

MENTORING AND COMMUNITY SERVICE FOR RECRUITMENT AND RETENTION OF WOMEN IN SCIENCE AND ENGINEERING AT THE UNIVERSITY OF ARIZONA

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Abstract — Two programs through the Women in Science and Engineering program (WISE) at the University of Arizona (UA) focus recruitment and retention efforts on women from community colleges and the university in science and engineering. Project Futurebound recruits women in science, technology, engineering, and mathematics (STEM) fields, with a special focus on women of color, from Pima Community College. Transferring women are supported through a mentoring community and internships in UA research laboratories. Strategies for dealing with transfer shock and building community among women students have been key for retention. A second program, the Virtual Development Center project, engages women engineering students with local communities in designing technology with social relevance. Women engineering students motivated by the desire to contribute to community have volunteered to participate in these projects and talk about the relevance of the projects as a deciding factor for staying in engineering.

Index Terms — community service, mentoring, recruiting, retention

INTRODUCTION

Research by Hartman [1], Seymour [2], and Seymour and Hewitt [3], offers specific strategies for addressing bias, discouragement, isolation and socialization problems that inhibit young women's entry into and persistence in the sciences. Strategies include improved counseling about academic, career, and personal concerns; use of role models and mentors; and taking advantage of cooperative arrangements across educational levels. MacCorquodale [4] noted that women who enter careers in science, math or engineering need high levels of academic self-confidence. Having encouraging mentors and career counselors has been reported as vital for women students. Research on minority students who have left the sciences [3] highlights two additional critical areas: providing adequate income and financial support during schooling and strengthening pre-college and/or community college preparation for many minority students.

The Women's Experiences in College Engineering (WECE) Project [5] was an evaluative study of Women in Engineering (WIE) or Women in Science and Engineering (WISE) programs in the retention of women students in STEM fields. The WECE Project followed the often-cited 1997 study by Seymour and Hewitt [3] which examined why undergraduates leave science and engineering. WECE was a cross-institutional study focusing on college experiences to explain the persistence, or conversely, the attrition of women in engineering programs. WECE researchers hypothesized that five critical factors would explain the lack of women in engineering:

- Lack of self-confidence and engineering self-efficacy,
- Lack of pre-college experience and knowledge in engineering,
- Curricular focus, pedagogy, and climate in engineering,
- Lack of female peers and role models,
- Gender and societal issues.

The WECE Project results offered many recommendations to increase retention of women in engineering. Among those recommendations were:

- collaborative outreach projects between universities, community groups, and local school districts
- increasing points of contact with women early in their academic careers
- building a community of women in engineering to reverse the affects of isolation, self confidence, self-efficacy, and "chilly climate" issues and increase persistence of women students.

Margolis and Fisher [6] and Goodman [5] reported that women students in STEM who participate in social enrichment activities are more likely to stay in engineering. Mentoring, study groups, internships, and other related activities can all contribute to feelings of belonging and self-efficacy for women in engineering.

Transfer students from community colleges are confronted by additional challenges such as *transfer shock* (dropping GPA in first semester following transfer). Transfers have a difficult time maintaining a high GPA,

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while working additional hours to meet financial needs and coping with transitional issues. Transfer shock often results in a student's decision to drop out of science or school all together. Rhine et al. [7] advise warning prospective transfers that a drop in GPA is likely to adequately prepare individuals psychologically for transfer shock. Carlan and Byxbe [8] have shown that transfer students who get past transfer shock and persist continue to improve their grades and achieve similar GPA's by graduation time to those students who entered a four university as freshman. But will they survive transfer shock?

WOMEN IN SCIENCE AND ENGINEERING PROGRAMS AT THE UNIVERSITY OF ARIZONA

Two programs through the Women in Science and Engineering program (WISE) at the University of Arizona (UA) focus recruitment and retention efforts on women from community colleges and the university in science and engineering. Project Futurebound recruited women, with a focus on women of color, while at community colleges who were considering transfer to the UA in STEM fields. A second program, the Virtual Development Center (in collaboration with the College of Engineering and Mines), recruited sophomore engineering women willing to work on community action internships with local middle schools as part of a VDC Sophomore Initiative. Junior engineering women were also recruited (volunteered) for the 2-year VDC project explained below.

