August, 2004

Like Your Classes, Know Your Professors? Predictors of Talented College Students' Science and Technology Careers

James Daniel Lee, *University of South Alabama*
Christina Stow, *University of South Alabama*

Introduction

This research is prompted by concerns that science and technology fields in the United States cannot attract enough talented native-born persons to sustain the current advantage this country now enjoys in those areas. Science and technology are not inherently unattractive to U.S. students; the disinterest in careers appears to be cultivated by educational experiences. For example, National Assessment of Educational Progress data (NCES 2003) show that in fourth grade about two-thirds of American students feel they are good at, and like, mathematics, but this falls to about half by twelfth grade. Regarding science, about half feel they are good it, at and two-thirds like it, in fourth grade. By twelfth grade, only two-fifths feel they are good at, and about half like, science. For the academically talented, science and technology careers are still an attractive option in high schools. However, persons who are interested in science and technology careers while in high schools are more likely than not to eventually drop their intentions to attain those careers (Astin and Astin 1993; Hilton and Lee 1988; Green 1989; NCES 2000). Women and disadvantaged minorities are even more likely to drop those intentions than men, whites, and Asians (National Research Council 1991; Babco 1999, 2000, 2001; C-IDEA 2000; NCES 2000). This phenomenon forms a supply-opportunity gap that universities typically fill by importing talented and interested persons from foreign nations (National Science Board 2002).

Scientific and technological advances have become essential for growth and a healthy economy in the developed world. Developing nations that traditionally supply much of the science and technology talent for US universities are wise to this phenomenon, and many have begun to invest heavily in improving science-related opportunities at their own universities (National Science Board 2002). This investment is beginning to pay off in ways that were unanticipated in prior decades. For example, major US science and technology corporations are beginning to export jobs to those nations, perhaps recognizing that it may be cheaper to hire talented persons overseas rather than hiring imported talent in the United States (and certainly more than investing in developing the talent pool in the US) (Bridis 2004). Indeed, improvements in job opportunities and the quality of life in many such developing nations is making the decision that talented persons often make to move to the US for more prosperity versus staying in one's home culture less attractive (National Science Board 2002). Such structural changes in those nations promise to leave the supply-opportunity gap in the United States unfilled. If this occurs, it will speed up the loss of science and technology opportunities in the United States.

A complicating issue is that particular science and technology disciplines also attract persons differently (Jacobs 1995; National Science Board 2002). Therefore, there are situations where there is an imbalance in the status characteristics of persons in a discipline when compared with the general population. Because persons tend to choose careers where they see persons like themselves working (Lee 1998), the race and sex imbalances may produce self-fulfilling prophesies of the characteristics of fields in future generations. Data for 1998 (National Science Board 2002) show that women make up roughly 56% of graduates at the baccalaureate level, and 50% of the college-aged population, while disadvantaged minorities make up roughly 15% of graduates at the baccalaureate level, and 29% of the college-aged population. However, when you look at degree attainment in various science and technology fields, you see strongly varying numbers. For example, women earned 45% and disadvantaged minorities earned 13% of natural science baccalaureate degrees, women earned 19% and disadvantaged minorities earned 12% of engineering baccalaureate degrees, and women earned 61% and disadvantaged minorities earned 19% of social and behavioral science baccalaureate degrees (National Science Board 2002).

Much of the responsibility for loss of talent and segregation into niche fields lies somewhere within the college-level experience of science and technology students. Some SME fields lose 50 percent or more of students from freshman to senior year of college (Astin and Astin 1993; NCES 2000). While it is tempting to charge that persons who drop just cannot handle the rigorous curriculum, there is a mountain of evidence that indicates that most students who drop are otherwise capable of achievement in science and technology (Green 1989; Seymour and Hewitt 1997).

There are several characteristics about the ways university-level science and technology is organized that lead to students dropping out. Understanding these begins with seeing that persons who pursue or drop out of science and technology majors are making personal choices (Lee 1998, 2002; Xie and Shaumann 2003), and the choice making needs to be understood as a social psychological process where personal characteristics range in compatibility with the characteristics of local science and technology educational settings.

