

Recruiting Women into Engineering Graduate Programs

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Abstract - Since women are seriously underrepresented in engineering graduate programs, programs are needed to bridge existing retention programs for undergraduate women with retention programs for graduate women in engineering. These efforts are likely to strengthen the pipeline of women entering academia.

The National Science Foundation-funded Women in Engineering Scholars program is designed to encourage more women to pursue graduate school in engineering. The Scholars Program is administered through the Women in Applied Science and Engineering (WISE) Program at Arizona State University and it includes strong industry participation.

The Scholars Program is based on a theory of self-efficacy or one's belief about how well she or he can perform a given task or behavior: this includes providing the students with opportunities to experience performance accomplishments, encouragement, and support. The first programmatic component is mentoring for the participants by women earning, or who have earned, graduate degrees in engineering. This aspect also provides for formal and informal networking opportunities to create a supportive community for the participants. This segment concludes with an industry-sponsored banquet for the Scholars, their mentors, and other supporters.

The second component includes a series of workshops and seminars on what to expect from, and how to apply to, graduate school. The highlight of this segment is an 8-week summer research experience with an Engineering faculty member. This experience concludes with research symposia at which Scholars present their projects and accomplishments.

A description of the program will be presented including budget and funding, participant recruiting, preliminary results, and lessons learned.

Introduction

Women continue to be seriously underrepresented in engineering graduate programs. In Fall, 1996, women accounted for only 19.2% of the masters students and 16.2% of the doctoral students enrolled in engineering programs [Engineering Work Force Commission, 1997]. A recent survey found that only 44% of students majoring in engineering their freshman year were still in engineering their senior year. Women and minority students were more likely to switch out of engineering than men and majority students [Astin, 1996]. Additionally, the transition from

undergraduate to graduate programs is one of three critical points in a woman's engineering education [Betz, 1994].

While many programs seek to facilitate women's entry into engineering there are few programs which encourage women to pursue graduate degrees in engineering. Programs are needed to bridge existing retention programs for undergraduate women with retention programs for graduate women in engineering. These efforts are likely to strengthen the pipeline of women entering academia.

By increasing the number of women obtaining graduate degrees in engineering, the number of available role models for women considering engineering will increase. Also, given that engineers with graduate degrees tend to exert more power and influence in industry, increasing the number of women with such degrees will help to create a more gender-inclusive environment. Finally, because some individuals earning graduate degrees in engineering remain in academia, increasing the number of women earning such degrees with help to create a more gender-inclusive environment in engineering, especially in graduate programs.

Women in Engineering Scholars Program

The National Science Foundation-funded Women in Engineering Scholars program is designed to encourage more women to pursue graduate degrees in engineering. The Scholars Program is administered through the Women in Applied Science and Engineering (WISE) Program, in the College of Engineering and Applied Science (CEAS) at Arizona State University.

The Scholars Program aims to increase participants' self-efficacy for attending graduate programs in engineering and to increase the visibility of women in graduate programs, thereby helping to create a more gender-friendly environment. Self-efficacy is defined as one's belief about how well she or he can perform a given task or behavior [Bandura, 1977].

Self-efficacy theory as it applies to women's career development, particularly in engineering, has been widely researched [see Hackett & Betz, 1992]. They found that the socialization of women provides them with less access to the sources of information important to the development of strong expectations of efficacy with respect to their careers [Betz and Hackett 1981]. In fact, research has supported the idea that the sex-role socialization of females is less likely than that of males to facilitate the development of strong career-related self-efficacy expectations, particularly for nontraditional fields [Hackett, Lent & Greenhaus, 1991].

Women and girls today are either not encouraged, or are actively discouraged, from engaging in a variety of activities that serve to increase and strengthen their expectations of personal efficacy. Therefore, women's continued underrepresentation in engineering graduate programs may be due to low self-efficacy expectations with regard to behaviors required for the successful pursuit of and performance in those programs. The Scholars Program is designed to increase a young woman's self-efficacy for pursuing engineering graduate programs by providing her with opportunities to experience performance accomplishments, vicarious learning, encouragement and support, and lowered physiological arousal.