The Futurebound program seeks to address "transfer shock" and to increase success/retention of women transfers by building a mentoring community of STEM women at UA and providing information for navigating the university system. *Project Futurebound: Identification Of Effective Strategies To Increase Placement And Success Of Women In Science And Engineering (Special Focus: Minority Women)* is funded by the National Science Foundation (NSF) under grant No. HRD-0120878. The Virtual Development Center (VDC) Program in the College of Engineering and Mines seeks to involve women in the design and use of technology by bringing together women, engineering students and community members to envision new technological solutions. Our objectives for the sophomore initiative are:

- to stop the flow of sophomore women away from engineering by involving them in relevant community projects,
- to engage students with women mentors from industry,
- to present role models to the middle school girls.

The Futurebound and the VDC Sophomore initiative came together with the common goal of retaining women in engineering. Each Futurebound transfer student was assigned a faculty mentor at the community college and a research sponsor at UA. Additionally, transfer students met weekly as a group with the director and graduate assistant for the program. Futurebound provided yearlong stipends for

the research experience for both the transfers and sophomores. Transfers worked within research laboratories at the UA. Sophomore engineering women volunteered to work in teams of four with an industry mentor from the Society of Women Engineers, a teacher, and middle-school students at local middle schools. Sophomores met with teachers and industry mentors weekly and with VDC faculty advisors monthly to report on project status.

Futurebound Project

The specific context of the community college and the attributes of its student body are critical to the Futurebound Project. We recognize that women and girls from ethnically underrepresented groups are not a homogeneous group or one analogous to men from the same groups. Community college students are older on average than university undergraduates, have more familial responsibilities, and greater needs for income. They are most often women, non-white, and first generation [9]. Affordable tuition, flexible class schedules, smaller class sizes, and accessible faculty are all characteristics that lead higher proportions of students of color, and especially women of color, to begin academic pursuits at community colleges rather than four-year colleges and universities. Turning to the community colleges, e.g. Pima Community College, a Hispanic Serving Institution or Dine Community College (on the Navajo Reservation) as the site to recruit and advance students of color, offers a promising pool, especially of women of color. The specific characteristics of community college students also point to the need to tailor programs to them.

Program components aimed at addressing transfer shock and increasing student success are:

- Internship
- Research Seminar
- Program Mentoring (director and graduate assistant)
- UA Research Sponsor Mentoring
- Career Seminars
- Pre-transfer Course
- Pima Community College Mentoring
- Orientation
- Peer Tutoring
- Peer Study Groups.

During the first year, 25 community college students were admitted to the Futurebound program and paired with Pima Community College faculty mentors. After transferring to the UA all students interviewed with UA researchers and notified the Futurebound program about research preferences ranked from highest to lowest. Students were then assigned in most cases to their first choice research experience.

At the same time sophomore engineering women began middle-school projects and met regularly with VDC faculty, SWE mentors, and teachers. At one middle school the students redesigned traffic patterns around a school within a

busy urban setting to allow parents to drop-off and pickup their children safely. In a second school, sophomores worked with a teacher to revise curriculum and classroom demonstrations in line with math and science standards.

All 40 women students (transfers and sophomores) participated in a Research Seminar in Spring 2003 which met weekly to discuss issues of gender and ethnicity, ethics, and careers in science and engineering. The spring seminar class culminated in a student symposium where students presented on their research internship projects.

Virtual Development Centers (VDC)

The University of Arizona is one of ten university sites participating in the Virtual Development Center, along with Santa Clara University, Purdue, Texas A&M, Smith College, University of Colorado at Boulder, University of Arizona, University of California at Berkeley, University of Washington, and University of Texas at El Paso. The VDC, conceptualized by the Institute for Women and Technology (IWT), seeks to engage women from culturally diverse groups in the development of new technologies.

At the UA the leadership team includes engineering faculty (Aronson and Goldberg) and a WISE research scientist (Reyes). The UA VDC program recruits sophomore and junior level women engineering students to work on community-based design projects. The sophomore initiative was explained earlier. Here we will focus on the junior-senior level projects. The juniors participated in a 2-year program which began by building a relationship with a community partner, gathering information on community needs, creation of a *Requirements* document which outlined a technology solution to address needs, and finally building and field-testing technology with the community partner.

Year 1 opens with an Innovation Workshop, facilitated by IWT, and brings together community members, engineering women students and faculty to brainstorm important issues and needs of the community. The Innovation Workshop creates an environment in which every voice is heard and all ideas are valued. Ideas are discussed with increasing focus until a few projects can be defined. The final product from Year 1 is a *Requirements* document. In Year 2, continuing students from Year 1 lead multidisciplinary design teams of mixed-gender students in implementation of the *Requirements* document and field-testing of the new technology with the community partner.