There is now compelling research that demonstrates the importance of personal characteristics for determining educational outcomes in science and technology. Most important of these is identity theory research (Lee 1998, 2002) indicating that identity prominence and identity content strongly predict the likelihood that someone will be interested in sciences and choose science-related activities. Basically, this research has found that the more persons define themselves like their definitions of particular science and technology professionals, such as a chemist or a biologist, the more that person is interested in that particular field. For example, students define science as "masculine," and girls interested in science have self-concepts that fall somewhere between perceptions of scientists and other girls (Lee 1998). Further, the more students engage in science-related endeavors with persons for whom they have positive emotional connections, the more prominent their science and technology identity is. This is important because the more prominent their science and technology identity, the more they engage in science-related behaviors. Identity prominence has been shown to be strongly related to interests and activities. Indeed, identity content and identity prominence are able to explain some of the gendered and racial patterns seen in science and technology interests and behaviors.

Gender and race are important status characteristics that shape the likelihood of successful career attainment in science and technology. The research that explores the effects of these characteristics illustrates the notion that individual “fit” with social contexts is important for producing science-related careers.

Because gender and race are dimensions around which many social contexts are organized, women and underrepresented minorities generally develop self-concepts that are distinct from their counterparts’. In studying career choices, some researchers have documented critical distinctions between women and men and disadvantaged minorities and whites and Asians. Women have a greater tendency to choose career fields for personal and altruistic reasons, whereas men are more instrumental in their career choices (Seymour and Hewitt 1997; Rayman and Brett 1993; Scarbecz and Ross 2002). In addition, girls tend to discount their ability in mathematics and generally attribute greater ability to males in quantitative fields (Catsambis 1994; Correll 2001; Goodman Research Group 2002). Girls also have a greater tendency to link their self-evaluations to external evaluations such as grades (Correll 2001). On the other hand, disadvantaged minorities appear to differ from whites and Asians in that they will often select careers for the good of their communities, rather than for personal satisfaction (Seymour and Hewitt 1997). Underpreparedness, borne of underfunded schools, also leads to lower feelings of confidence in science and technology among disadvantaged minorities (Seymour and Hewitt 1997). Stereotype threat (Steele and Aronson 1995), lower accomplishment on tasks prompted by the realization that others expect persons of one’s group to do poorly, likely hinders disadvantaged minorities’ science-related career goals.

Understanding that relationships, definitions of others, and self-concepts are important for determining career choices points to the importance of understanding the climate of science and technology at universities through which science and technology professionals must pass on the way to their careers. College-level contexts may be compatible or incompatible with the characteristics of the variety of students aspiring toward science-related careers. Several characteristics of these settings have been highlighted as reasons students abandon, and why particular groups such as women and disadvantaged minorities abandon more, science and technology career plans. Among these factors are the weed-out culture, uninspiring science and technology classes, and lack of "connection" with fellow science and technology students.

College-level SME attrition and segregation is often associated with the attitudes and behaviors of instructors and professors. Many scientists pride themselves on the large numbers of students who fail their lower-division courses, or who switch out of their major (Green 1989). This is likely due to the prevailing belief that only a select few have the inherent talent to succeed in science-related studies—a perspective that is discounted by research showing how frequently talented students are driven away by weed-out efforts (Green 1989; Seymour and Hewitt 1997). For example, Seymour and Hewitt (1997) find that college GPAs are not substantially different for those who switch and those who do not. The average woman switches out with a higher GPA than switching men. Moreover, switchers cannot be distinguished from non-switchers by high school preparation level or conceptual difficulties.

Tobias (1990) demonstrated that the university-level science and technology teaching environment is quite often uninspiring for talented students. Seymour and Hewitt (1997) find that the most prominent reasons given by higher-ability students for dropping science-related studies are: loss of interest in science related to bad experiences in science classes; belief that other majors offer a better education; poor teaching in science classes; and the demanding pace in the science curriculum. Office of Technology Assessment (1988, 1989) findings that liberal arts, historically black, and technical colleges have better records of retaining science and technology students point out that educational contexts matter. Among the factors that help are smaller classes and more contact with faculty. These factors point to the importance of relationships formed in pursuit of a degree.

While the above factors deter students, they cannot fully explain why people drop out because those who stay in give the same complaints (Seymour and Hewitt 1997). It appears that interpersonal relationships are critical. Lee (2002) finds that the more high school students develop emotionally satisfying relationships around science-related activities, the more they develop self-concepts centered on science and technology and engage in related activities. Goodman Research Group's (2002) study of women in engineering found evidence that those who participated in social support activities were more likely to stay in their engineering major. The emphasis on competition and weeding students out in college contexts is inexplicably hostile and impersonal to women and disadvantaged minorities who had grown accustomed to a high school culture with nurturing teachers (Seymour and Hewitt 1997). Female students tell Seymour and Hewitt (1997) that their biggest need is to get support from faculty.

