O
5. By using GRE test preparation software published by ETS	O	O
6. By using GRE test preparation software not published by ETS	O	O
7. Self-study	O	O
8. Other preparation	O	O
9. No preparation	O	O

y. Is there any one geographic region in which you would prefer to attend graduate school? (Select only one.)

1 O New England (Connecticut, Maine, Massachusetts, New Hampshire, Rhode Island, Vermont)
2 O Mid-Atlantic (Delaware, District of Columbia, Maryland, New Jersey, New York, Pennsylvania)
3 O South (Alabama, Florida, Georgia, Kentucky, Louisiana, Mississippi, North Carolina, South Carolina, Tennessee, Virginia, West Virginia)
4 O Midwest (Illinois, Indiana, Iowa, Kansas, Michigan, Minnesota, Missouri, Nebraska, North Dakota, Ohio, South Dakota, Wisconsin)
5 O Southwest (Arizona, Arkansas, New Mexico, Oklahoma, Texas)
6 O West (Alaska, California, Colorado, Hawaii, Idaho, Montana, Nevada, Oregon, Utah, Washington, Wyoming)
7 O Any region would be acceptable

z. **In courses in your undergraduate major field only, what grade average have you received so far?** (If your college does not use letter grades, please mark the letter grade that is the closest equivalent to your grade average.)

1 O D or lower
2 O C-
3 O C
4 O B-
5 O B
6 O A-
7 O A

DO NOT WRITE IN THIS AREA. FOR ETS USE ONLY.

FOR ETS USE ONLY

aa. Considering **only your last two college years**, approximately what overall grade average have you received? (If your college does not use letter grades, please mark the letter grade that is the closest equivalent to your grade average.)

1 O D or lower
2 O C-
3 O C
4 O B-
5 O B
6 O A-
7 O A

bb. About how many hours per week did you spend working for wages during your most recent school year?

1 O 0
2 O 1 – 5
3 O 6 – 10
4 O 11 – 20
5 O More than 20

cc. About how many hours per week did you spend in community service activities during your most recent school year?

1 O 0
2 O 1 – 5
3 O 6 – 10
4 O 11 – 20
5 O More than 20

dd. In which of the following areas have you received your most important honor, award, prize, or other recognition? (Select one only.)

1 O Student government or organization
2 O Professional - an award or prize for field work or publication of a scholarly article or book
3 O Community service - election or appointment to a community service unit, activity, or group
4 O Literary - editing the college paper, yearbook, or literary magazine or having a poem, story, or article published in a public paper or magazine
5 O Artistic - a high rating in a music contest, a part in a play, opera, or show, or an award in an art competition
6 O Scientific - an award or recognition in a science competition
7 O Athletic - a letter in athletics
8 O None of the above categories

ee. If you took the Test of English as a Foreign Language (TOEFL), what was your Total Score?

15. REMITTANCE

ENTER DOLLARS AND FILL IN OVALS FOR TOTAL AMOUNT ENCLOSED

(If less than $100, fill in leading 0) – DO NOT SEND CASH OR FOREIGN CURRENCY. ETS cannot be held responsible for loss of cash payments. Refer to the Registration Instructions for acceptable methods of payment.

Make remittance payable to Graduate Record Examinations.

DOLLARS

14. TESTS, PUBLICATIONS, and FEES

Fill in the ovals and dollar amounts for all items that apply.

