Developing Leadership Skills and Creating Community in Engineering Students

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Abstract

The goal of the program Identifying and Developing Engineers as Leaders (IDEAL) was to improve retention of students with demonstrated financial need (based on the FAFSA) during the first two years of their engineering studies and to develop their leadership skills. The goal was accomplished by increasing engagement in both curricular and extracurricular activities. The objectives of the program were: 1) to identify incoming engineering students with high potential for leadership, 2) to enhance and build leadership skills, 3) to build academic excellence, and 4) to foster community among students through living in the Engineering Living and Learning Community (ELLC).

The IDEAL program provided scholarships in the first and second years of the engineering curriculum, years in which engineering and computer science students have high attrition rates. After successfully completing the first two years, participants were supported by the university for their third and fourth years. In order to remain eligible for the IDEAL program, participants were required to maintain at least a 3.000 GPA at the end of each academic year, live in the ELLC, remain in good standing with the university, and continue to make academic progress towards a degree program in the Bobby B. Lyle School of Engineering at Southern Methodist University (SMU).

The program directors worked closely with the engineering recruiting office to identify eligible admitted students with an interest in pursuing a major in engineering or computer science. Candidates were recruited based on past academic achievement, leadership potential, curricular/extracurricular experiences, demonstrated financial need, and diversity.

IDEAL scholars participated in three main co-curricular experiences aimed at building community and increasing their leadership skills: block scheduling, academic advising and a weekly seminar. IDEAL scholars were in common sections of calculus, English and computer programming. The academic adviser also provided priority advising for IDEAL scholars, occurring before advising for all other students. The required weekly seminar series covered a variety of topics aimed at fostering student development.

IDEAL scholars lived in the ELLC, located in an on-campus residence hall. The resident assistants (RA) in the ELLC are junior and senior engineering students, and the residential community programming is typically engineering related. A faculty-in-residence from the Department of Computer Science and Engineering works closely with the RAs of the ELLC to plan various events, holds office hours in the ELLC, and routinely joins a group of students from the ELLC for meals and events.

Data on student success and program activities was collected through quantitative student data and a summative survey given to the participants at the conclusion of the spring semesters. Of the 28 students in the program, two left SMU and one changed majors out of engineering. Both term and cumulative GPAs of IDEAL scholars were on average 0.2 points greater than their

peers. IDEAL scholars reported that program activities supported and fostered their personal and professional development. Scholars' view of leadership was expanded, and all scholars participated in extracurricular activities with many taking on leadership roles. To date, 11 of the 28 scholars have had summer internships, and an additional 4 pursued academic endeavors during the summers.

Introduction

Attrition in computer science and engineering majors in the US remains high, with a retention to degree of only 50 percent.[1] At Southern Methodist University (SMU), approximately one-third of engineering and computer science students leave the Lyle School of Engineering before completing the subset courses for their intended major. Thus the first two years of study were identified as critical for improving retention to a degree. This work describes the Identifying and Developing Engineers as Leaders (IDEAL) program at SMU that was designed to address the problem of retention in the first two years of study in engineering and computer science. SMU is located in a smaller town situated within a large urban area. SMU's student population is approximately 11,000 of which approximately 6,000 are undergraduate students. The Lyle School of Engineering undergraduate population is approximately 1,000. Undergraduate degree programs in the Lyle School of Engineering include: civil engineering, environmental engineering, electrical engineering, engineering management, computer engineering, computer science and mechanical engineering.

Background

One of the overarching goals of the program was to increase retention of undergraduate engineering students, particularly throughout the pivotal first two years of study. The impact on the persistence/retention of numerous interventions and programs is reported in the literature on engineering education and higher education more generally. Outside-the-classroom interactions with faculty members, meaningful interactions with peers, and on-campus living-learning community involvement have been shown to positively affect student persistence in college.[2] Astin indicates that student-faculty interaction has a positive correlation with a large number of areas related to personal growth, intellectual growth, and behavioral outcomes including intellectual self-esteem, leadership, and an orientation towards helping other students or tutoring.[3] Vogt studied the effects of approachability and accessibility of faculty on students in the areas related to academic self-efficacy and performance.[1] The study results showed a significant inverse correlation between faculty distance (approachability and accessibility) and other constructs measured such as self-efficacy, academic confidence, and critical thinking.

