

## **AC 2010-1356: UNDERGRADUATE ENGINEERS AND INTERDISCIPLINARY PEER-MENTORING GROUPS**

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# Undergraduate Engineers and Interdisciplinary Peer-Mentoring Groups

## Abstract

In conjunction with a National Science Foundation-sponsored scholarship program, we have implemented an interdisciplinary peer mentoring support system. This paper describes the structure of the scholarship cohort, its advising program and associated seminar, and presents results from interviews with engineering and computer science student participants. These results indicate key successes of this program and we provide implementation suggestions for other related programs. Overall, students made connections with peers from multiple majors, while developing academic, professional and life skills.

## Introduction

Facilitating professional development and mentoring for STEM (science, technology, engineering and math) students can be a challenge for programs but is important for students' ultimate success and satisfaction with their careers. A National Science Foundation S-STEM grant allows our Midwestern comprehensive university to award scholarships to cohorts of 23 students enrolled in one of the following majors: Mathematics; Computer Science; Biology; Information Technology; Electrical, Mechanical, Civil, and Computer Engineering; and Electronic, Manufacturing, Automotive and Computer Engineering Technology. Scholars can renew their \$5000 scholarships (which provides almost full tuition assistance) for up to a total of three years. Key components of the program are the integration of research and academic experiences and a broadened participation of underrepresented groups. Other grant implementations may focus on cohorts within a single major, such as the graduate software engineering program at UW LaCrosse<sup>1</sup>, but we feel the benefits of an interdisciplinary program offer value beyond the scope of a single-major program. Additionally, by including biology, we have been able to increase the number of women recipients, creating a sense of critical mass within the program to support the women in engineering and computer science.

Selected students receive financial support and an opportunity to develop academic, professional and life skills through a weekly scholars seminar. The seminars familiarize scholars with various university support services, allow participation in interdisciplinary discussions addressing broad academic and career issues, and build relationships with other scholars in an interdisciplinary setting. A small group of math, science and engineering faculty oversees the seminar and selection of scholars.

This paper describes the structure of the interdisciplinary scholarship cohort, its advising program and associated seminar, and presents results from anonymous surveys and semi-structured interviews with the engineering and computer science student participants from the first three years of the program. We also present background research supporting peer mentoring and faculty involvement, and describe the process of selecting our scholar cohort and the structure of the seminar. We conclude with implementation suggestions for developing similar interdisciplinary communities of learners in other settings.

## **Background**

One objective of this program is to raise the retention rate for scientists and engineers as they transition from under- to upper-classmen through STEM scholar involvement in learning communities and the more personalized faculty mentoring system developed for this project. Research shows that student success can depend on integration of academic and social experiences (e.g., Treisman<sup>2</sup>) which can be facilitated with collaborative learning, faculty mentoring and creation of study cohorts. Kraemer<sup>3</sup> suggests that faculty interaction with students, both formal and informal, as well as developing study habits, contributed strongly to Hispanic student persistence in academic endeavors. In a study of engineering students at four universities, Vogt<sup>4</sup> showed that faculty manner towards students, whether open or closed, creates a difference in student achievement. One goal of our program is to strengthen faculty-student interactions. Student feedback suggests that the seminar and other informal connections was a successful means to accomplish this goal. In addition, addressing the issue of cultural adaptation to an academic culture is important for underrepresented and non-traditional students. Besterfield-Sacre et al.<sup>5</sup> studied gender differences in freshmen engineering students related to their confidence and self-perceived ability to succeed in engineering. They found that female students had lower confidence than male students in their basic engineering knowledge and skills, problem solving abilities, and creativity. Building confidence in female students in their abilities to solve problems and master basic engineering concepts is essential encouragement to facilitate the pursuit of science and engineering career paths, where they are often the minority.

Given this background, peer and faculty mentoring of second year students and outreach to first year, prospective students and students transferring from community colleges is paramount to success in both raising retention rates and increasing the number of minorities in STEM disciplines. We directly address sophomores as they transition into the rigor of their advanced studies, juniors as they move into leadership roles and seniors as they enter the work force or graduate programs. Students are eligible to apply for the scholarship during their first year of study. The availability of scholarship funds is a strong incentive to prospective and first-year students.