		Fee	AMOUNT
TEST FEES			
	O General Test	$35	$
	O Subject Test	$35	$
	O Test center surcharge for testing in India, Japan, Korea, and Taiwan	Add $20	$
	O Test center surcharge for testing in other locations outside of the U.S., Puerto Rico, and U.S. Territories	Add $15	$
	O Late Registration (U.S. and P.R. only)	Add $15	$
	O Standby Registration	Add $30	$
Test Disclosure Service →	O Test Disclosure Service	$11	$
Available for the General Test administered on December 8 & 10, 1990, February 2 & 4, 1991 and June 1, 1991. See the **Bulletin.** (U.S. postage included)	**Practicing to Take the GRE Tests.**		
	O General Test – No.8	$12	$
	O General Test – No.7	$10	$
PUBLICATIONS — Fill in the oval and dollar amount for each publication ordered. (U.S. postage included)	O Biology – 2nd Edition	$11	$
	O Chemistry – 2nd Edition	$11	$
	O Computer Science – No. 1	$ 9	$
	O Economics – No. 1	$ 9	$
	O Education – 2nd Edition	$11	$
	O Engineering – 2nd Edition	$11	$
If you do not fill in the oval for the publication you are ordering, it will not be shipped and any fee submitted will be refunded.	O Geology – No. 1	$ 9	$
	O History – No. 1	$ 9	$
	O Literature in English – 2nd Edition	$11	$
	O Mathematics – No. 1	$ 9	$
	O Music – Revised	$ 9	$
	O Physics – No. 1	$ 9	$
	O Political Science – No. 1	$ 9	$
	O Psychology – 2nd Edition	$11	$
	O Sociology – No.1	$ 9	$
Software (Includes Practicing to Take the GRE General Test – No. 7) $70 each (U.S. postage included)	O IBM Edition	$70	$
	O Macintosh Edition	$70	$
Directory of Graduate Programs: 1990 & 1991 — $14 each (U.S. postage included)	O Volume A: Agriculture, Biological Sciences, Psychology, Health Sciences, and Home Economics	$14	$
	O Volume B: Arts and Humanities	$14	$
	O Volume C: Physical Sciences, Mathematics, and Engineering	$14	$
	O Volume D: Social Sciences and Education	$14	$
POSTAGE AND HANDLING FOR PUBLICATIONS — Postage and handling for addresses in North America, U.S. Territories and APO addresses is included in the price of publications.	**Postage and handling for all other addresses:**		
	O First book	$ 4	$
	O ______ (number) additional books x	$ 2	$
	O Software (each set)	$10	$
Fill in TOTAL DOLLAR amounts in both places for accurate processing →	ENTER TOTAL REMITTANCE ENCLOSED		$

PAGE 3

DEPARTMENT CODE LIST FOR ITEMS 11 AND 12 ON THE REGISTRATION FORM AND MAJOR FIELD CODE LIST FOR ITEMS 13-j AND 13-l ON THE REGISTRATION FORM

NATURAL SCIENCES

Agriculture
- 0101 Agricultural Economics
- 0102 Agricultural Production
- 0103 Agricultural Sciences
- 0104 Agronomy
- 0105 Animal Sciences
- 0106 Fishery Sciences
- 0107 Food Sciences
- 0108 Forestry and Related Sciences
- 0109 Horticulture
- 0111 Parks and Recreation Management
- 0112 Plant Sciences (Except Agronomy, see 0104)
- 0113 Renewable Natural Resources
- 0110 Resource Management
- 0114 Soil Sciences
- 0115 Wildlife Management
- 0199 Agriculture — Other

Biological Sciences
- 0201 Anatomy
- 0221 Bacteriology
- 0202 Biochemistry
- 0203 Biology
- 0204 Biometry
- 0222 Biophysics
- 0205 Botany
- 0206 Cell and Molecular Biology
- 0207 Ecology
- 0208 Embryology
- 0209 Entomology and Parasitology
- 0210 Genetics
- 0211 Marine Biology
- 0212 Microbiology
- 0213 Neurosciences
- 0214 Nutrition
- 0215 Pathology
- 0216 Pharmacology
- 0217 Physiology
- 0218 Radiobiology
- 0219 Toxicology
- 0220 Zoology
- 0299 Biological Sciences — Other

Chemistry
- 0302 Analytical Chemistry
- 0301 Chemistry, General
- 0303 Inorganic Chemistry
- 0304 Organic Chemistry
- 0305 Pharmaceutical Chemistry
- 0306 Physical Chemistry
- 0399 Chemistry — Other

Computer and Information Sciences
- 0401 Computer Programming
- 0402 Computer Sciences
- 0403 Data Processing
- 0404 Information Sciences
- 0405 Microcomputer Applications
- 0406 Systems Analysis
- 0499 Computer Sciences — Other

Earth, Atmospheric, and Marine Sciences
- 0501 Atmospheric Sciences
- 0502 Environmental Sciences
- 0503 Geochemistry
- 0504 Geology
- 0505 Geophysics and Seismology
- 0507 Meteorology
- 0508 Oceanography
- 0506 Paleontology
- 0599 Earth, Atmospheric, and Marine Sciences — Other