The living situation (on-campus, commuter, etc.) has a significant impact on students' persistence.[4] Many studies support the positive benefits of participation in a living-learning community. Soldner *et al.*[5] state that participation in a science, technology, engineering, or math (STEM) living-learning community "have the capacity to enhance the quality of students' peer and faculty interactions and deepen their sense of social support" (p. 330). However, some studies found only small positive relationships between participation in a living-learning community and persistence.[2] Fundamentally, though, no negative effects to participation have been noted.

Future employers of engineering and computer science undergraduates want more than just a solid technical education. A number of "soft skills" must be developed as well. Some of these skills include work ethic, timeliness, attendance, and professionalism.[6] The Center for Professional Excellence indicates that 95% of human resources managers feel universities should include professionalism training as part of the curriculum.[7] This professionalism training should include skills for interviewing, communication, and common expectations in the workplace.

Program Description - Student Selection

Candidates were initially screened in collaboration with the Director of Undergraduate Recruiting and Retention in the Lyle School of Engineering. The screening process consisted of three phases: initial review, admissions file review, and interview. The initial review began with the program directors reviewing the pool of admitted students who were US citizens, met the minimum financial need based on their FAFSA (Free Application for Federal Student Aid) application, and were planning to enroll in the Lyle School of Engineering. The program directors also reviewed the academic potential of the candidates. The academic potential of a candidate was determined by their holistic admissions review, high school GPA, number of units completed, and standardized test scores (SAT and/or ACT).

Program directors selected a smaller list of candidates, chosen from the candidate pool, for which the candidate's admission file was reviewed. The admission files provided more detailed academic information, such as the rigor of their high school curriculum and leadership potential. Both academic and non-academic leadership activities were considered, including high school organizations, work experience, community service, and other non-academic organizations. The file review also provided student essays and recommendation letters, providing the program directors a more comprehensive view of a candidate's potential.

After all candidate admission files were reviewed, the program directors selected a group of candidates to interview. Program candidates were interviewed by one of the program directors, either in person during a campus visit or via a telephone interview. The program directors used several questions as a framework for the interview discussion and are listed below:

- What is your intended major?
- Why are you interested in this major?
- How do you define leadership?
- What did you learn from a leadership perspective in one of your high school experiences?
- What kind of activities do you want to continue with in college? How do you want to get involved?
- What are you looking forward to most about college?

The purpose of the questions was to gauge the candidate's sincerity in pursuing a major in engineering or computer science and for the program directors to learn more about the candidate's leadership background and potential. After interviews were completed, the program directors selected the top candidates, alternate candidates, and which candidates to reject. Students selected for the program were sent an offer letter with terms and conditions via email and a hard copy via U.S. mail, which had to be signed and mailed back by a deadline. If any

students declined the offer, an offer letter was sent to a candidate on the alternate list. Scholars received $10,000 per year as long as they remained in good standing, which was defined as progress toward a degree in the Lyle School of Engineering, maintaining at least a 3.000 cumulative GPA, living in the Engineering Living and Learning Community, and active participation in programmatic activities as described in the next section.

Program Description - Program Components

In designing the components of the program, one of the guiding principles was to provide each IDEAL scholar the opportunity to develop a close relationship with their peers, formal and informal interaction with faculty members, and the opportunity to develop non-technical soft-skills.

The cornerstone programmatic component of this program was the seminar series aimed at broadening students' understanding of leadership and developing the students' leadership and professional skills. Each week during regular semesters, the IDEAL scholars and program directors met for a one hour seminar. Topics and activities for the seminars have varied widely over the lifetime of the program, but all seminars were structured to impart information or provide students opportunities to put into practice skills they were learning. The seminars can be broken down into roughly four categories: presentations or discussions led by the program directors or IDEAL scholars, presentations by guest speakers, common readings and discussions, service activities and outreach, and social/student bonding. Program directors and guest speakers from industry presented information on leadership and professionalism. Program directors presented on topics including public speaking and presentation skills, managing a person's digital presence, and resume writing. Guest speakers from industry shared their academic and professional experiences and were some of the most popular presentations. Topics of guest speakers included an introduction to intellectual property law, on being an entrepreneur in the technology industry, and looking back at a 20+ year career of being a female professional engineer. Each semester's seminar series included a common reading experience and discussion. These readings and discussions were a bridge that took students from learning about a facet of leadership in the reading to a discussion of how to implement it. A complete list of the readings can be found in the references.[8-17] IDEAL scholars put into practice leadership and professional skills through presentations to the group and service projects. Presentations from IDEAL scholars included strategies for attending a career fair and obtaining an internship or job offer, techniques for successful digital design of posters and presentations, and practicing presentations for a class project. Service opportunities included visiting a local elementary school and working with younger students who were part of an after-school engineering explorers program. Each semester, informal dinners and holiday parties provided opportunities for informal interaction with the program directors and to get to know each other better.

