

INCREASING WOMEN'S RETENTION AND PERSISTENCE A REPORT ON RESEARCH IN PROGRESS

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The only woman in the sophomore physics course, Alice Newton finds herself the unwilling social interest of her TA, Tom Kepler. Tom continually comments on how attractive he finds Alice and calls her in her dorm to ask if she needs help with her work. Alice is very uncomfortable with Tom's attention, and after much soul searching, goes to see Professor Brahe who teaches her course. Alice respects Professor Brahe a great deal and feels that he will be able to address her concern.

Professor Brahe finds Alice's situation disquieting, but suggests that since less than half of the semester is left, she should "tough it out" for the remainder of the course. "You have to be tough to succeed in physics" he explains. "And while you could take this case on, it would probably cause you more trouble than it's worth." He further explains: "Tom is lonely, being so far away from his family and friends. The male:female ratio makes it very difficult for Tom to have a social life. If he's not allowed to pay attention to students, who will he meet?"

Alice reports that she continues in the course, but feels physically sick ever time she goes to class. She doesn't do as well as she usually does and switches majors at the end of the semester.

This apparently fictitious case is based on a real student's story.

Developing successful programs to encourage women to seek and sustain careers in science and engineering requires a strong base of information on student needs and perceived needs, on faculty attitudes and perceived attitudes as well as on specific program evaluation. Too often, colleges and universities develop or decide not to develop support programs based on anecdote, myth, or tradition. In this paper, we introduce a research plan in progress, and selected findings of research to date, and present a brief rationale of the importance of developing standard protocols for assessing institutional climate and praxis.

At Carnegie Mellon, a cross-college, cross-disciplinary committee has developed a research plan to survey and interview both undergraduates and graduate students and faculty about their experiences and expectations. To better understand the synergy of institutional climate, environment and the

nature of student and faculty populations, we have designed surveys in which questions asked of students are parallel to those asked of faculty. The questions used in both surveys are based on a review of related literature with the express intent of testing significant hypotheses raised in the literature. Several such hypotheses are suggested by anecdotal evidence and by the rather sparse survey data available; systematic data on choice of careers and retention are hard to come by for both men and women. Some of the hypotheses that we generated are:

- Women need external validation of their success or worth.
- Women tend to underestimate their ability to succeed, especially in technical areas.
- Women more often feel their profession should be of service and are more likely to feel that engineering and science are not of service.
- A financially rewarding career is one of the primary reasons for women's decision to study science or engineering.
- Women with a father or brother in science or engineering are more likely to decide to study science or engineering (or perhaps it is encouragement that is important).
- Women are more likely than men to reject science or engineering because of certain prevalent attitudes toward work in the classroom and workplace (hierarchical organization, competition rather than cooperation, etc.).
- Lack of financial aid seriously hampers women from staying in science and engineering in college.
- The fear that it is hard to balance family and a science or engineering career turns women away from studying science or engineering.

We need to understand which of these factors are really important, and whether they are different for women than they are for men, whether institutions need to change for all people or only for women. This paper presents results from the student surveys and tests several of these hypotheses.

Student Survey

The student survey was mailed to undergraduate and graduate students early in the spring semester 1992. Of the 7,148 students at Carnegie Mellon, 1,800

received the survey and 413 responded. Students were given two weeks to return their response. As mail surveys at Carnegie Mellon usually generate a very small response rate, students who completed the survey were given a chance to enter a lottery for three \$100 prizes. The response rate was surprisingly high for our community, (23%).

Students completing the survey were told that the University was "interested in understanding and improving the academic experiences of both undergraduates and graduate students." The survey included basic information about the student's major, college, year, race/ethnicity, marital or partner status, and work experience as well as general academic experiences and goals.