Health and Medical Sciences
- 0601 Allied Health
- 0602 Audiology
- 0603 Chiropractic
- 0604 Dental Sciences
- 0605 Environmental Health
- 0606 Epidemiology
- 0607 Health Science Administration
- 0608 Immunology
- 0609 Medical Sciences
- 0621 Medicinal Chemistry
- 0610 Nursing
- 0618 Occupational Therapy
- 0611 Optometry
- 0612 Osteopathic Medicine
- 0613 Pharmaceutical Sciences
- 0619 Physical Therapy
- 0614 Podiatry
- 0615 Pre-Medicine
- 0616 Public Health
- 0620 Speech/Language Pathology
- 0617 Veterinary Medicine
- 0622 Veterinary Science
- 0699 Health and Medical Sciences — Other

Mathematical Sciences
- 0701 Actuarial Sciences
- 0702 Applied Mathematics
- 0703 Mathematics
- 0704 Probability & Statistics
- 0799 Mathematical Sciences — Other

Physics and Astronomy
- 0801 Astronomy
- 0802 Astrophysics
- 0803 Atomic/Molecular Physics
- 0804 Nuclear Physics
- 0805 Optics
- 0808 Physics
- 0806 Planetary Science
- 0807 Solid State Physics
- 0899 Physics and Astronomy — Other

Natural Sciences — Other
- 0999 Natural Sciences — Other

ENGINEERING

Engineering — Chemical
- 1001 Chemical Engineering
- 1002 Pulp and Paper Production
- 1003 Wood Science
- 1099 Chemical Engineering — Other

Engineering — Civil
- 1101 Architectural Engineering
- 1102 Civil Engineering
- 1103 Environmental/Sanitary Engineering
- 1199 Civil Engineering — Other

Engineering — Electrical and Electronics
- 1202 Communications Engineering
- 1201 Computer Engineering
- 1203 Electrical Engineering
- 1204 Electronics Engineering
- 1299 Electrical & Electronics Engineering — Other

Engineering — Industrial
- 1301 Industrial Engineering
- 1302 Operations Research
- 1399 Industrial Engineering — Other

Engineering — Materials
- 1401 Ceramic Engineering
- 1402 Materials Engineering
- 1403 Materials Science
- 1404 Metallurgical Engineering
- 1499 Materials Engineering — Other

Engineering — Mechanical
- 1501 Engineering Mechanics
- 1502 Mechanical Engineering
- 1599 Mechanical Engineering — Other

Engineering — Other
- 1601 Aerospace Engineering
- 1602 Agricultural Engineering
- 1603 Biomedical Engineering
- 1604 Engineering Physics
- 1605 Engineering Science
- 1606 Geological Engineering
- 1607 Mining Engineering
- 1608 Naval Architecture and Marine Engineering
- 1609 Nuclear Engineering
- 1610 Ocean Engineering
- 1611 Petroleum Engineering
- 1612 Systems Engineering
- 1613 Textile Engineering
- 1699 Engineering — Other

SOCIAL SCIENCES

Anthropology & Archaeology
- 1701 Anthropology
- 1702 Archaeology

Economics
- 1802 Econometrics
- 1801 Economics

Political Science
- 1901 International Relations
- 1902 Political Science and Government
- 1903 Public Policy Studies
- 1999 Political Science — Other

Psychology
- 2001 Clinical Psychology
- 2002 Cognitive Psychology
- 2003 Community Psychology
- 2004 Comparative Psychology
- 2005 Counseling Psychology
- 2006 Developmental Psychology
- 2007 Experimental Psychology
- 2008 Industrial and Organizational Psychology
- 2009 Personality Psychology
- 2010 Physiological Psychology
- 2011 Psycholinguistics
- 2016 Psychology
- 2012 Psychometrics
- 2013 Psychopharmacology
- 2014 Quantitative Psychology
- 2015 Social Psychology
- 2099 Psychology — Other

Sociology
- 2101 Demography
- 2102 Sociology

Social Sciences — Other
- 2206 American Studies
- 2201 Area Studies
- 2202 Criminal Justice/Criminology
- 2203 Geography
- 2207 Gerontology
- 2204 Public Affairs
- 2205 Urban Studies
- 2299 Social Sciences — Other

HUMANITIES AND ARTS

Arts — History, Theory, and Criticism
- 2301 Art History and Criticism
- 2302 Music History, Musicology, and Theory
- 2399 Arts — History, Theory, and Criticism — Other

Arts — Performance and Studio
- 2401 Art
- 2402 Dance
- 2405 Design
- 2403 Drama/Theatre Arts
- 2406 Fine Arts
- 2404 Music
- 2499 Arts — Performance and Studio — Other