In 2001, engineering women students developed a *Requirements* document which outlined client needs for creating an information system for lay health providers (Promotoras) in Nogales, Arizona. In Fall 2002, two of the women students returned to lead a team of engineering students in the development and field-testing of the technology that will be delivered to the Promotoras at the end of the spring semester 2003.

The first Innovation Workshop of 2002 was held at the Community Foodbank Program offices in Tucson, AZ. Twenty-seven community representatives (i.e., local farmer,

food cooperative owner, restaurant owner, compost program person, food security commission members, foodbank workers) joined university faculty and students in brainstorming projects needed by the Tucson community working on food security. Women students chose one project to develop while continuing to meet with Foodbank staff for clarification of needs. A second Innovation Workshop was held with members of the Tucson Muscular Dystrophy Association (MDA). Students spent the remainder of Project Year 1 meeting with MDA staff, patients, families, and medical personnel to refine the MDA *Requirements* document. The technological solutions, for the Foodbank and MDA projects, will be the final products of 2003-2004 year student teams led by some of the women students who have worked on the *Requirements* documents during 2002-2003.

RESULTS

Weekly meetings with Futurebound transfers during the fall semester were filled with discussions about time management, intense expectations of courses, poor teaching and good teaching, internship experiences, test taking skills, and adjustments as a result of moving from small classroom settings at the community college to large classes at the university. Only three of the original Futurebound participants left the program. Futurebound students (transfers and VDC sophomores) were asked to complete questionnaires and volunteers (self-selected) participated in year-end focus groups. In year-end focus group interviews, Futurebound transfer students articulated their dependence on the group for support.

The support group was really important, it was a hard transition. I would have felt like a failure (without it).

Futurebound provided valuable research experience, contacts with professors that you could maybe continue on with, in graduate school.

The program was invaluable!

Of all of the program components offered to address transfer shock, transfer students ranked the research lab and mentoring by program director and graduate assistant as the most valuable. Questionnaires asked students to rank the most important program components for their success in STEM. Students ranked Internship (94%), Research Seminar (72%), Mentoring (48%), and Career Seminars (44%) as the most important program components.

When asked *Q: What do you feel were the benefits you received from your participation in this program?* Transfer students focused on the mentoring, support (emotional and monetary) and research experience, all elements that contributed to their success.

TABLE I

FUTUREBOUND ENGINEERING STUDENTS EXIT SURVEY RESULTS OF BENEFITS FROM PARTICIPATING IN THE FUTUREBOUND PROGRAM (N=15)

<i>Q: What do you feel were the benefits you received from your participation in this program?</i>
<ul style="list-style-type: none"> • Great team experience. • Internship which related to my major and I formed great relationships with other women and learned a lot about group work. • Definitely had fun working with our group. • Learning how to work in a team with other female engineers and becoming involved w/a project that inspires young women. • Success of completing a project, meeting other sophomore engineers, learning more about design obstacles. • Working hands-on a project. • Working with the kids. • Experience working with engineers and in a team. • Working with great kids. Good resume application, good money and the best, working with great people, especially working with kids and five great ladies. • Public speaking experience had a lot of fun. • I got a paid job which gave me experience in my field and led me to learn that Civil engineering is not something that I want to do for life. • Experience not only in the engineering field, but politics that go into getting a design passed. • Valuable experience with women engineers and a good introduction to the design process. • Establishing a relationship with my peers and learning how to be a mentor myself. • Networking with other engineers, being able to apply engineering skills and relationships with the community and professors.

Engineering sophomores valued the team experience and working with other women in engineering.

TABLE II

FUTUREBOUND/PCC TRANSFER STUDENTS EXIT SURVEY RESULTS OF EXPECTATIONS OF BENEFITS FROM PARTICIPATING IN THE FUTUREBOUND PROGRAM (N=16)

<i>Q: What do you feel were the benefits you received from your participation in this program?</i>
<ul style="list-style-type: none"> • Learned a lot. • I learned a great deal about the reproductive physiology of cattle and the impact of infertility in beef and dairy cattle. • I have learned a lot and made a lot of contact. • Practical experience- broadening view of science. • Research techniques. • The class was very interesting and made me aware of many gender aspect (sic). • Much More! Advice, finds, internship. • I was able to work with wonderful people in Dr. _'s group. • The experience I gained by working in lab. • Research experience. • Working with grad students and meeting people like me. • Excited • I learned about research, friendship, and lab work. • Exposure to research, a great research group to work with and networking opportunities. Most of all, I received the benefits of a great mentoring program. • Networking skills. • I feel I had a very valuable experience in my internship, I enjoyed it very much.