## **Scholarship Selection**

Scholarships are available for 23 students per year and are renewable for up to a total of three years. For example, if a student enters the scholar cohort as a sophomore, their scholarship is renewable their junior and senior year. The progression of a student through the program provides valuable opportunities for “stepping stone peer mentoring” and individual student development. Our selection process addresses diversity issues by factoring in major, gender, year, eligibility for subsidized financial aid (a program requirement), community college background and first-generation status. In addition, we ask students to write a brief essay describing how they will contribute to the program diversity given a broad definition that incorporates such things as race, religion, socioeconomic status, and breadth of experience in communities. We strive to select students who are motivated and who could have an improved educational experience given the opportunity to be a member of the cohort, to attend the seminar,

and to reduce outside work hours because of the scholarship. Each year, we have assessed strong pools of candidates and found diverse recipients to create our cohorts of scholars.

### **Seminar Structure**

In developing this program, we created a weekly 1-credit seminar course listed at both a 200- and 400-level. This allows us to have distinct expectations for students at different points in their academic careers. A typical seminar may include a 10-15 minute lecture followed by small group work, a panel discussion, outside speakers or presentations by scholars. Scholars are regularly divided into smaller groups for discussion and peer-mentoring. Group composition varies to meet the specific objective of each discussion. For example, broad major groups are used to facilitate peer mentoring amongst students within disciplines. Groups by year (sophomore, junior, senior) are used to facilitate interdisciplinary discussions amongst students at similar stages in their education. We found that it is important to have less structured time to foster student-student and student-faculty interaction. Topic guidance provides the structure to allow students to establish connections, share personally and professionally, and encourage peer mentoring. Grading is credit/no-credit and is based primarily on attendance.

General seminar themes include student goals and reflections on progress towards the goals, career and graduate school preparation, small group interaction and group projects. Outside of the seminar, scholars engage with faculty and industry mentors on projects that apply their discipline to real-world problems and are encouraged to present their results and experiences to regional high schools and community colleges, as well as at conferences, including our university undergraduate research conference. The seminar provides scholars with an opportunity to explore a set of topics related to achieving success in academic, professional and personal realms. Speakers during our first two years included faculty from philosophy and biology departments, university alumni who are currently candidates in Ph.D. programs, a local yoga teacher, visiting researchers and industry members as well as student participants.

Although many topics were covered in only one class session, we have also assigned a group project each semester that has spanned several seminar sessions. For example, students explored the issue of global warming after having heard a research presentation about plants in the Antarctic. Another project was inspired by the students reading a novel with environmental themes over winter break. During the following semester, they discussed ethical issues related to environmental science, with framework provided by an ethics professor. The students also developed academic advising modules to be presented to first year STEM students. For each project, the groups were led by seniors who were responsible for organizing final presentations. Member selection varied but typically allowed an interdisciplinary group experience. The academic advising modules are currently incorporated into college advising seminars available for all students. The scholars take part in leading these seminars, supporting the outreach goals of the grant.

### **Student Feedback**

Two forms of feedback are presented here: from anonymous surveys and from interviews. Here, we focus on the richer answers provided in free-form student comments that accompanied the

survey questions. The ten interview subjects were from a variety of majors and we present the results from the engineering, computer science and information technology majors. The anonymous survey results came from the entire set of students. A limitation of this work is that it is only applied to students who are scholarship recipients. Thus the results come from a limited set of students. A long-term goal is to implement aspects of this program across the college to increase the number of students who benefit.

### **Anonymous Survey Results**

The benefits of the seminar for students tended to be related to learning a specific idea, such as interviewing skills or resume writing, or related to the networking and connective aspects of the program. A typical response was “getting to know other people outside of biology and understanding how different people learn, study, and think. Getting to know faculty through the program.” One student appreciated “associating with students that I have more in common with as opposed to the traditional student.” We also found evidence that students are reflecting on what they learn in the seminar and how it can affect the rest of their learning: “The work with learning styles made me more aware of my needs and others’ needs to accomplish learning.”

By soliciting student feedback at the end of each term, we were able to incorporate suggestions for improving the course in the next term. For example, there was a desire for help with “things that we cannot learn in classes that we take, like seeking a job, what it is like when we graduate, etc.” By hosting recent alumni as guest speakers, students were able to ask questions related to these issues. Another student sought increased mentoring development. In the subsequent term, we provided explicit discussions of mentoring, including classroom modeling of multiple types of interactions with varied groups and small and larger-scale projects.

Finally, another student described the benefits of learning non-content information in the interdisciplinary group: “This mix of assignments/projects allows for improving skills and experiences with both faculty and students. Learning through the experiences of others is valuable. It not only saves me time but it provides different perspectives to similar situations. These interpersonal skills will be of great benefit as I move on with my career and life.” While we are looking forward to improving the experience for students, with more outreach activities and improved connections with industry, comments such as “This is the best program our college could have” confirms that we are making an impact on the student scholars and that our program design has a solid framework.