Questions ranged from the most significant factors for choosing the course of study, the nature of students' current academic experience in the classroom, relations with professors and advisors, various environmental factors (stress, workload stress, discrimination, harassment), significant encouragers (fathers, mothers, partners), future career expectations, and areas of improvement. Sixty-eight questions were presented in a closed-ended format, with a scale from one to five being utilized where one represents "Not to any extent" and five represents "To a very great extent." The survey included five open-ended questions, answers to which -- not surprisingly -- have proved to be as interesting as the close-ended questions. It's also worth noting that of the 413 students (23%) who answered these questions, 216 (52%) offered to speak about their experiences to the research team in person.

The graduate student environment differs from that of the undergraduate students; they have access to different resources and more contact with faculty members on the average. We expected that many of the means of the factors would be significantly different for graduate and undergraduate students. T-tests of the means were performed, yielding the majority of the sixty-eight factors to be significantly different for graduate and undergraduate students. Therefore, the analysis of these factors was done separately for graduate and undergraduate students.

In this paper, we focus on factors where the institution may make a difference for women. Other significant differences between men and women were also found with respect to factors such as the importance of encouragement from parents, partners and friends.

The following table states the hypothesis in the first column with the corresponding variables from the survey in the second column.

**Summary of Factors
Where the Institution Makes a Difference for Women Students***

Hypothesis	Survey variables
Women need external validation of their success or worth.	<ul style="list-style-type: none"> • Good grades as a significant factor in choice of major ($UW > UM$) • Extent of feeling evaluated fairly by faculty ($UW > UM$) • Amount of support or encouragement for academic work from organized discussion or support groups ($GW > GM$)
Women tend to underestimate their ability to succeed, especially in technical areas.	<ul style="list-style-type: none"> • Confident of their abilities ($UW < UM, GW < GM$) • Extent of feeling prepared by their previous studies ($UW < UM$)
A financially rewarding career is one of the primary reasons for women's decision to study science or engineering.	<ul style="list-style-type: none"> • Anticipation of a financially rewarding career (<i>no significant differences</i>) • Interest in the subject as a significant factor in choice of major ($UW < UM, GW < GM$) • Likelihood of serving as a leader in their field ($GW < GM$) • Likelihood of attaining the salary level that they desire ($GW < GM$)
Women are more likely than men to reject science or engineering because of certain prevalent attitudes toward work in the classroom and workplace (hierarchical organization, competition rather than cooperation, etc.).	<ul style="list-style-type: none"> • Extent of feeling discriminated against ($GW > GM$) • Extent of feeling sexually harassed ($UW > UM, GW > GM$)
The fear that it is hard to balance family and a science or engineering career turns women away from studying science or engineering.	<ul style="list-style-type: none"> • Likelihood of interrupting career to raise a family ($UW > UM, GW > GM$)

* UW = Undergraduate Women, UM = Undergraduate Men, GW = Graduate Women, GM = Graduate Men

Discussion of Hypotheses

We have analyzed the data for gender differences between students currently enrolled in science and engineering. The significant differences are stated for the $p=.05$ level. The students in science and engineering constitute seventy one percent of all students who returned the survey. Of these students, sixty one percent of them are undergraduate students (48% male, 52% female) and thirty nine percent are graduate students (56% male, 44% female).

Women who responded to our survey do need external validation of their success or worth. Undergraduate women reported that good grades in their major or related subjects were significantly more important to their choice of major as compared to what undergraduate men reported. For the undergraduate women, good grades ranked second only to interest in the subject as a significant factor in their choice of major. Undergraduate women also reported a significantly higher extent to which they feel they are evaluated fairly by the faculty than undergraduate men. Graduate women reported receiving significantly more support or encouragement from organized discussion or support groups for their academic work than graduate men reported.

Women tend to underestimate their ability to succeed, especially in technical areas. Although women have higher SAT scores than men in different disciplines, undergraduate women reported feeling significantly less well prepared by their previous studies than undergraduate men reported. Despite the fact they often achieve higher overall grade point averages, both undergraduate and graduate women reported feeling significantly less confident of their abilities than their male classmates.

