

Strategies for Retention and Recruitment of Women and Minorities in Computer Science and Engineering

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This paper describes the efforts and results of a plan for actively recruiting students to undergraduate computer science and engineering programs at the University of North Texas (UNT). It also describes a series of activities aimed at improving retention rates of students already in our programs. Such recruitment and retention of students is critical to the country's efforts to increase the number of engineering professionals, and is a priority for the Computer Science and Engineering (CSE) Department at UNT.

INTRODUCTION

Computer science and engineering communities have been exploring efforts to attract more students, especially women and minorities, to computer science and engineering degree programs and to retain them once they are there [1]. This paper describes the efforts and results of a plan for actively recruiting students to undergraduate computer engineering programs at the University of North Texas (UNT). It also describes a series of activities aimed at improving retention rates of students already in our programs. Such recruitment and retention of students is critical to the country's efforts to increase the number of engineering professionals, and is a priority for the Computer Science and Engineering (CSE) Department at UNT.

Students often arrive at the decision to go into engineering because they performed well in mathematics and science in high school. However, they typically lack a realistic understanding of what computer engineering is. Students struggling with the transition

from high school to college see very little “real” computer engineering to inspire them, and thus they tend to opt out after their freshman year.

We designed a three-part plan to achieve our recruitment and retention goals:

- Sponsorship of *portable and mobile* summer computer engineering robotics camps for middle and high-school women students, coordinating with the regional Girl Scouts council to help with recruitment;
- Creation of an Ambassadors’ program using current computer science and computer engineering students as a form of outreach to area high schools and junior colleges; and
- Expansion of our successful undergraduate mentoring program.

To implement our three-part plan, we executed the following three strategies:

Strategy 1. Summer Robotics Camps: Based on the success of the BEST Robotics (Boosting Engineering, Science and Technology), sponsored by the UNT College of Engineering, and First Robotics programs in area high schools and middle schools, UNT CSE sponsored several one-week Robotics Summer Day Camps for middle and high-school women.

Strategy 2. Ambassadors Cohort: The CSE Department identified and recruited a core group of current students to act as Ambassadors for the Computer Engineering program. These Ambassadors accompanied faculty members and advisors on recruiting visits to area high schools and junior colleges in order to share their experiences and to answer questions from prospective students. They also served as hosts for open house events for prospective students and parents visiting the College of Engineering and the CSE Department.

Strategy 3. Mentors Cohort: In conjunction with the Ambassadors cohort, this effort expanded the duties and membership of the cohort to include upper-level undergraduates to serve as mentors for small groups of students, targeting specifically women students enrolled in engineering. Mentors met with these new students several times during each semester and assisted them with the rigors of adapting to the university and the CSE program, as well as assisted them with specific problems in their coursework. Each mentor maintained a set of hours every week in which they were available to their mentees in a Help Clinic.

The three phases are built upon currently accepted educational practices. The robotics summer camp used problem-based learning approaches, similar to those described in [2]. This study clearly demonstrates the significant benefits of teaching students how to think by using a problem-based approach. We developed a mobile laboratory so that the summer camp can be held at several locations, thus broadening and expanding the reach of the camps to traditionally underserved populations and geographical regions. Similarly, both the ambassador and mentoring programs derive from research showing how the recruitment and retention of women in engineering-related fields can be increased by providing opportunities to develop student-to-student relationships [3, 4].

STRATEGIES TO INCREASE ENROLLMENTS AND RETAIN EXISTING STUDENTS

Strategy 1: Summer Robotics Camps

Special summer camps for engineering students are a strategy that has been effective in promoting computer engineering among high school women [5]. Evidence exists that a curriculum developed around the programming of robots can attract new women students into computer science and engineering. As a result of this research and our experience hosting the *BEST Robotics program*, we sponsored two, one-week Robotics Day Camps for women in grades nine to eleven; one camp was offered at the North Texas Research Park in Denton and a second at a location in Dallas. The motivation for these camps was to increase the number of women who select computer engineering as a field of study. Our mobile laboratories allowed us to hold summer camps at multiple locations, thus broadening and expanding the reach of the camps to traditionally underserved geographical regions.

The Robotics Camps were organized around team-based, project-oriented activities that utilize a number of mobile resources, including laptops and the BOE-BOT (Board of Education Basic Stamp Microcontroller Carrier Board produced by Parallax). The curriculum consisted of open-ended projects that produce observable behaviors and allow students to explore beyond the limits of the defined exercises. Such activities included programming the robots to draw different shapes as creative as the ones shown in Figure 1. Teams explored collaborative and collective efforts as well as independent operations. Working in a team environment encouraged the camp attendees to make individual contributions to the overall success of their efforts, regardless of whether their individual strengths lie in problem analysis, system design, construction or programming.