The hostility of the science and technology culture in colleges is exacerbated by students' affiliational choices. In college, women and disadvantaged minorities appear to have more difficulty forming social ties rooted in science-related activities than in other domains. Astin (1993) reports that peer groups have a major effect on students' academic and personal development. He finds, however, that students hang out with, and are therefore influenced most by, persons who are from the same sex, race and SES categories. Therefore, ideas brought into college by particular groups are reinforced and further entrenched there. Consequently, female and disadvantaged minority science, math, and engineering majors are more likely to be discouraged from science and technology studies by peers who do not believe persons like them fit into those fields.

Seymour and Hewitt (1997) report that, ultimately, women and minorities feel like they do not fit in. Many women report that the way they ought to act in science and technology settings is inconsistent with their feminine gender identity. Many minorities experience the feeling of abandoning cultural styles. For example, the individualist orientation of science-related disciplines run counter to obligations to the minority group. Students' status as women and/or minorities in male- and majority-dominated classes leads them to feel ill-at-ease, to be intimidated, and to lose self-confidence. Choosing to drop science-related career interests seems sensible in these circumstances.

Data and Methods

Since the flow of science and technology talent is overwhelmingly outward, we focus on students who were already in the science and technology talent pool near the end of high school. The respondents in this research can be characterized as highly talented university students who in high school were interested in pursuing science, math, and engineering careers. They are a subset of respondents who had participated in survey research on highly motivated students who were attending summer programs that worked to foster careers in science and technology. Not a representative sample of general high school science and technology students, this sample was formed by identifying successful and interested students who were at that stage where students begin doubting their science and technology plans.

Selection of programs that were the source of this sample is described in other publications (Lee 1998, 2002). The ten participating programs were located in California, the District of Columbia, Florida, Indiana, Iowa, Massachusetts, Pennsylvania and Texas, at nine universities and one private high school. Each program hosted mostly students entering their junior and senior years in high school, although some students were at other grade levels. One program was for girls only; another was only for minority students.

We use in-depth face-to-face interviews, conducted in spring 1999, with 58 students selected from those who had participated in the survey research. These students were selected on the basis of availability to participate if they were attending one of four universities designated for recruitment: Harvard University (16 respondents), Massachusetts Institute of Technology (14 respondents), Boston University (2 respondents), and Indiana University-Bloomington (26 respondents). These universities were selected to ensure a mix of public and private university students, but also to ensure that the students were attending universities with nationally competitive science and technology facilities. Students were also recruited so as to ensure variations in sex and race in the sample; 29 respondents were male, 29 female, and 33 were white, 14 Asian, and 11 disadvantaged minority. Most of the students were sophomores when they were interviewed.

On average, the interviews with the students lasted about an hour and a half to an hour and forty-five minutes. They were fairly structured and covered issues related to students' science and technology interests and experiences from the time prior to program attendance to the time of the interview. Especially targeted for inquiry were students' high school and collegiate experiences and relationships with others that might have altered their intentions to pursue scientific or technological careers.

We content analyze the interviews to discover the ways college experiences may alter students' majors and career intentions. For each point of inquiry there were questions that were intended to elicit the information we use. However, on all issues, all other areas of the interviews were reviewed for relevant information. In this report we focus on the effects of courses and relationships to science and technology professors on students' career trajectories. To do so, we first documented each student's career interests and likelihood of achieving those interests, including self-reported likelihood and our own assessments given the student's statements elsewhere. Relevant questions included:

- What type of career are you trying to pursue right now?
- On a scale of one to ten, how likely are you to become a [career professional]?
- Suppose you were told you cannot get a job in [career], what occupation would you try for next? Probe: If not a science, why not another science?

We also documented majors and minors, as well as whether their interests in science and technology had grown stronger, weaker, or stayed the same during college. Related questions included:

- I want to get clear on how you got from the interests you had during the summer program and those you have now. Why and when did you make the switch? or Did you ever waver? When did you declare your major? Probe: If not volunteered, what is you your major? Any others? Do you have any minors?
- Have your interests in science and technology grown stronger, weaker, or stayed the same in college? Please explain why.
- What [could make you/made you] want to drop out of science and technology?
- How [would you/did you] feel about dropping out? [Would/Was] the decision [be] hard to make?