Perhaps this is why undergraduate women reported a significantly higher extent to which they feel they are evaluated fairly by the faculty than undergraduate men. This is interesting to report because their expectations of the grades they deserve are lower. One piece of evidence for the latter explanation is that women with higher grades reported to be less likely to apply for graduate school or for prestigious fellowships.

A financially rewarding career is one of the primary reasons for women's decision to study science or engineering. Anticipation of a financially rewarding career ranked as one of the most important reasons for choosing a major, but there were not significant differences between men and women at either the undergraduate or graduate level. However, when describing their level of interest in the subject as a factor influencing their choice of major, both undergraduate and graduate women report being less interested in the subject material than their male classmates. We are interested in looking at the relationship of this variable to the fields' service orientation. Furthermore,

graduate women report feeling less likely that they will serve as a leader in their field compared to reports from the graduate men. The graduate women also report feeling that they are less likely to attain the salary level that they desire.

Women are more likely than men to state that they feel uncomfortable in science or engineering because of certain prevalent attitudes toward work in the classroom and workplace (hierarchical organization, competition rather than cooperation, etc.). Both undergraduate and graduate women report feeling sexually harassed to a significantly greater extent than their male classmates. Graduate women also report feeling discriminated against more extensively than male graduate students.

The fear that it is hard to balance family and a science or engineering career is greater for women in science and engineering. Both undergraduate and graduate women reported being more likely to interrupt their career to raise a family than the undergraduate and graduate men. However, no significant differences were found between how likely men and women believed that they would be able to satisfactorily balance their career and family. In our interviews with students, we plan to explore whether this fear has turned women away from the field as we hypothesize it has.

Other Observations

The discussion of the hypotheses involved only factors where the institution may make a difference. Other factors, beyond the scope of the institutions, emerged as being significantly different for the male and female students. Differences between undergraduate men and women were discovered in factors relating to the extent of encouragement or support from people. Women reported encouragement from their parents as being significantly more important to their choice of major than undergraduate men. Undergraduate women also reported receiving more support or encouragement for their academic work from their spouse or partner and friends outside of the university than the undergraduate men.

The Faculty Survey

We pilot tested the faculty survey in summer 1992. The survey was developed to raise questions parallel to the student survey so that the resulting report could compare and contrast issues of similar concerns from the perspective of students and of faculty. In the faculty survey, we also test a number of hypotheses based on anecdotal evidence. For example, we are specifically interested in how parents of college-aged daughters answered the questions compared to others, and especially the way the responses of these

college-aged women's fathers' responses compared to others. We are in the process of revising the survey for distribution in the future.

A Case for Cross-Institutional Research

However interesting the results of these surveys or the surveys we are conducting on program effectiveness (not covered here), we believe that individual institutional surveys are of limited usefulness until we develop ways of comparing experiences across institutions. At Carnegie Mellon, the support programs are operating in tandem with the research being conducted. Findings can redirect the focus and programs will better suit the students' needs. Until we have a better understanding of different institutional climate, environment, and the nature of student and faculty populations at different institutions, it will be difficult to judge a potential for an effective program, and its application, especially for dissemination. We need to know more about which women (majority/minority, first generation college, low socio-economic income, or women with disabilities) do well in various environments. We need to know which programs have a positive impact on different kinds of communities. We need to know how a critical mass of women impacts male and female faculty attitudes, or whether attitudes are largely influenced by such personal experiences as having a college-aged daughter. We need to build a common set of hypotheses and design surveys which include some common open-ended and closed-ended questions. Then the use of a common method of analysis and discussion of interpretation can generate valid conclusions and recommendations to improve the retention of women, or indeed of all people in engineering.

Interdisciplinary, cross-university research is required to develop understanding of the impact of campus or department climate on women's attachment and retention; impact of a discipline's culture on faculty attitudes and behaviors, and how these factors interact in different institutional settings over time.