### **Engineering Student Interviews**

Interviews with students used a semi-structured approach starting with three basic questions:

1. What has been your experience in the seminar?
2. Has being in an interdisciplinary group been helpful for you or not? How?
3. Are there things that we could do that would be more helpful for you as a [EE, CivE, AutoTech, CS, etc.] major?

What was very clear from the student interviews was how important the group experience had been. The responses were positive and students confirmed that attending the seminar was valuable to them. In some cases, it helped students establish connections that contributed to the

continued pursuit of their academic work. Other key benefits included the interdisciplinary group learning, whether related to major-required content or not, and making goals and reflecting on them.

### Connection & Belonging

The students interviewed confirmed that they felt they were part of a community. For most, the experience helped address feelings of isolation, especially given the academic rigor of their programs. “I like the positive feedback of meeting with others. Getting the opportunities to internetwork with the different majors. Just being able to get validation. Even to trade horror stories/positive stories about professors, homework, coping skills, experiences, contacts and how to deal with things. ... And to know if you have problems, you have someone to get in touch with.” It was important for engineering students to realize that they are not alone in their academic struggles. One student expressed “There’re not very many people you meet that are always studious and working like you are. Makes you realize you’re not the different one.” Another said, “I talked to older students, seniors, professors in the program, [it] helped me get through that stage where I wanted to quit.” A third said, “I like sensing I’m a part of something else, like Oh! they’re still here, going through classes. I like the sense of familiar faces, knowing people, having something in common, it helps.”

The students were able to use the seminar to build their network of peers through the context of learning a new topic with others outside their major. “The guest speaker [Global warming, perspectives from Antarctic research] was good because it prompted conversations amongst us a week later, two weeks later. That would lead off into tangents that built into a social network. ... That one key event cascaded into all these other opportunities.”

Feedback suggests that the diversity of student participants was a key component of its success for the students. “Like a support group almost. It’s been helpful to associate with students, or non-traditional students. I know there are non-traditional support groups. But being non-traditional, I can’t be at any of them. ... Knowing there are other dads on campus, it kind of helps you through it. ... [In the seminar] I was able to speak through things and get some feedback.”

### An Interdisciplinary Group

Did the interdisciplinary aspect help the engineering majors? Overall, the answer was yes. In general, student feedback suggests that participants benefited from learning how to approach a scientific or nonscientific topic using diverse approaches. “I like the interdisciplinary part. I guess it’s maybe not as serious as it would be if it was all CS [computer science]. It’s been really nice having the connection with Student X. When we took [a class] together, I was able to work with him and it was fun because he’s so smart.” “It’s great to meet others doing well in their field of study and motivated to make changes. I think it’s also great because I’m encouraged to learn more and about fields other than my own.” “I think it was helpful to see what the other majors are doing or you just stay focused on what you’re doing. Like I’m in EE so that’s a lot of worrying. Plus where you go to work, you’re going to work with all kinds of people, so it’s good to get to know them.”

“I think [the interdisciplinary aspect] is vital because the electrical engineers are still doing so much interconnected stuff most people aren’t aware of. Biology and computers—they are using them and there’s so much overlap. The fact that we can talk with each other, the fact that there are so many emotional, sociological, and psychological problems for all of us, we can talk about them now and not just have to deal with them when we are out in the workforce.” Another talked about the diversity within the program, “I’ve learned that in each major, there tends to be a certain mindset, because you picked that major and you like that area of study. Within your own groups you tend to be a lot alike. There’s not a whole lot of diversity. That’s why I like this scholarship, definitely sees diversity as more than the color of your skin or religion. That’s a major thing that I don’t think a lot of people understand.” Students found strengths in the differences as well. Not only did engineers benefit, other majors benefitted from contact with the engineers: “Being able to talk to the electrical engineers and listen to the issues they have with the math, there are so many similar problems .... You realize you can get help from someone outside your major for these issues. Because they are in different majors, they might have a different approach that can help you.”

### Reflecting & Goal Making

The importance of establishing goals and reflective self-assessments was a recurring theme in the seminar. One student provided the following feedback. “The assignment of getting goals really helped. Having the goal there and then accomplishing it was cool. Having the goal set before made it different. It made me feel better because I accomplished it.” Reaching a goal had greater importance for this student because of the goal setting and the awareness of reaching the goal. Taking the time to reflect on accomplishments and enjoy them was valuable for this student.