We then focused attention on discussion surrounding their classes, taking detailed notes on which college classes were their favorite and which were their least favorite. The questions:

- Reflecting on your college classes, name two classes in college that have been your favorites? In general, what made you like them?
- Now name two classes in college that have been the worst? In general, what made you dislike them?
- How did you do in each of these classes?
- Generally, have you done better in science or non-science classes? Why?

We also detailed their relationships with professors, classifying them by level of involvement and attachment to these professionals. Relevant questions were:

- [In the context of dropping out:] How [would/did] others react?
- If you were to drop out [of science and technology], are there any professors that you would tell?

Finally, we grouped students by their areas of interest, and found strong relationships between science and technology involvement, area of interest, and classes and relationships.

Results

The findings of our analyses are presented in Table 1. After determining where students' career interests lay at the time of the interview, we grouped students into four categories. Those who were: (1) in quantitative fields or computing, 15 students or 26%, (2) in life sciences or medicine, 21 students or 36%, (3) undecided on field, but still in science and technology, 8 students or 14%, or (4) dropping or likely to drop, 14 students or 24%. As a check on our classifications of where students' interests lay, we checked on how they characterized their interests in science and technology in college—whether their interests had grown stronger, stayed the same, or gotten weaker. We found no reason to question our determinations of their likelihood to pursue science and technology careers.

Among the 15 with quantitative and computing interests, only two reported that their interests had grown weaker. Their comments make it clear that they do not expect their interests to remain at a lower level.

> Robert (C): I should say they've grown somewhat weaker, though I don't think that's a permanent thing. . . . It's mainly a backlash I think against this really difficult math class I took all this year. . . . It was really a good class and I had a lot of fun in it, but it was just

> too much at times.
>
> Frank (4): Maybe a little bit weaker. A lot of required classes, distribution classes that we have to take kind of opened my eyes to the humanities and the other, the other stuff that I'm not really . . . some little stuff out there is slightly appealing—not enough that I'm going to run to it.

Among the medical and life sciences group, none of the 21 students reported weaker interest in science and technology.

Among the 8 undecided students still interested in a science and technology career, only one reported interests getting weaker. The weakness is related to the emphasis of college classes not being aligned with his own. This student, Todd (2), explains that he is less interested in details about how things work:

> I think it has to do with my personality type. . . . Initially, I was attracted to physics because I liked, you know, the "why." You know, why things work. . . . when you look at it, like, and you really start doing stuff, physics is really "how," okay?

Finally, among those who where were dropping or likely to drop, only three of 14 report stronger interests. Their interests, however, are rooted in something other than the content of science and technology fields. One, John, has a troubled collegiate record, and he went back to college and declared a major in computing after some friends and he talked up the idea of starting an internet company to make lots of money. The example below begins with the interviewer's astonishment when John (9) reports stronger interest in science and technology:

> I: Stronger, really?
> J: Just because, because of the computer thing.
> I: ...the computers have kind of revived your interest in technology?
> J: Yeah. At least in themselves as a mode of getting, like, money.

The other two reporting stronger interests link their changes in interest to relationships with friends. Gloria (Y) reports:

> I've been able to actually see. Like, and, and know people that work on these. Like, I know [Phil] who works in the biology department. He's working on a Polymer for—so you don't have to go in if you have a cancerous tumor of the brain.

For his part, Roger (R) says:

> I'd say again, it has grown stronger because one of my roommates is actually a, um, a um, is concentrating in neuropsychology . . . I have a lot of conversations with him in the room and with other people.

Sex and Race Patterns

The students in this research were not selected on the basis of their intended careers. Therefore, patterns by sex and race may reflect typical outcomes, with patterns affected by the factors that are associated with persons' sex and race. One caveat is in order however. Racial patterns in science and technology interests may be affected by the institutions selected as sites for data collection. Indiana University-Bloomington does not have engineering programs, and the student body, because of state demographics, also has fewer disadvantaged minorities. On the other hand, Massachusetts Institute of Technology was host for one of the minority summer programs, attracting minority respondents to attend university there. These factors likely lead to more minorities in quantitative and computing fields, but fewer in life sciences and medicine.