Students in the program were also required to live in the Engineering Living and Learning Community (ELLC) for the complete two years of their program participation. The ELLC has been in existence since approximately 2005 and has grown over the years from 25 students to 75 students, and it is housed in a four-year residence hall with a total of 250 students. Additionally, the upperclass resident assistants (RAs) are also engineering majors. As part of their engineering RA duties, a portion of their programming efforts must be engineering related. Some of the

major events of the ELLC in which students have the opportunity to participate include Pancakes with Profs (engineering faculty join students in the residence hall for dinner and conversation) and Dinner with the Dean (the engineering dean joins the students for dinner in the residence hall and holds a roundtable discussion afterwards). The residence hall in which the ELLC resides also has a faculty member who lives in residence. The faculty member is one of the program directors, but there is no relationship between his faculty-in-residence duties and the program. He serves as a point of contact for students related to academic issues and hosts a number of programs each semester to allow students to interact informally. The ELLC is one of the most popular themed communities on campus, and the ELLC students self-form a strong sense of community, through study groups and peer mentoring that takes place in the community.

Cohort enrollment in common first year courses was the third programmatic component of the IDEAL program. Engineering and computer science students were required to complete several shared courses during the first year of the engineering and computer science curricula, but multiple sections of each of these courses were offered. Where possible, the Office of Undergraduate Advising in the Lyle School of Engineering arranged for all of the IDEAL scholars to be enrolled in the same sections. Courses included Calculus I, Calculus II, English Rhetoric I, English Rhetoric II, and Introduction to Computer Science.

The last major program component was small group meetings each semester. The IDEAL scholars were broken into three smaller groups each semester and paired with one of the three program directors. Once or twice each semester, each program director would meet with his/her small group to discuss varied topics such as high school-to-college transition issues or how to prepare for midterms and finals. This also provided an opportunity for second year IDEAL scholars to impart any wisdom to the first years that had been accumulated over the course of their time at the university.

Program Description - Evaluation Methods

Program results were collected from quantitative data at the conclusion of each semester and summative surveys at the conclusion of each spring semester. Quantitative data included demographics, time to engineering/computer science major declaration, and term and cumulative GPAs. The term and cumulative GPAs of the IDEAL scholars were compared to their peers who entered the university at the same time and with similar admission characteristics as the IDEAL scholars. IDEAL scholars completed summative surveys at the end of each spring semester to provide feedback on program components and to gauge their leadership development.

Results and Discussion

The program consisted of three cohorts of students: Cohort A consisted of 9 students who entered the university in the fall of 2010, Cohort B consisted of 8 students who entered in the fall of 2011, and Cohort C consisted of 11 students who entered in the Fall of 2012. Each cohort was active in the program for the first two years of their studies after which their scholarships were continued through the regular engineering scholarships and programmatic activities ceased. Each cohort represented approximately 3% of the total size of the first year engineering and computer

science student body at SMU. The size of the program was intentionally small to allow for community building and the opportunity to pilot programmatic activities.

The program directors aimed to include a diverse group of students in the program. Of the 28 IDEAL scholars, 21% were non-white as compared to 33% of the entire first year engineering/computer science class, and 46% of the scholars were female as compared to 30% of the entire first year engineering/computer science class.

All students intending majors in engineering or computer science at SMU must first meet the required subset for their desired major. Most students complete the subset at the end of their first year. All scholars successfully declared their intended engineering or computer science major within one to two semesters of coursework with the exception of one student.

Over the four years of programmatic activities, only three students left the program. One student in Cohort A changed to a major outside of engineering/computer science but remained enrolled in at SMU. One student in Cohort B and one student in Cohort C left SMU. One additional student was added to Cohort C for the 2013-14 academic year. The additional student had the same major as the student who left Cohort C. Table 1 summarizes the number of IDEAL scholars declaring each major.