The Scholars Program also acts as a retention program for undergraduate women in engineering. By providing information about career opportunities for women with graduate degrees in engineering, the Scholars Program provides participants with motivation for continuing and excelling in engineering. In addition, by forming a community of peers, the Scholars Program enables participants to build a supportive network, which fosters their academic development.

As noted above, self-efficacy, or one's belief about how well she or he can perform a given task or behavior, is fostered through four sources of information: Past performance accomplishments, vicarious learning (seeing others model the behavior), encouragement and support, and lowered physiological arousal (such as lowered anxiety) [Bandura, 1986]. Performance accomplishment is reported to be the most effective means of increasing self-efficacy followed by vicarious learning.

The Scholars program consists of two major components, Professional Development and Community Building, which are designed to provide women students with opportunities to experience these four sources for developing self-efficacy for attending a graduate program in engineering. Within the Professional Development component, participants learn about what to expect from graduate school and how to apply, and gain experience conducting and presenting research. The Professional Development component is based primarily on the performance accomplishment source of self-efficacy. The Community Building component includes opportunities for participants to get to know one another and CEAS faculty, and includes a mentoring program. The Community Building component is based primarily on the vicarious learning source of self-efficacy. Encouragement and support, lowering of anxiety related to graduate school (i.e. physiological arousal) are sources of self-efficacy included in both components.

Program Description

Participants were recruited by letters, announcements, and flyers. Women, classified as juniors with a GPA of 2.8 or better, or who were nominated by a faculty member, were

eligible to apply to the program. For the Fall, 1997 cohort, the average GPA is 3.4. The program, limited to 20 students, includes 7 underrepresented minority students (1 Native American, 3 Hispanics, and 3 African Americans). Three additional students were invited to participate in the program as alternates with the understanding that they are eligible to participate in all program activities but would not receive a stipend.

Successful applicants to the program are called "Women in Engineering Scholar Nominees". Nominees attend an orientation session, during which their potential to pursue graduate degrees by virtue of their academic performance is acknowledged by the Dean of the CEAS. Nominees are introduced more thoroughly to the Scholars program activities, and have the opportunity to get to know one another through group activities and ice breakers.

Throughout the year, seminars and workshops on topics relative to graduate school are offered. Deans, department chairs, faculty, mentors, current graduate students, a representative from the Graduate College, and other related professionals present during these workshops. A sampling of workshop topics includes: What Can You Do With A Graduate Degree in Engineering, What to Expect from Graduate School, Choosing a Graduate Program, Faculty/Student Open-House, Breaking the Glass Ceiling, Writing an Effective Resume/Curriculum Vitae, The Graduate School Application Process, Interviewing to Get In, Gender Differences in the Classroom, and Creative Financing in Higher Education. Nominees must participate in a minimum of 8 of these 10 workshops to successfully complete the Scholars Program. However, each workshop is video taped so that individuals who are not able to attend may view them.

In addition to the workshops, once a month nominees have an opportunity to attend a networking event. These events are intended to help the nominees form a community which provides both a professional network and peer support and encouragement throughout the graduate school application process. Women who have obtained or are pursuing graduate degrees in engineering were recruited to serve as mentors for the nominees. Mentors are also invited to each event.

At the end of the year an awards banquet, supported by industry contributions, will be held for all nominees. All nominees, their parents, and mentors are invited to attend the awards banquet. At the banquet, those nominees who have successfully completed the academic year portion of the Scholars Program are awarded the title of "Women in Engineering Scholar", by the Dean of the CEAS and receive a \$500 scholarship to attend graduate school. All nominees receive a certificate of participation.