We found that among the students dropping, five (36%) were male and nine (64%) were female, a clear overrepresentation of female students (50% of the respondents were female). Students remaining in science and technology are 55% male and 45% female. Along the racial dimension, nine (64%) of the dropping students were white or Asian, but 5 (36%) were disadvantaged minority. Disadvantaged minorities are overrepresented too; the percent disadvantaged minority in this sample is 19%. Of those remaining in science and technology, 86% are white or Asian and 14% are disadvantaged minority. Consistent with patterns seen nationally, among this set of talented students, more women and disadvantaged minorities drop science and technology career aspirations.

Of note are the patterns by sex and race seen in the three groups of students still intending science and technology careers. Among the undecided group, five (63%) are male and three (37%) are female, while six (75%) are white or Asian and two (25%) are disadvantaged minority. Among the life sciences and medicine, eight (38%) are male and 13 (62%) were female, indicating greater interest in these fields by the women. By race, only one person (5%) was from the disadvantaged minority group. Again, this may reflect university selection. Among those intending careers in quantitative fields and computing, 11 (73%) are male and four (27%) are female. Combined with the findings for life sciences, this overrepresentation of males in quantitative areas confirms other work that sees a clear gender divide in the aspirations of science and technology students. The racial breakdown shows 12 (80%) white and Asian and three (20%) disadvantaged minority. Again, university selection likely produced this outcome.

Classes

Independent of checking for interest in science and technology, we analyzed respondents' discussion of their favorite and least favorite classes. Distinct differences emerged after grouping students by their interest areas, including expected differences between those in science and technology and those dropping or likely to drop, but also surprising differences between areas of interest in science and technology.

It is hard to discern a norm among the 15 quantitative and computing students in regards to classes. There appears to be a mixture of science-related and non-science classes listed as favorite and worst. However, only two mention no science courses as favorites, but each of them aspires to become a math professor. Asked to name two favorite classes, those in quantitative and computing fields mention nine non-science and 20 science-related courses. Asked to name two worst classes, they volunteer 16 non-science and 20 science courses.

For the 21 students in life sciences and medicine, the preferences for classes are distinct. The prevailing norm is for mention of favorite classes to include a non-science course and for worst classes to include a science class. Asked to name two favorites, these respondents report 19 non-science classes and 22 science classes. On the other hand, their two worst classes included only five non-science and 35 science-related classes. These students clearly have negative outlooks on their science course experiences.

The prevailing norm among the undecided science and technology students is for favorite and least favorite classes to include at least one science class. When these eight students were asked to name their favorite classes, they mentioned six non-science courses and 12 science-related courses. When naming their worst classes, five non-science courses and 11 science courses were discussed. Perhaps the tensions felt from having equal numbers of good and bad science courses lead to some of the indecisiveness among these students.

The pattern among students dropping science and technology is unlike those of the other three groups. The prevailing norm among these students is for favorite classes to be non-science classes, and for worst classes to include at least one science class. Asked to name two favorite classes, the 14 subjects dropping intentions for careers in science and technology mentioned 25 non-science courses and five science courses. Asked to name two of their worst classes, they named nine non-science courses and 16 science-related courses.

Professors

Analyzing the students' links to professors introduced more clear patterns. About half the 15 quantitative and computing students mention relationships with professors. Two were working with professors in a lab setting, and seven (including one of the previous two) say that they would tell a science and technology professor if they were to decide to drop their science-related career plans.

Among the 21 life sciences and medicine students, almost all report relationships with professors. Nine reported working in a professor's lab and one reported seeing professors regularly. Another seven could name professors that they would tell if they were to decide to drop their science-related career plans. Among the four students mentioning no relationships, one reports having shadowed a physician over the summer.

Among the undecided science and technology students, half mention relationships with professors. Two report working with professors, and one reports seeing a professor regularly. Finally, one reports the need to tell a particular professor if he were to drop out.

Among the 14 students who were dropping science and technology, only one reports a relationship with an science and technology professor. This student, Nicole (11), reported telling one professor, but not by design:

> I forget why, but I saw him, or he e-mailed or something, I forget what. So I told him I changed my major, and he was like, "Wow! That's great," you know.

Conclusions

The findings in this research point out fairly dramatic distinctions between the four groups of students that we analyzed. Quantitative and computing students appear to like a range of courses, having had many good and bad science-related courses, but fewer good, and more bad, non-science courses. Also, many appear to have developed relationships with science and technology professors, but this does not appear essential to them. In many ways, it seems that the content of courses keeps many of these students engaged in their career tracks.