Developing strategies for academic, professional, and personal advancement in an environment that strove to minimize stress was a key benefit of the scholar program. Having an opportunity to learn new things in a setting where they were not being graded was valuable to the students. “The seminar’s definitely an asset for my education. It is enjoyable. I do like being there. It’s something different. It’s an hour I don’t have to be stressed out. We get to be exposed to different things, different ideas, different topics. [You can] listen to other people and you’re not in it alone.” However, we can still improve on the topic selection: “It would be nice if you could get seminars more specific to my major. But it might be difficult. But other than that I think you’re doing a good job.”

### Implementation Suggestions

In our program, the students are required to attend the seminar as part of their acceptance of the scholarship. It is difficult to move away from the importance of financial incentives for students to attend seminars like the one described here. Many students are just too busy to see beyond completing the next assignment in their major courses or preparing for the next test. However, one of the clear benefits to students participating in this type of seminar experience is a stress-free (i.e., non-graded) experience of learning. The seminar provides opportunities to learn more about one’s self, develop academic and life skills, and prepare for their future careers all in an interdisciplinary environment. Developing life-long learners is easier when there is a sense of

enjoyment around learning. Marketing these benefits, and providing simple incentives such as tickets for group outings to arts or sporting events or pizza and other snacks, can help motivate students. Alternately, a program like this could be paired with the scholarships already awarded by departments or colleges.

In an ideal world, students would attend and actively participate in the seminar because they value what they are learning. However, the rigor of academic life with the added responsibility of outside work create a reality that makes it difficult for many students to make a non-major required class a priority. In our program, participation in the seminar is required for accepting the scholarship. In lieu of a financial incentive, institutions could consider allowing the seminar course to count as an elective towards fulfilling graduation requirements. Degree accreditation boards such as ABET are requiring accredited programs to achieve program outcomes which include: an ability to function on multi-disciplinary teams; an understanding of professional and ethical responsibilities; the broad education necessary to understand the impact of engineering solutions in a global and societal context; a recognition of the need for, and an ability to engage in life-long learning; and a knowledge of contemporary issues.<sup>6</sup> These outcomes are difficult to fully achieve in major courses alone. Courses such as this seminar provide an avenue to better meet some of these outcomes. Thus, it is reasonable to allow students to use a portion of their credits from the seminar course as an elective that meets diversity, interdisciplinary teams, mentoring or leadership development requirements for graduation.

Three key aspects are important to consider when implementing a seminar or program like this. The first is the creation of a stress-free (or at least reduced-stress) environment where students are still aware that they are learning. For students who value learning, this becomes an additional motivation for participation. The second is including an interdisciplinary aspect in the group so that there are a broader set of possible outcomes for any project or discussion. The third is allowing for easy access to faculty willing to engage with students. Support for faculty who wish to be involved with students can come from the administration. The faculty involved with this program receive course load reductions to compensate for administrative and advising time. Faculty commitment includes about an hour of preparation each week, an investment of time in the recruitment and publicity of the scholarship program, and an intensive week of application review each year. In addition, there is active mentoring between faculty and students during the seminar and the hour after. We note, though, that improved relationships with students often results in students seeking faculty out for advice throughout the year. In addition to the interdisciplinary experience that the scholars have, the affiliated faculty have benefited from their work together and the closer connections they have to their college community. (For other information on the benefits of interdisciplinary mentoring for faculty, see Bates<sup>7</sup>.)

## **Reflection & Future Directions**

After three years of mentoring, the faculty participants have become increasingly aware that the continued professional success of the selected grant recipients requires some individualized attention for each scholar, which can be accomplished through the structure of the seminar. The recipients, as defined by the program criteria, are diverse: multiple majors, male, female, nontraditional students, students with different ethnicities, religious affiliations, backgrounds, and family structure. Student success requires a nurturing of the individuals' exceptions rather

than conforming to an established framework. Additionally, students who strive for perfection often need to learn to balance studying with activities often associated with quality of life. By “requiring” outside activities, students learn the benefits that taking a break or learning something new can have on their own learning experience. We believe our approach, of having faculty available for mentoring and developing stepping-stone peer-mentoring, has helped and will continue to help our scholars complete their degrees and meet their career goals. This is supported by positive feedback from our scholars.

Ultimately, this type of seminar program can benefit all students. In an engineering context, interdisciplinary work, an increased percentage of women and minority students, and the opportunity to learn about content areas that may benefit from their technical expertise broadens the overall engineering curriculum.

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