

Model for Mentoring and Retaining Engineering Students from Underrepresented Groups

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Underrepresented Groups in Engineering

This paper describes a successful model for integrating academic, social, and financial support with mentorship to retain engineering and science students in underrepresented groups at Tufts University. Our approach requires the commitment of faculty, graduate students, and university academic resource administrators. Good program management and schedule coordination are critical for the success of the program. After three semesters in the mentoring program, our students have shown significant improvements in GPA, and an increase in course completion rates as compared with those of their peers at Tufts University.

Introduction

It is widely recognized that there is an urgent national need to increase the enrollment of academically talented students, from underrepresented groups, in post-secondary engineering, science, and mathematics degree programs. However, merely getting them enrolled is not enough. If we, as a nation, are to have any chance of meeting the anticipated workforce demands in these high-technology fields, we must strive to improve the retention and graduation rates of these students and empower them with academic success. For students from low-income families and diverse backgrounds, strong support and encouragement is needed for them to persist in their quest for degrees in their chosen fields, given the demanding academic workload and often overwhelming adjustments required for college life.

For these reasons, Tufts University, with support from the National Science Foundation, has created the Computer Science, Mathematics, and Engineering Scholars (CSEMS) program to actively support a select group of first and second-year undergraduates through a combination of financial aid, peer mentoring, and academic enrichment. CSEMS scholarships are offered to financially-needy students, with priority given to women and underrepresented minorities. With the committed involvement of five faculty members and two graduate students, we have realized significant early success in our goals, namely the improved academic performance and retention rates of the CSEMS Scholars.

Tufts CSEMS Program

Through a coordinated comprehensive approach, the CSEMS program actively supports fourteen freshmen, ten sophomores, and three community college transfer students who are currently

enrolled in engineering, mathematics, and computer science degree programs. In addition to financial aid, the students meet on a weekly basis for faculty advisor conferences and academic enrichment workshops. Some of the students thus become involved in undergraduate research opportunities and summer internships with the faculty advisors. Moreover, the students are engaged in peer-mentoring activities through pairings between freshmen and sophomores, and small groups within a discipline.

Scholar Selection

CSEMS students are selected based on their intended majors (engineering, mathematics, or computer science), demonstrated financial need, and demographics. In accordance with the National Science Foundation, students who receive the awards are U.S. citizens, nationals, or aliens admitted as refugees at the time of application. Priority is given to women and underrepresented minorities.

Financial Aid

CSEMS Scholars are awarded an annual stipend, in lieu of federal work-study obligations, for their first two years of college. Award renewal in the second year is contingent upon satisfying the following conditions: scholars must be pursuing a major in engineering, computer science, or mathematics; scholars must be enrolled full-time; and scholars must maintain a 3.0 GPA in their program, or have developed a written plan with their advisor for academic improvement. The benefits of not having to work at a part-time job during the school year are obvious. Time ordinarily spent working for campus food services, or restocking library shelves can be redirected to academic endeavors, especially when students are presented with a robust support system and a framework for academic success. This award is currently being subsidized through the National Science Foundation. Effort is underway to secure long-term funding through individual donations, corporate sponsorships, and other government agencies.

Why Freshmen and Sophomores?

The transition from high school to college can be a difficult one: students need to assume responsibility for their own learning, more so than when in high school; they are expected to proactively seek out the help and support they need; the standards for coursework are higher; academic peers are all bright and motivated; and the increased size of the student body and campus can lead to a sense of being in an impersonal environment. The workload and rigor of introductory engineering and science courses can be especially daunting. As a result, many students become discouraged and transfer out of engineering and science majors during their freshman and sophomore years. In order to achieve the highest impact in our effort to increase the retention and academic success of these students, we focus on the first and second years of their college experience.

Peer Mentoring Groups

One unique aspect of the CSEMS program at Tufts is the establishment of peer-mentoring groups in which sophomores in the program advise freshmen on everything from course

selection and degree choices to resolving roommate disputes. Mentoring groups are formed on the basis of academic interest, and most freshmen have two sophomore mentors. The advantage of this situation is that in many cases a sophomore mentor can offer more personal and pertinent advice than a faculty advisor. Sophomores have the advantage of being able to clearly remember the struggles and successes, the agonies and elations, and the problems and solutions involved in being a freshman in an engineering or science field, since they have recently experienced them. Most sophomore mentor-freshman interaction takes place on an informal basis during the weekly meetings. In addition, sophomores are encouraged to touch base with their freshmen advisees in one-on-one sessions twice over the course of a semester. Acting as mentors allows the second-year students to reflect on their own progress since entering the program. In this way, they become more confident in coping with life in college and in tackling more difficult upper-division coursework.