On the other hand, life sciences and medicine students have dramatically different experiences. These students demonstrate high levels of antagonism toward their science courses—they generally do not like them. However, these same students report high levels of relationships with science and technology professionals. This group of students appear to confirm the general image of life sciences and medicine that currently prevail: that these fields are about people rather than the scientific content.

A different image emerges for those who are undecided, but still intending science and technology careers. Those students appear to have been "yanked around" through their studies because they have had good and bad experiences in science and technology classes. It would seem that bad experiences might lead these students to keep uncommitted to particular fields of study. Regarding professors, many appear to have developed relationships, but these do not appear essential to these students.

The final group of students point to the importance of connection to science and technology classes and professors if students are to succeed in their quests to achieve careers in those areas. The dropping students appear to have had few good, but many bad, science-related courses. These students have also developed very few relationships with science and technology faculty. This combination of bad classes and few faculty ties appears to diminish students' interests and desires to go into science and technology fields.

What the distinct experiences of the students in this research points out is that course experiences and relationships with faculty are critical determinants of college students' persistence in, or discontinuation of, science and technology studies. All of the students in this research were identified as academically talented and interested in science and technology careers prior to their participation in university-level science and technology studies. The university-level experiences that we isolated in this report have deterministic relationships with these students' career paths.

It is clear that students need either positive experiences in the classroom or relationships with faculty members if they are to successfully persist in science-related careers. Those who did not find either type of experience, found themselves dropping out of science and technology. Indeed, the experiences expected by students may vary with whether their field is quantitative or a life science in orientation. Life sciences and medicine students are retained with relationships to faculty even though they find their science courses unappealing. On the other hand, the quantitative students seem to need rewarding classroom experiences more than relationships with faculty. This division of students is consistent with that found in other ongoing research on science and technology students (Lee unpublished), which finds differences between predictors of interest in quantitative fields and life sciences. Most notable among these is that interest in quantitative fields and life sciences are inversely related, that men prefer quantitative fields over life sciences versus the opposite for women, and that masculine persons are more likely to avoid life sciences.

Our findings by sex and race are consistent with those of other researchers. Women and disadvantaged minorities are more likely to drop science and technology career interests. However, we also add some insight to the outcomes by sex and race. The common experiences of the students dropping, regardless of status characteristics, were that they had negative experiences in the science classroom, positive experiences in non-science classes, and no significant relationships with scientists, mathematicians, and engineers. These data demonstrate that the women and disadvantaged minorities were less likely to have formed these kinds of positive experiences that increase retention. The negative outcomes by sex and race may simply reflect the lower likelihood of these groups to enjoy the classes and/or form relationships with professors. Students with similar experiences will have similar outcomes. Further exploration of these critical factors is needed. But persons interested in increasing retention of women and minorities should monitor classroom experiences and help create relationships to faculty.

A second critical finding about sex is that the women in this sample are drawn to life sciences and medicine, while men are drawn to quantitative fields. Much can be made of the fact that the students in the life sciences tend to have negative classroom experiences, but positive relationships to science and technology faculty. This is consistent with speculation that women are more motivated by relationships with other persons than by mechanistic studies. Are the life sciences students more likely to have relationships only because women are more likely to have relationships and are drawn those disciplines? The answer appears to be no. The female students outside this area appear to have no more relationships than the males. It is more likely that the opportunity to have relationships in the life sciences are drawing women into or keeping them interested in those areas. If this finding can be validated in other research, a powerful tool for drawing women into areas where they are critically underrepresented may have been discovered. Fostering opportunities to build relationships with professors should encourage greater female participation.

These findings shed new light on the importance of university classes and professors. Those students who cannot enjoy the classes or have relationships with professors drop. Those who have mixed enjoyment in classes remain undecided, and many of these will have relationships with faculty. Those who enjoy the classes tend to be in quantitative fields, and many of these have relationships with faculty. But those who have more negative experiences in classes, but relationships with professors are most often found aspiring for careers in life sciences and medicine. Women and minorities are more likely to have negative experiences with classes and no relationships with faculty, leading to more dropping science and technology careers. Women also become drawn to life sciences and medicine by relationships with faculty.

References

Astin, Alexander W. 1993. *What Matters in College? Four Critical Years Revisited.* San Francisco: Jossey-Bass.

Astin, Alexander W. and Helen S. Astin. 1993. *Undergraduate Science Education: The Impact of Different College Environments on the Educational Pipeline in the Sciences.* Los Angeles: Higher Education Research Institute, UCLA.