FIGURE 1

ROBOTS CAN BE PROGRAMMED TO “DRAW” AND “DOODLE” CREATING ROBOART AS SEEN BY THESE STUDENTS HIGHLIGHTING THEIR COLLABORATIVE EFFORTS IN USING THE ROBOTS

The camps’ enrollment was limited to women in the ninth, tenth, and eleventh grades. Evidence from the BEST Robotics events held at UNT in the fall of 2005 indicates that women are particularly attracted to educational and creative activities focused on robotics. For example, over one-third of the students who participated in the 2005 BEST competition were women. Anecdotal evidence from women attending this event, however, suggests that interaction among team members could be improved significantly if women-only teams were allowed to compete. Several women complained

that their male teammates often ignored their advice or suggestions. As a result of such remarks and other research [6], we have decided to limit camp attendees to women only.

In order to ensure that there were sufficient numbers of women participating in the camps, we embarked on an aggressive recruitment plan. We believed that the BEST Robotics program was one of our greatest sources for potential participants. The BEST Robotics program, conceived and launched by engineers at Texas Instruments, held its first competition in 1993. The program has grown steadily, expanding beyond Texas into 11 different states, with over 6000 students competing in 27 local events. UNT's hosting of a site provided a great opportunity to recruit young women who participated in this event.

In addition, representatives from the Girl Scouts of the Cross Timbers Council (GSCTC) had agreed to work with us in advertising and promoting the robotics camps. Currently, 172 ninth through eleventh grade women participate in the GSCTC, and GSCTC's overall recruitment efforts extend to all North Texas area schools with a potential audience of 11,000 women. The Cross Timbers Council assisted in recruiting eligible participants from the other Girl Scout councils in the Dallas-Ft. Worth metroplex, and helped with some of the administrative duties. Finally, we visited nearby schools' robotics and technology clubs and made presentations to educate and recruit women students.

Strategy 2: Ambassadors Cohort

National statistics show that the most critical time for losing students is at the end of their first year in college [1]. Several studies have argued that colleges can improve retention by establishing a group ethos or identity [7, 8]. The role of the "community" is even more important for increasing women retention rates. For example, retention studies for underrepresented groups in engineering have shown that a cohort of peers can be an extremely effective factor in retention. Astin [3] maintains that a student's peer group is the single most potent source of influence for enhancing student learning and personal development.

Based on these studies, we identified and recruited a group of women students who are currently enrolled to act as Ambassadors for the Computer Engineering degree programs. These Ambassadors accompanied faculty members and advisors on recruiting visits to area high schools and junior colleges. They shared their experiences and helped to answer questions from prospective students. The Ambassadors also served as hosts when prospective students visit the CSE Department. In addition, they served as mentors for small groups of freshman or transfer students in order to help them with the transition into CSE. Cohorts consisted primarily of students from traditionally underrepresented groups, including women. In turn, the recruiting and mentoring activities of the cohorts focused on the needs of the underrepresented segments of potential and entering students. The goal of this program was to create an environment within the CSE department that is friendly, inviting and nurturing to women students.

Strategy 3: Mentors Cohort

In conjunction with the Ambassadors cohort proposed in Strategy 2, we expanded the duties and membership of cohorts to include upper-level undergraduates to serve as mentors for small groups of students, targeting specifically women. Mentors met with entering students several times each semester and provided guidance or help wherever

needed. Each mentor maintained a set of scheduled hours in the Help Clinic to be available to their mentees. The program also provided a place for groups to gather several times each semester so that students could assess their progress and network with other students, thus creating a stronger sense of community within CSE.

Expanded Current Program to Improve Retention Rates

In a previous Technology Workforce Development project¹, the CSE department explored two strategies to improve retention of freshman students. The first strategy involved the development of a majors-only version of the introductory programming course. The second strategy was to create a Help Clinic staffed by undergraduate students who would act as mentors to aid students with problems in utilizing computer resources at UNT. Preliminary analyses of surveys and grade distributions may indicate that student performance improved as a result of these strategies.

In the fall of 2002, 25% of the students enrolled in the department's first computer science and engineering course used the Help Lab. This number increased to 60% in the spring of 2003. Course surveys conducted during this same period indicate that none of the students who used the Help Lab anticipated failing their classes, while students who never used the Lab had much lower expectations. In addition to students enrolled in the introductory courses, transfer students who were unfamiliar with C++ and/or UNIX systems used the Help Lab with greater frequency. Student surveys also include positive comments such as, "I would not have completed CSCE 1030 without the Help Lab", and the "TA and the Lab were excellent. I would not have been able to do half of the programs without his help in the Lab". In light of such success, and in keeping with our recruiting and retention strategies, we created an additional cadre of mentors, specifically targeted to assist students from underrepresented groups in their first year at UNT.