Two graduate student mentors play pivotal roles in the peer-mentoring framework. They act as the 'meta-mentors' for the sophomore-freshmen teams, answering questions and offering advice on an on-going basis. The graduate mentors also act as the liaison between the faculty members and the CSEMS students. They plan and coordinate all activities for the program, communicate with the students and faculty members, and manage the data collection process for program assessment. Good program management and coordination is key to the success of the program.

Faculty Advisors

In addition to peer mentoring, the CSEMS program ensures that students have regular contact with faculty members currently involved with teaching and research in engineering, computer science, or mathematics. Five faculty members are currently involved with the program, serving as role models and advocates for the program's goals. All five are women, and they represent diverse cultural, ethnic, and academic backgrounds. The current CSEMS faculty members are from the departments of Civil and Environmental Engineering, Mechanical Engineering, Computer Science, and Mathematics.

The faculty members all attend one group session a month dedicated to advisor-student communication. In addition, at least one faculty member attends each weekly CSEMS meeting. By providing this extra attention and contact, we can recognize and address, at an early stage, the students' challenges and problems. This also allows advisors to build relationships and trust with their advisees so that students will feel that they have someone on the faculty to seek out for advice on college life and its expectations.

To help these students become more responsible for their academic work, and to alert advisors when scholars may require assistance, students report their academic progress at the monthly meetings. Should a student receive a C or lower on an examination, that student is expected to contact the advisor immediately rather than wait for the next regularly scheduled conference. If the problem persists, the student will develop a plan for seeking existing support resources. Those individuals who do not maintain a 3.0 average at the semester's end will be expected to develop a written plan for leveraging support services and improving their study regimen.

Academic Enrichment Activities

Through a variety of guest speakers who attend the regular weekly meetings, the CSEMS Scholars are exposed to a variety of resources, campus support services, and active research being conducted by university faculty. For example, in the first part of this semester (Spring 2004), the students participated in a workshop on writing cover letters, resumes, and job interview skills, had an opportunity to speak with a representative from the counseling center, and saw a presentation on routing algorithms for integrated circuit design. A sample list of topics that were implemented during the past semesters of the CSEMS program consists of:

- Study skills
- Coping with the fear of failure
- Finding research projects, internships, and summer jobs
- Help! How do I decide which courses to take!
- Minorities in majority environments: Staying afloat
- How to survive college
- Identifying careers in science and engineering
- Writing resumes and cover letters

Engaging Students in Undergraduate Research

The CSEMS program believes in the importance of undergraduate research. Students who are involved in research programs are more motivated, learn to cope with responsibility, develop leadership skills, and can better utilize their knowledge for real-life problem solving in their disciplines. We expose students to different areas of research and introduce them to faculty members who are seeking research assistance. As a result, we have been able to place 60% of the current CSEMS sophomores in undergraduate research internships.

Building a Sense of Community

Students with demonstrated financial need face more than just the constraints of time imposed by economic necessity. For them, succeeding in college is also a matter of understanding the codes of academia. It is a challenge that is often faced alone. The parents of many of these students, for example, are not college graduates, and so, are unable to impart critical insights as to what they can expect from academia. The lack of role models, such as older siblings or family members who have experienced academic success, also denies them assistance to map out the college terrain. Much of the protocol of academic life that more affluent students find familiar may appear strange and even off-putting. For women and underrepresented minorities such problems may be especially acute.

We believe that academic success in engineering and science majors is difficult to achieve if working alone. Feeling part of a group is essential through the first years of college, especially for women and underrepresented groups of students. Other than providing academic support and resources, the CSEMS program provides an opportunity for students to build relationships with one another through both our weekly meetings and other social activities that we organize. While a sense of community may be more difficult to measure than outcomes such as grade point

average (GPA) or course completion rates, we feel that it is an equally important benchmark of our program's success.