Babco, Eleanor L. 1999. *Up Hill Climb: The Status of African Americans in Science and Technology*. Washington, DC: Commission on Professionals in Science and Technology. (http://www.cpst.org/web/site/pages/pubs/African%20Americans/Status%20Report1.htm).

__________. 2000. *Limited Progress: The Status of Hispanic Americans in Science and Engineering.* Washington, DC: Commission on Professionals in Science and Technology. (http://www.cpst.org/web/site/pages/pubs/Hispanics.hispanics.htm).

__________. 2001. *Under-represented Minorities in Engineering: A Progress Report.* Washington, DC: Commission on Professionals in Science and Technology. (http://www.cpst.org/Minorities.pdf).

Bridis, Ted. 2004. “Technology Firms Defend Moving U.S. Jobs Overseas.” Wednesday, January 7, 2004. The Associated Press State & Local Wire.

C-IDEA (The Center for Institutional Data Analysis and Exchange). 2000. *1999–2000 SMET Retention Report.* Norman, OK: University of Oklahoma.

Catsambis, Sophia. 1994. “The Path to Math: Gender and Racial-Ethnic Differences in Mathematics Participation from Middle School to High School.” *Sociology of Education.* 67:199-215.

Correll, Shelley J. 2001. “Gender and the Career Choice Process: The Role of Biased Self-Assessments.” *American Journal of Sociology*. 106:1691-730.

Goodman Research Group. 2002. *Final Report of the Women’s Experiences in College Engineering (WECE) Project.* Cambridge: Goodman Research Group, Inc. (http://www.grginc.com/WECE_FINAL_REPORT.pdf).

Green, Kenneth C. 1989. “A Profile of Undergraduates in the Sciences.” *American Scientist.* 77:475-80.

Hilton, Thomas L. and Valerie E. Lee. 1988. "Student Interest and Persistence in Sciences: Changes in the Educational Pipeline in the Last Decade." *Journal of Higher Education.* 59:510-26.

Jacobs, Jerry A. 1995. "Gender and Academic Specialties: Trends among Recipients of College Degrees in the 1980s." *Sociology of Education*. 68:81-98.

Lee, James Daniel. 1998. "Which Kids Can 'Become' Scientists? Effects of Gender, Self-Concepts, and Perceptions of Scientists." *Social Psychology Quarterly*. 61:199-219.

Lee, James Daniel. 2002. "More than Ability: Gender and Personal Relationships Influence Science and Technology Involvement." *Sociology of Education.* 75:349-73.

Lee, James Daniel. unpublished. "Life Sciences are for Women and Minorities: How Sex, Race, and Identities Channel Interests and Activities in Science and Technology Fields." (www.southalabama.edu/sociologyandanthropology/lee/leeresearch.htm).

National Research Council. 1991. *Women in Science and Engineering: Increasing their Numbers in the 1990s.* Washington, CD: National Academy Press.

National Science Board. 2002. *Science and Engineering Indicators—2002*. Arlington, VA: National Science Foundation (NSB-02-1).

NCES (U.S. Department of Education, National Center for Education Statistics). 2000. *Entry and Persistence of Women and Minorities in College Science and Engineering Education*. Washington, DC: Office of Educational Research and Improvement.

NCES (U.S. Department of Education, National Center for Education Statistics). 2003. NAEP Data. http://nces.edu.gov/nationsreportcard/NAEPdata/.

Office of Technology Assessment. 1988. *Educating Scientists and Engineers: Grade School to Grad School.* Washington, DC: US Government Printing Office. (OTA-SET-377; http://www.wws.princeton.edu/~ota/ns20/alpha_f.html).

_________. 1989. *Higher Education for Science and Engineering: A Background Paper.* Washington, DC: US Government Printing Office. (OTA-BP-52; http://www.wws.princeton.edu/~ota/ns20/alpha_f.html).

Rayman, Paula and Belle Brett. 1993. *Pathways for Women in the Sciences: The Wellesley Report Part I.* Wellesley, MA: Wellesley College Center for Research on Women.

Scarbecz, Mark and Judith A. Ross. 2002. "Gender Differences in First-Year Dental Students' Motivation to Attend Dental School." *Journal of Dental Education* 66:952-61.

Seymour, Elaine and Nancy M. Hewitt. 1997. *Talking about Leaving: Why Undergraduates Leave the Sciences.* Boulder: Westview Press.