English Language and Literature
- 2502 American Language and Literature
- 2503 Creative Writing
- 2501 English Language and Literature
- 2599 English Language and Literature — Other

Foreign Languages and Literatures
- 2601 Asian Languages
- 2609 Classical Languages
- 2602 Foreign Literature
- 2603 French
- 2604 Germanic Languages
- 2605 Italian
- 2606 Russian
- 2607 Semitic Languages
- 2608 Spanish
- 2699 Foreign Languages — Other

History
- 2701 American History
- 2702 European History
- 2703 History of Science
- 2799 History — Other

Philosophy
- 2801 All Philosophy Fields

Humanities and Arts — Other
- 2901 Classics
- 2902 Comparative Language and Literature
- 2903 Linguistics
- 2904 Religious Studies
- 2999 Humanities and Arts — Other

EDUCATION

Education — Administration
- 3001 Educational Administration
- 3002 Educational Supervision

Education — Curriculum and Instruction
- 3101 Curriculum and Instruction

Education — Early Childhood
- 3201 Early Childhood Education

Education — Elementary
- 3301 Elementary Education
- 3302 Elementary Level Teaching Fields

Education — Evaluation and Research
- 3403 Educational Psychology
- 3401 Educational Statistics and Research
- 3402 Educational Testing, Evaluation, and Measurement
- 3404 Elementary and Secondary Research
- 3405 Higher Education Research
- 3406 School Psychology

Education — Higher
- 3501 Educational Policy
- 3502 Higher Education

Education — Secondary
- 3601 Secondary Education
- 3602 Secondary Level Teaching Fields

Education — Special
- 3701 Education of Gifted Students
- 3702 Education of Handicapped Students
- 3703 Education of Students with Specific Learning Disabilities
- 3704 Remedial Education
- 3705 Special Education
- 3799 Special Education — Other

Education — Student Counseling and Personnel Services
- 3801 Personnel Services
- 3802 Student Counseling

Education — Other
- 3901 Adult and Continuing Education
- 3908 Agricultural Education
- 3902 Bilingual/Crosscultural Education
- 3903 Educational Media
- 3904 Junior High/Middle School Education
- 3909 Physical Education
- 3905 Pre-Elementary Education
- 3906 Social Foundations
- 3907 Teaching English as a Second Language/Foreign Language
- 3910 Vocational/Technical Education
- 3999 Education — Other

BUSINESS

Accounting
- 4001 Accounting
- 4002 Taxation

Banking and Finance
- 4101 Commercial Banking
- 4102 Finance
- 4103 Investments and Securities

Business Administration and Management
- 4201 Business Administration and Management
- 4202 Human Resource Development
- 4203 Institutional Management
- 4204 Labor/Industrial Relations
- 4205 Management Science
- 4206 Organizational Behavior
- 4207 Personnel Management
- 4299 Business Management — Other

Business — Other
- 4301 Business Economics
- 4302 International Business Management
- 4303 Management Information Systems
- 4304 Marketing and Distribution
- 4305 Marketing Management and Research
- 4399 Business — Other

OTHER FIELDS

Architecture and Environmental Design
- 4401 Architecture
- 4402 City and Regional Planning
- 4403 Environmental Design
- 4404 Interior Design
- 4405 Landscape Architecture
- 4406 Urban Design
- 4499 Architecture and Environmental Design — Other

Communications
- 4501 Advertising
- 4502 Communications Research
- 4503 Journalism and Mass Communications
- 4504 Public Relations
- 4505 Radio, TV, and Film
- 4506 Speech Communication
- 4599 Communications — Other

Home Economics
- 4601 Consumer Economics
- 4603 Family Counseling
- 4602 Family Relations
- 4699 Home Economics — Other

Library and Archival Sciences
- 4702 Archival Science
- 4701 Library Science

Public Administration
- 4801 Public Administration

Religion and Theology
- 4903 Ordained Ministry/Rabbinate
- 4901 Religion
- 4902 Theology

Social Work
- 5001 Social Work

Other Fields
- 5101 Interdisciplinary Programs
- 5102 Law
- 5199 Any Department Not Listed

Appendix B

Codes Defining Science/Engineering Areas

The mathematics, natural sciences, and engineering codes used in this study were based on the department code list in the GRE background questionnaire (last page of Appendix A). Undergraduates specifying the following major field codes were selected for this study:

0201 - 0299	Biological sciences
0301 - 0399	Physical sciences
0801 - 0899	Physical sciences
0401 - 0499	Computer sciences
0501 - 0599	Earth sciences
0701 - 0799	Mathematical sciences
1001 - 1699	Engineering

Appendix C

Survey of Science, Mathematics, and Engineering Majors

EDUCATIONAL TESTING SERVICE PRINCETON, N.J. 08541

609-921-9000
609-734-1090 (Fax)
CABLE-EDUCTESTSVC

DIVISION OF APPLIED
MEASUREMENT RESEARCH

January 1991

Dear GRE Test Taker:

Recently, several federal agencies and national panels have predicted a shortage of graduate-level talent in some fields of science and engineering. In light of this concern, the Graduate Record Examinations (GRE) Board is currently sponsoring a study to determine more about the bases on which undergraduate science and engineering majors decide upon a graduate field of study.

We are writing to you because, when you registered to take the GRE recently, you indicated that you are currently a science or engineering major. This questionnaire asks about your undergraduate experiences, your thoughts about a career, and your plans for graduate school. Completing the questionnaire will probably take about 15 minutes. We hope that the time you devote to filling out the questionnaire will also benefit you by helping you clarify your own thoughts and feelings about your future.

All of your responses will be kept confidential. The statistical findings from this research will be published by the GRE Board, and we expect the educational and scientific community to be greatly interested in the information that you and your fellow students can provide.

If you have any questions about the project, feel free to call me at 609-734-5548.

Thank you for your participation.

Sincerely,

Jerilee Grandy

Jerilee Grandy
Project Director

SURVEY OF SCIENCE, MATHEMATICS, AND ENGINEERING MAJORS

UNDERGRADUATE STUDIES

A. The following statements, both positive and negative, are often made by students describing their undergraduate experiences. Please read each statement carefully regarding the field or department in which you are majoring, and indicate how much you agree or disagree by circling the appropriate number.

	STRONGLY AGREE	AGREE	NOT SURE/ NEUTRAL	DISAGREE	STRONGLY DISAGREE
I have enjoyed courses in my major better than most other subjects................	1	2	3	4	5
Many labs have been taught by teaching assistants who were unsure of themselves...	1	2	3	4	5
Students have generally been helpful to one another..............................	1	2	3	4	5
Homework has taken too much time..	1	2	3	4	5
Course work in my major has convinced me <u>not</u> to do graduate work in that field....	1	2	3	4	5
Subjects in my major field have been more difficult than I expected...............	1	2	3	4	5
I have enjoyed laboratory work..	1	2	3	4	5
Career opportunities in this field are very limited...............................	1	2	3	4	5
I enjoyed science more in high school than I have in college......................	1	2	3	4	5
The atmosphere among students in my department has been competitive...............	1	2	3	4	5
I have a lot in common with other students in my department.......................	1	2	3	4	5
Courses have sometimes been obstacles rather than vehicles for learning...........	1	2	3	4	5
One or more professors have encouraged me to do graduate work in this field.......	1	2	3	4	5
I enjoyed math more in high school than in college................................	1	2	3	4	5
Many of my professors could not teach very well...................................	1	2	3	4	5
I feel I could make a real contribution in this field.............................	1	2	3	4	5
Many professors in my department do not know me...................................	1	2	3	4	5
If I were starting over again, I would major in this same field...................	1	2	3	4	5
Burnout is a real problem for majors in my field..................................	1	2	3	4	5
The competition in labs has been so fierce that some students have sabotaged the experiments of others..................................	1	2	3	4	5
My instructors have encouraged me to continue in this field.......................	1	2	3	4	5
I have difficulty imagining myself as a scientist or an engineer..................	1	2	3	4	5
I have high regard for the other students in my department........................	1	2	3	4	5
Most of my professors have little interest in students............................	1	2	3	4	5
Most people in this field have no real humanitarian concerns......................	1	2	3	4	5
Courses in my major have turned out to be very different from what I expected.....	1	2	3	4	5
If I missed a lecture, I could always get notes from someone else.................	1	2	3	4	5
All important courses have been taught by knowledgeable faculty...................	1	2	3	4	5