Program Assessment & Results

The program was assessed at the end of its first year by two staff members from the Center for Engineering Education Outreach (CEEEO) at Tufts. Data for the assessment were collected throughout the year using advisor logs, surveys, and individual and group interviews. The graduate student advisors collected the surveys at the end of each weekly meeting, and the CEEEO staff members conducted the interviews at the beginning and end of the school year. In addition, the CSEMS students' academic performance was compared with that of institutional averages in the Fall of 2003. Responses from the students regarding their perceptions of the usefulness of various resources as well as suggestions for improvements in the program were incorporated into changes for the second year.

According to the surveys, the two most successful aspects of our program were the content of the seminars and the development of a community on which the students could rely. The students particularly enjoyed the resume building workshop that helped them in preparation for applying for summer internships. Students also agreed that the seminars helped them to become more familiar with campus resources such as the Academic Resource Center, where students can get free help from tutors. Students further felt that the faculty research presentations provided insights into careers in engineering, computer science, and mathematics, as well as opened them to new ideas outside of their own fields of interest.

By the end of the year, the students had developed important relationships that fostered a sense of community. This community included the CSEMS students, graduate student advisors, faculty advisors, and deans. Several students described the support of this community as very important in their evaluation surveys. It was clear from the surveys that the overall effect of introducing the students to such a community was positive. As one student put it, "having more people to say 'Hi' to really makes you feel more connected." Furthermore, students agreed that involvement in the CSEMS program has both helped them meet more students outside their majors and made them feel like they were a part of a supportive community of students at Tufts. Thus, the CSEMS program successfully fostered relationships among students and faculty that should lead to the students' continued success in CSEMS majors at Tufts.

A Fall 2003 study which examined grade point average and number of courses dropped by CSEMS students compared to a control group of Tufts students found that despite dropping fewer classes (1.53 vs. 2.83 a year) the CSEMS scholars maintained higher GPAs (3.30 vs. 2.96) (see Table 1).

Table 1: Mean of GPA

Group	Fall GPA	N	Significance Level	Spring GPA	n	Significance Level
CSEMS	3.38	13	.018*	3.23	14	.055
Control	2.92	35		2.85	33	

*indicates a statistical significance of $<.05$

We also examined the number of courses that were dropped in mid-semester by students in the CSEMS programs compared with that of a control group. In CSEMS, 61.4% of students dropped at least one course during the academic year, while 97% of students in the control group did so (see Table 2).

Table 2

Group	% of students who dropped courses	# of dropped courses per student
CSEMS	61.4	1.53
Control	97	3.03

Finally, we are proud to maintain a 90% attendance rate at our weekly seminars even with excused absences for exams and other academic obligations. And, we are pleased that 60% of our CSEMS sophomores are actively participating in undergraduate research, gaining valuable experience.

Next Steps

While we are encouraged by the initial success of the CSEMS program, we realize that there is much work to be done to maintain, improve, and expand on these accomplishments. We have three primary objectives for the program in the coming year. First, we hope to include the involvement of two or three third-year CSEMS scholars who would contribute to the program in an advisory role. The primary responsibility of these advisors would be to provide training and support for the sophomore mentors and to organize community-building activities throughout the year. The addition of these advisors would be contingent on the procurement of non-NSF funding. Second, we hope to conduct a long-term study of the academic progress of our students. We hope that such a study would produce consistent and statistically relevant results that point to the continued success of the CSEMS scholars. Finally, we hope to build and expand on relationships with industry partners. The advantages of such relationships are many, including potential sources of funding, internship and job opportunities for our students.

Conclusion

The Tufts CSEMS model of financial aid, peer-mentoring, academic enrichment, and close contact with faculty members has empowered our students with a measurable level of academic success compared with their peers in only three semesters of operation. We believe that this program works. The CSEMS coordinators, with the cooperation and support of Tufts University, are striving to improve and expand the program to offer the same assistance to future engineers and scientists. Ultimately, we hope this program will improve the robustness, diversity, and sustainability of the American high-technology workforce while helping to bridge the gap that isolates our nation's disenfranchised citizens.

Acknowledgements

This paper is based on work supported by NSF grant #0220651. The authors would like to acknowledge the dedication of the CSEMS faculty and coordinators, as well as the unflagging support of the Tufts University administration. Christine Cunningham and Meredith Knight, from the Center for Engineering Education Outreach at Tufts University, conducted the evaluation and analysis of the program. Finally, we would like to thank the CSEMS Scholars. Without their enthusiasm and commitment, none of this would be possible.

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