Steele, Claude M. and Joshua Aronson. 1995. "Stereotype Threat and the Intellectual Test Performance of African-Americans. *Journal of Personality and Social Psychology*. 69:797-811.

Tobias, Sheila. 1990. *They're not Dumb, They're Different: Stalking the Second Tier*. Tucson, AZ: Research Corporation.

Xie, Yu and Kimberlee Shauman. 2003. *Women in Science*. Cambridge: Harvard University Press.

Table 1. Respondents organized by area of interest, sex, race, change in interest in science and technology, favorite classes, worst classes, and relationship to professors.

				Classes		
Case	**Sex**	**Race**	**Interest**	**Favorite**	**Worst**	**Relationships**
Quantitative Fields and Computing						
C	Male	White	Weaker	NS*		Would tell if dropping
4	Male	White	Weaker	SS	NNS	
25	Male	White	Same	NS	NN	Would tell, works in lab
18	Male	White	Stronger	NS	NS	
K	Male	White	Stronger	SS	NN	Would tell if dropping
P	Male	White	Stronger	S?	NN	
N	Male	Asian	Stronger	NN	NS	
CC	Male	Asian	Stronger	NS	SS	Works in lab
U	Male	Asian	Stronger	SS	NN	
19	Male	Black	Stronger	NS	NS	Would tell if dropping
F	Male	Black	Stronger	SS	NS	Would tell if dropping
X	Female	White	Same	NN	SS	
A	Female	Asian	Same	SS	NS	
I	Female	Asian	Stronger	SS	NS	Would tell if dropping
B	Female	Black	Stronger	SS	NS	
Life Sciences and Medicine						
5	Male	White	Same	NN	NS	Would tell if dropping
10	Male	White	Same	NS	NS	
3	Male	White	Stronger	NS	SS	Works in lab
7	Male	White	Stronger	NS	SS	Would tell if dropping
8	Male	White	Stronger	NS	S	Works in lab
23	Male	Asian	Same	NS	SS	Works in lab
21	Male	Asian	Same	S		Would tell if dropping
24	Male	Asian	Stronger	NS	SS	Works in lab
20	Female	White	Same	NN	SS	Would tell if dropping
E	Female	White	Same	NS	SSS	Works in lab
13	Female	White	Same	SS	NN	Would tell if dropping
BB	Female	White	Same	SS	SS	Works in lab
26	Female	White	Stronger	NS	NS	
17	Female	White	Stronger	NS	SS	Would tell if dropping
L	Female	White	Stronger	NS	SS	(shadowed physician)
12	Female	White	Stronger	N?	SS	Works in lab
14	Female	Asian	Stronger	NS	SS	Would tell if dropping
16	Female	Asian	Stronger	S	SS	Works in lab
H	Female	Asian	Stronger	NS	SS	Works in lab
AA	Female	Asian	Stronger	NSSS	SS	Sees them around
Z	Female	Black	Stronger	NS	SS	

*N=Non-Science, S=Science, ?=undetermined

Table 1 (continued). Respondents organized by area of interest, sex, race, change in interest in science and technology, favorite classes, worst classes, and relationship to professors.

Case	Sex	Race	Interest	Classes Favorite	Classes Worst	Relationships
Undecided but in Science and Technology						
2	Male	White	Weaker	NS*	NS	Works in lab
G	Male	White	Stronger	SSSS	SS	
FF	Male	White	Stronger	SS	NS	
EE	Male	Asian	Stronger	NS	NS	Would tell if dropping
O	Male	Black	Same	NS	NS	
DD	Female	White	Same	NSS	SS	Sees them around
D	Female	White	Stronger	NS	SS	
S	Female	Hispanic	Same	NS	NS	Works in lab
Dropping or Likely to Drop						
1	Male	White	NA	NNN	NN	
15	Male	White	Same	NN	NS	
R	Male	White	Stronger	NN	NN	
9	Male	White	Stronger	NNN	?	
T	Male	Black	Same	NN	SS	
11	Female	White	Weaker	NN	SS	Told when asked
V	Female	White	Weaker	NN	NS	
W	Female	White	Weaker	NN	S?	
J	Female	White	Same	NS	NS	
6	Female	Asian	Weaker	NS	NS	
M	Female	Hispanic	Weaker	NN	NS	
Q	Female	Hispanic	Weaker	NN	SS	
22	Female	Hispanic	Same	SS	SS	
Y	Female	Hispanic	Stronger	NS	SS	

*N=Non-Science, S=Science, ?=undetermined