EVALUATION

The educational activities proposed here were designed to motivate student learning and improve retention rates of UNT's CSE programs. The project's overall goals were as follows: develop summer camps that include creative problem-solving laboratory experiences to attract women students to the field of engineering; create an Ambassadors program to help retain women in computer engineering; and expand existing mentoring programs to help create a learning community in CSE.

The evaluation plan included both formative measures to provide feedback to project developers and summative assessment to address project effectiveness. Formative evaluation strategies contribute to the development and implementation of the curriculum. Formative Evaluation questions included:

- How do students rate the quality of and their satisfaction with various activities?
- How do instructors, mentors, and cohorts view the usefulness of their activities or participation?

The summative evaluation addressed the quality and usefulness of the completed activities. Summative evaluation questions included:

- What was the overall quality and effectiveness of the activities based on student/participant ratings and reviews?

¹ TWD grant 003594-CS2002-0000 – *Retention Strategies for Computer Science and Engineering*

- How does the success of these activities compare to other Computer Engineering programs that have similar activities in terms of performance, retention rates, and recruitment rates?
- What were the demographic characteristics of students enrolled in each type of activity and how do they compare with demographic characteristics of students in the department as a whole?

Finally, we used a number of different evaluation techniques to document our success. These measures included participant activity evaluations, focus groups, participant performance, interviews (with students, faculty, and industry representatives), and a variety of surveys.

Overall these programs seem to have had a positive impact on our new student and continuing student values as compared with Fall 2004 to Fall 2005. Our overall student population has increased approximately 1.5% from Fall 2004 to Fall 2005 as shown in Table 1. Actually, our numbers have increased even more during this period, but the period coincides with the introduction of a new program in Computer Engineering that attracted some students away from Computer Science, although they still remain in the department. In the 2004-2005 year, approximately 80 students entered this program, with growth of about 25% in the 2005-2006 year. Even without the Computer Engineering students in the count, our growth is contrary to the downward national trend in Computer Science programs during the same period. We expect further improvement as we expand these efforts and we will continue to track the students who participate in both programs to determine their progress if already in a STEM degree program, or their eventual higher education choices as they move from high school into baccalaureate programs. The costs for the programs range from about \$212 per student engaged by outreach programs, to about \$600 per student in the mentoring programs. Student support for continuing and advanced students who assist with the programs averages \$375 per student. Table 2 shows the number of new minority and women students that have enrolled in Computer Science and Computer Engineering over the last two years. As can be seen the number of women in Computer Engineering has more than doubled in the last year.

| GOALS AND COSTS | | | | | |
|------------------------------|--|--------------------------|-----------------------------|--------------------------|---------------------------|
| | High School Students (Outreach) | Entering Students | Progressing Students | Advanced Students | Graduated Students |
| Fall 2004 Headcount | N/A | 88 | 253 | 436 | 390 |
| Fall 2005 Headcount | N/A | 230 | 233 | 324 | 382 |
| Number of students benefited | 400 | 150 | 25 | 40 | N/A |
| Dollar amount spent | \$85,000 | \$10,000 | \$15,000 | \$15,000 | N/A |

TABLE 1

NUMBER OF STUDENTS IMPACTED AND COST PER STUDENT GROUP

| | Fall 2005 | Fall 2006 |
|--------------------------|---------------|---------------|
| Computer Science | | |
| Total | 480 | 453 |
| Women | 49 | 54 |
| Men | 431 | 399 |
| Fraction of women | 10.21% | 11.92% |
| African American | 54 | 57 |
| Hispanic | 31 | 38 |
| American Indian | 6 | 6 |
| minority fraction | 18.96% | 22.30% |
| | | |
| Computer Engr | | |
| Total | 127 | 150 |
| Women | 11 | 25 |
| Men | 116 | 125 |
| Fraction of women | 8.66% | 16.67% |
| African American | 29 | 31 |
| Hispanic | 10 | 16 |
| American Indian | 1 | 3 |
| minority fraction | 31.50% | 33.33% |

TABLE 2

Women and minority enrollment in the Computer Science and Engineering Department at the University of North Texas for Fall 2005 and Fall 2006

DISCUSSION AND SUMMARY

Computer science and engineering communities have been exploring efforts to attract more students to computer science and engineering degree programs and retain them once they are there. This paper described the efforts and results of a plan for actively recruiting minority and women students to undergraduate computer engineering programs at the University of North Texas (UNT). It also described a series of activities aimed at improving retention rates of students already in our programs. Such recruitment and retention of women and minorities is critical to the country's efforts to increase the number of engineering professionals, and is a priority for the Computer Science and Engineering Department at UNT.

We initiated a three-part plan to achieve our recruitment and retention goals:

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