B. Please rate each of the following aspects of the department or program in which you have majored.

	EXCELLENT	GOOD	FAIR	POOR
Intellectual environment	1	2	3	4
Curricular and career advising	1	2	3	4
Laboratory facilities	1	2	3	4
Scholarly and professional competence of the faculty	1	2	3	4
Academic ability and preparation of students majoring in this department	1	2	3	4
Appropriateness of procedures (grades, papers,exams) used to evaluate students	1	2	3	4
Teaching methods (eg. lectures, seminars, audio/video aids)	1	2	3	4
Accessibility of faculty members to undergraduates	1	2	3	4
Variety of advanced course and program offerings	1	2	3	4
Flexibility of the program to meet individual needs	1	2	3	4
Opportunities to pursue individual projects	1	2	3	4
Opportunities for student evaluation of courses and instruction	1	2	3	4
Opportunities to assist professors in their research	1	2	3	4
Useful faculty criticism of your work	1	2	3	4
Faculty helpfulness in dealing with class work	1	2	3	4

C. Compared with other students majoring in the same field, indicate how you would rate yourself on each item below:

	WELL ABOVE AVERAGE	SOMEWHAT ABOVE AVERAGE	ABOUT AVERAGE	SOMEWHAT BELOW AVERAGE	WELL BELOW AVERAG
Math skills	1	2	3	4	5
Laboratory skills	1	2	3	4	5
Study skills	1	2	3	4	5
Reading skills	1	2	3	4	5
Writing skills	1	2	3	4	5
Test-taking skills	1	2	3	4	5
Ability to think through problems	1	2	3	4	5
Quality of homework	1	2	3	4	5
Ability to organize work	1	2	3	4	5
Speed in solving problems	1	2	3	4	5
Time spent on homework	1	2	3	4	5
Relationships with instructors	1	2	3	4	5
Relationships with fellow students	1	2	3	4	5

CAREER PLANS AND EXPECTATIONS

A. In answering this question, assume the current value of the dollar does not change. Also assume you will complete graduate school.

Once you are out of graduate school and have become established professionally -- in perhaps 10 or 15 years -- about how much money do you expect to earn annually?

( ) Less than $20,000	( ) $ 75,000 - $100,000
( ) $ 20,000 - $ 30,000	( ) $100,000 - $150,000
( ) $ 30,000 - $ 40,000	( ) $150,000 - $200,000
( ) $ 40,000 - $ 50,000	( ) $200,000 - $250,000
( ) $ 50,000 - $ 75,000	( ) More than $250,000

How important is it to you to have an income at least that large?

( ) Not important at all
( ) Somewhat important
( ) Quite important
( ) Extremely important

B. Jobs may be characterized in a number of ways. For example, a salesperson works largely with people while a mechanic works largely with things. Most jobs require some balance between the two extremes. On the following scales, rate the characteristics of the job you would most like to have.

MORE OF THIS CHARACTERISTIC			ABOUT EQUAL			MORE OF THIS CHARACTERISTIC
Practical/applied	( )	( )	( )	( )	( )	Theoretical/basic
Working with people	( )	( )	( )	( )	( )	Working with things
Working with math	( )	( )	( )	( )	( )	Working with words
Attention to detail	( )	( )	( )	( )	( )	Attention to total picture
Competitive emphasis	( )	( )	( )	( )	( )	Cooperative emphasis

C. How important to you is each of the following job characteristics or opportunities?

	NOT IMPORTANT	SOMEWHAT IMPORTANT	VERY IMPORTANT	EXTREMELY IMPORTANT
1. Technical challenge	1	2	3	4
2. Opportunities for advancement	1	2	3	4
3. Pleasant co-workers	1	2	3	4
4. Physically attractive environment	1	2	3	4
5. Flexible work schedule	1	2	3	4
6. Prestige/respect	1	2	3	4
7. Job security	1	2	3	4
8. Variety	1	2	3	4
9. Contribution to society	1	2	3	4

Now decide which <u>three</u> of these characteristics are most important to you, and circle the numbers (1 through 9) to the left of those three characteristics.