During the summer following the academic year activities, a Scholar participates in an 8-week research experience. Each research assistant works roughly 200 hours with local faculty and receives a \$1500 stipend. Faculty working with Scholars are required to attend a

diversity seminar that includes information on creating a gender-inclusive classroom and lab atmosphere. Twenty faculty with ongoing research projects agreed to attend such a workshop and include a Scholar in their summer research activities. In fact, there are more slots than are required to place all of the Scholars, however, this ensures that Scholars are matched with a research project of their interest. Through the diversity training and increased exposure to these talented engineering women students and mentors, participating faculty have a heightened sensitivity to the issues for women in engineering. Participating faculty are therefore an incidental population benefiting from the Scholars Program.

At the end of the summer, Scholars make a presentation about their research project at the Women in Engineering Scholars Research Forum. The Scholar's mentor and research project faculty and research assistants are invited to attend, and participants are encouraged to invite other guests. This Forum gives participants an opportunity to build research presentation skills. During her senior year, a Women in Engineering Scholar has opportunities to receive additional guidance for completing graduate school applications and other related tasks, provided by WISE Program and Graduate College staff.

The program is still in its first year; however, some of the visible successes of the program includes friendships among the participants; strong mentoring relationships; great workshops filled with productive interaction; and strong faculty support. The research experience will take place this summer and should prove to be a program highlight. The program was funded by NSF as a one-year pilot program; however, the program will be eventually instituted as a regular part of the WISE program activities sustained by industry, university, and research support. The program is housed within the WISE Program and coordinated by a half-time graduate assistant. At its outset, the budget included funds for personnel to run the program, travel funds for conferences, dissemination, and an NSF project directors meetings. Participant support costs were the biggest category in the budget, 40% of the entire budget (\$100,000). These costs include funds for scholarships and research assistant stipends for the participants.

Evaluation

Summative evaluation may direct some program modification, however, formative evaluation to date indicates a successful program. For the outcomes assessment since program participants are compared with other similarly abled and motivated students, the true effect of the program's influence on a woman in engineering's likelihood to pursue a graduate degree in engineering will be determined.

Since the Scholars program's goal is to increase the number of women in engineering graduate programs, the program hopes to maximize the number of applications to

these graduate programs. A control group was created in order to make comparisons between program participants and other similarly-abled and motivated students. Control group members will be matched as closely as possible with nominees based on their interest and confidence in pursuing a graduate degree, GPA, major, ethnicity, and age. In addition to control group members, information about program participants' application, acceptance and enrollment in graduate engineering programs is compared to other women and men in undergraduate engineering programs. Men and women who are seniors in engineering the year following the initial year of the Scholars Program will be surveyed via an existing e-mail network as to whether or not they have applied to graduate school. Those students who have applied to graduate school will be tracked to determine acceptance and enrollment rates. This information will be used to provide a baseline rate with which to compare program participants.

Outcome measures of the program will be: 1) Number of participants a) applying to b) accepted to c) planning to apply to and d) attending graduate programs in engineering the two years following the program, as compared to alternates or nominees who do not complete the summer research experience, a control group, and other junior women and men in engineering with similar GPAs; 2) Participants' GPA as compared to a control group; 3) Participants' retention in engineering as compared to a control group and to baseline retention data; 4) Participants' pre and post program self-efficacy for attending an engineering graduate program, compared with a control group; and 5) Participants' satisfaction with the Scholars program

Also, regardless of participants' career decisions, in order to determine how satisfied they are with the Scholars program so that improvements can be made for the future, a program evaluation survey will be completed by program participants at the end of the academic year programming, and again after the summer research experience. Also, focus group meetings were held at the close of the academic year for all participants, and again at the end of the summer for research participants. These groups discuss what was helpful or not helpful about the program, and what participants learned through their experiences. The focus group and surveys are administered through the Arizona State University Office of Evaluation.

Because women continue to be seriously underrepresented in engineering graduate programs and because the transition from undergraduate to graduate programs is one of three critical points in a woman's engineering education, programs are needed to bridge undergraduate programs to graduate programs for women in engineering. Programs such as the Women in Engineering Scholars program increases participants' self-efficacy for attending graduate programs in engineering (recruitment) and it also acts as a retention program for undergraduate women in engineering

by providing participants with motivation for continuing and excelling in engineering.

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