During interviews at the start of the VDC project in 2001, women engineering students ranging from sophomores to seniors, talked about having doubts concerning whether they should remain in engineering or change majors. Reasons for the uncertainty were never based on academic inability. Instead the doubts were the result of not wanting to sacrifice other aspects of their lives to fulfill expectations for engineering students. Specifically women students spoke of the desire to "have a life", wanting to combine diverse interests (working with children, photography, history, art, etc.) with engineering work, and contributing back to their own communities.

VDC participants were able to address needs to combine varied interests and found satisfaction in community service. We also found that women engineering students in same-gender groups during Year 1 were more self-confident by year-end than they had been at the beginning of Year 1. Women students talked about a new willingness to take lead roles in mixed gender groupings following experiences in Year 1. Prior to the VDC involvement, our women students spoke of stepping aside to allow male students to take the lead in technical projects. The UA VDC project created spaces in which women students could build self confidence,

work on relevant community projects, combine diverse interests, and pay back their communities.

Both in the literature and in personal communication, women students have expressed the need to feel that their training is relevant; i.e. training can be applied to real life problems and pay back their own communities. We hope that it is an effective method for both recruiting and retaining women and students from underrepresented ethnic groups in STEM fields.

Women students have also expressed a desire to bring together multiple interests in their lives as often as industry has called for broader training of students to include teamwork, communication, and project management skills. A panel discussion between professional engineers from local Arizona industries and UA engineering women students, prompted a Navajo woman student to ask why potential salaries dominated discussions when she wanted to know how she could "... return to the reservation and do some good". Moving students from the classroom out into the community, to work on socially relevant projects where students can bring together desires for community contribution and varied interests outside of engineering, puts engineering in a whole new context. The context is one in which women and multicultural engineers can move into positions as future leaders in research, industry, and small business realms. It also has tangible benefits for the communities to which Native American or other students of color are culturally connected and committed to contributing.

CONCLUSION

The WISE program at the University of Arizona has a strong commitment to increasing participation and success of girls and women, especially women of color, in STEM fields. Discussions with administrators of graduate preparation programs at UA such as MARC (Minority Access to Research Centers funded by National Institutes of Health) and McNair Scholars (funded by the Federal TRIO Programs), reveal low numbers of minority women participants at the UA. Transfer students from community colleges often experience transfer shock (dropping GPA in first semester following transfer), little to no laboratory experience, and financial burdens [9]. Since applications for graduate preparation programs are often due during the spring semester following transfer to UA, transfer students have a difficult time maintaining the necessary GPA and gaining research lab experience while working additional hours to meet financial needs and coping with transitional issues. These administrators suggested that a year long paid research internship experience on the UA campus would allow transfer students to earn a stipend, gain laboratory experience, focus on academic success and result in a larger pool of women of color applicants feeding into their

programs. Researchers [8] have shown that students who survive transfer shock continue to improve their grades and achieve similar GPA's by graduation time to those students who entered a four university as freshman.

While community colleges are a source from which to recruit women of color to STEM, mitigating transfer shock by providing a strong network of support and research experience is crucial for retention after transfer to a university. Service projects, for women who want to contribute to community, are also a powerful means of engaging female STEM students at the university who might otherwise opt out of STEM fields that seem too removed from real life issues. Meanwhile, community service projects are addressing unmet needs of local communities and underrepresented populations.

In the short term, we have only affected pedagogical change in the courses and projects related to Futurebound and the Virtual Development Center. We have however been able to address:

- Lack of self-confidence and engineering self-efficacy,
- Lack of female peers and role models,
- Gender and societal issues, and
- Attrition due to transfer shock

while focusing on the needs of community college women for financial assistance and academic support. Providing research experience and stipends through paid year-long research internships and building a community of STEM women has convinced women to stay in STEM fields at the UA.

We are convinced that collaborative projects such as Futurebound and VDC, which address specific needs of women transfer students and moving other women students into relevant community projects. These programs also represent a significant opportunity for recruiting women, especially women of color, from community colleges and for retaining women in science and engineering at universities who are at risk of switching out of STEM.

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