D. To what extent do you want a job that involves each of the following activities?

	NOT AT ALL	POSSIBLY	DEFINITELY
Teach, train, or instruct	1	2	3
Write, prepare reports or articles	1	2	3
Analyze numerical data	1	2	3
Operate instruments or equipment	1	2	3
Interpret and evaluate information	1	2	3
Concentrate on details	1	2	3
Advise, counsel, interview	1	2	3
Explain, answer questions	1	2	3
Reason mathematically	1	2	3
Design instruments or equipment	1	2	3
Keep records, catalog information	1	2	3
Think quickly	1	2	3
Persuade, negotiate, sell	1	2	3
Make presentations	1	2	3
Chart or diagram data	1	2	3
Draw or draft	1	2	3
Work with computers	1	2	3
Trouble shoot problems	1	2	3
Supervise or direct others	1	2	3
Read extensively	1	2	3
Gather data	1	2	3
Develop ideas	1	2	3

PLANS FOR GRADUATE STUDY

A. In what field do you plan to do graduate work? ______________________________

Using the major field category codes on the back of this questionnaire, please classify your intended graduate field into one of the categories and enter the code in this box --------------------> [ ]

Approximately when did you choose this field?

( ) Before college
( ) Freshman year
( ) Sophomore year
( ) Junior year
( ) Senior year

B. Please indicate the extent to which you agree or disagree with each of these statements about your intended field of study.

	STRONGLY AGREE	AGREE	NOT SURE/ NEUTRAL	DISAGREE	STRONGLY DISAGREE
There should be many jobs available in this field when I complete graduate work...	1	2	3	4	5
Success in this field will require good interpersonal skills......................	1	2	3	4	5
This field really doesn't interest me much, but an advanced degree in it will be useful to my career..	1	2	3	4	5
This field provides many opportunities for a substantial income...................	1	2	3	4	5
There are exciting new developments in this field................................	1	2	3	4	5
I am under pressure from my family to do graduate work in this field.............	1	2	3	4	5
In this field I will have an opportunity to make a significant contribution.......	1	2	3	4	5
This is a prestigious field..	1	2	3	4	5
I truly love this field and want to learn as much as possible about it...........	1	2	3	4	5
Success in this field will require good technical skills.........................	1	2	3	4	5
I expect this field to provide good opportunities for advancement................	1	2	3	4	5
A graduate degree in this field will prepare me for a number of different career possibilities..	1	2	3	4	5
I know personally one or more professionals in this field........................	1	2	3	4	5
I have already invested time and effort into this field and feel I must continue..	1	2	3	4	5
I have had work experience in this field...	1	2	3	4	5
I had one or more professors who strongly encouraged me to do graduate work in this field...	1	2	3	4	5
I expect my graduate courses to be less demanding than the undergraduate courses in my major...	1	2	3	4	5

So that we know something about your background and experiences, please indicate whether each of these statements is true or false.

	TRUE	FALSE	NOT SURE/ NOT APPLICABLE
My father is (or was) in a technical, mechanical, or scientific occupation........	1	2	3
My mother is (or was) in a technical, mechanical, or scientific occupation........	1	2	3
My mother approved of my undergraduate major field...............................	1	2	3
My father approved of my undergraduate major field...............................	1	2	3
My mother approves of my intended graduate major field...........................	1	2	3
My father approves of my intended graduate major field...........................	1	2	3
I have had one or more professors who encouraged me to do graduate work in this field..	1	2	3
I know personally one or more professionals in this field........................	1	2	3
I have had work experience in this field...	1	2	3

What was the single most important factor in your selection of a graduate field of study?

____

How different is your graduate field of study from your undergraduate major?

( ) Not at all different; the graduate field is a continuation of my undergraduate major.
( ) Slightly different.
( ) Moderately different.
( ) Greatly different; the graduate field bears little, if any, similarity to my undergraduate major.

If your graduate field of study will be markedly different from your undergraduate major field, discuss the various considerations that led you to change fields. If your graduate and undergraduate fields are about the same, discuss the factors that led to your decision to continue in the same field.

____

____

____

____

____

Thank you for participating in this research project. Your questionnaire responses are all confidential and will be used only for research purposes. We hope that the time you have devoted to completing this questionnaire has been helpful in clarifying your feelings and your plans for graduate study. We wish you the very best of luck in your academic and professional pursuits.

Please return the questionnaire in the postage-paid envelope provided, or mail it to

Educational Testing Service
Rosedale Road, 13-R
Princeton, NJ 08541

If you would like a summary of the survey results, circle the code number on the top of the front cover of this questionnaire.

MAJOR FIELD CODES

Natural Sciences

01 Agriculture
02 Biological Sciences
03 Chemistry
04 Computer and Information Sciences
05 Earth, Atmospheric and Marine Sciences
06 Health and Medical Sciences
07 Mathematical Sciences
08 Physics and Astronomy
09 Other Natural Sciences

Engineering

10 Chemical Engineering
11 Civil Engineering
12 Electrical and Electronics Engineering
13 Industrial Engineering
14 Materials Engineering
15 Mechanical Engineering
16 Other Engineering

Social Sciences

17 Anthropology and Archaeology
18 Economics
19 Political Science
20 Psychology
21 Sociology
22 Other Social Sciences

Humanities and Arts

23 Arts: History, Theory and Criticism
24 Arts: Performance and Studio
25 English Language and Literature
26 Foreign Languages and Literature
27 History
28 Philosophy
29 Other Humanities and Arts

Education

30 Education Administration
31 Curriculum and Instruction
32 Early Childhood Education
33 Elementary Education
34 Education Evaluation and Research
35 Higher Education
36 Secondary Education
37 Special Education
38 Student Counseling and Personnel Services
39 Other Education

Business

40 Accounting
41 Banking and Finance
42 Business Administration and Management
43 Other Business

Other Fields

44 Architecture and Environmental Design
45 Communications
46 Home Economics
47 Library and Archival Science
48 Public Administration
49 Religion, Theology, and Ministry
50 Social Work
51 Law

99 Other Field Not Easily Classified
00 Undecided

Appendix D

Postcard Reminder

Dear GRE Test Taker:

Recently we sent you a questionnaire about your undergraduate studies and career plans. If you have not yet filled it out, please complete it as soon as possible and return it to

Jerilee Grandy
ETS, 13-R
Rosedale Road
Princeton, NJ 08541

If you have already mailed it, ignore this reminder. Thank you for your participation in this research project.

Sincerely,

Jerilee Grandy

Jerilee Grandy
Project Director

Appendix E

Followup Letter

EDUCATIONAL TESTING SERVICE PRINCETON, N.J. 08541

609-921-9000
609-734-1090 (Fax)
CABLE-EDUCTESTSVC

DIVISION OF APPLIED
MEASUREMENT RESEARCH

April 1991

Dear GRE Test Taker:

In February we sent you a questionnaire asking about your undergraduate experiences, your thoughts about a career, and your plans for graduate school. We have not yet received your response.

Some of the people we have surveyed apparently have decided not to go to graduate school, and for this reason have not responded. We would like to receive responses from everyone we surveyed so we can be sure the results accurately represent all science, math, and engineering majors who took the GRE in December.

If you have not yet responded, we would greatly appreciate your taking 15 minutes or so to complete the enclosed questionnaire and mailing it to us in the enclosed envelope.

If you feel that the questionnaire does not apply to you -- if you have changed your mind about graduate school, for example -- please make a note to that effect on this letter and return it to us. We still want to hear from you and will read whatever comments you make.

All of your questionnaire responses and comments will be confidential. The findings from this research will be published by the GRE Board, and we expect the educational and scientific community to be greatly interested in the information that you and your fellow students can provide.

If you have any questions about the project, feel free to call me at 609-734-5548.

Thank you for your participation.

Sincerely,

Jerilee Grandy

Jerilee Grandy
Project Director

Appendix F

Questionnaire Scale Definitions

SCALE DEFINITIONS
(Negative sign indicates item was scored in reverse)

Scale		Items
1	COURSE DIFFICULTY	A4, A6, A19, A26
2	COURSE ENJOYMENT	A1, - A5. A7, - A9, A18
3	QUALITY OF INSTRUCTION	A28, - A2, - A12, - A15
4	RELATIONSHIPS WITH INSTRUCTORS	A13, - A17, A21, - A24
5	RELATIONSHIPS WITH STUDENTS	A3, - A10, A11, - A20, A23, - A25, A27
6	PERCEIVE SELF AS SCIENTIST	A16, - A22
7	QUALITY OF DEPARTMENT	B1 TO B15, REVERSED
8	PROBLEM-SOLVING SKILLS	C1, C6, C7, C10, REVERSED
9	STUDY SKILLS	C3, C8, C9, C11, REVERSED
10	VERBAL SKILLS	C4, C5, REVERSED
11	INTERPERSONAL SKILLS	C12, C13, REVERSED
12	CAREER OPPORTUNITIES	IIIB1, IIIB4, IIIB8, IIIB11, IIIB12
13	WILL DO BUT DON'T LIKE	IIIB3, - IIIB5, IIIB6, - IIIB7, - IIIB9

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