Table 1: IDEAL Scholars' Majors

Cohort	CS*	CpE	EE	CE	EnvEng	MS	ME
A	3	0	1	1	0	1	2
B	3	0	1	0	2	1	0
C	2	0	2	3	1	1	2
TOTAL	8	0	4	4	3	3	4

*CS = computer science; CpE = computer engineering, EE = electrical engineering, CE = civil engineering; EnvEng. = environmental engineering; MS = management science; ME = mechanical engineering.

In the Lyle School of Engineering, mechanical engineering has the largest undergraduate enrollment followed by computer science and management science. Computer science is overrepresented among the IDEAL scholars, and mechanical engineering and management science are underrepresented among the IDEAL scholars as compared to the undergraduate population.

Term and cumulative GPAs of scholars versus their peers were tracked each semester students were in the program. On average, IDEAL scholars' term and cumulative GPAs were 0.2 points higher than their peers who entered SMU at the same time with similar admission characteristics. Students in Cohort A graduated in May, 2014, and two students earned Latin Honors.

Participants completed a summative survey to gain feedback on program components and to gauge their leadership development at the conclusion of each academic year they were in the IDEAL program. Each student completed the survey twice - once at the conclusion of their first year in the program and once at the conclusion of their second year in the program. Students were asked for feedback on seminar components, such as their favorite and least favorite seminar topics, which were used to plan seminars for the next academic year. Students were also asked to rate their agreement with statements about programmatic components and their connections to faculty, peers and SMU on a scale of 1 (strongly disagree) to 5 (strongly agree). Summative surveys were anonymous, so responses from Cohorts A and B in spring 2012 and from Cohorts B and C in spring 2013 were indistinguishable. The average student response for the Likert scale questions is shown in Table 2. Spring 2014 responses from Cohort C were not available at the time of paper publication.

Table 2: Average Student Responses to Likert Scale Questions on Program Components.

Statement	Spring 2011*	Spring 2012*	Spring 2013*
Program Components:			
Meeting in small mentoring groups was helpful.	3.56	3.63	4.0
Living in the engineering residence community was a positive experience.	4.67	4.63	4.56
Participating in the program changed my view of leadership.	3.56	3.75	4.33
Connections to faculty and peers:			
I feel connected to the school of engineering.	4.67	4.38	4.56
At least one of my engineering/computer science faculty knows my name.	4.89	4.94	4.94
Compared to my high school friends at other universities, I have greater access to engineering faculty.	4.44	4.38	4.33
The majority of my friends at this university are also engineering/computer science majors.	4.11	3.81	3.67
In addition to my engineering/computer science friends, I have friends in other majors.	4.56	4.31	4.28
I feel connected to this university.	4.56	4.56	4.67

* Spring 2011 responses were from Cohort A at the end of their first year. Spring 2012 responses were from Cohorts A (at the end of their second year) and Cohort B (at the end of their first year). Spring 2013 responses were from Cohort B (at the end of their second year) and Cohort C (at the end of their first year).

Of the program components, the IDEAL scholars reported an increasingly favorable view of the helpfulness of the mentoring groups and an increasing view that the IDEAL program influenced their view of leadership. The increases in these ratings were most likely due to the refinement of mentoring group topics and seminar topics. Students consistently reported a high degree of satisfaction with the engineering residence community, and students regularly commented that living with other students in their majors was helpful due to the ease in forming study groups and the informal mentoring that occurred among students.

All IDEAL scholars reported feeling connected to faculty, peers and the university. IDEAL scholars consistently reported a high level of connection to engineering/computer science faculty. Additionally, IDEAL scholars were connected to peer groups - both inside and outside of the Lyle School of Engineering. Finally, IDEAL scholars felt connected to SMU.

The summative survey also included questions about their views of leadership and demonstrated leadership skills. During discussions of leadership early in each academic year, students used titles, such as CEO or president, as leadership descriptors. On the summative surveys, IDEAL scholars were asked to list three words to describe a leader, and students consistently used words to describe personal characteristics of a good leader rather than titles and management-oriented words thus showing development away from an initial view often observed in the fall terms in which students view leaders as people with titles. For IDEAL scholars, the average number of organizations and extracurricular activities in which they participated ranged from 4.89 in the 2010-11 academic year to 3.8 in the 2011-12 and 2012-13 academic years. They held an average of 1.1 to 1.8 leadership positions in any academic year. To date, IDEAL scholars have held 19 internships or research experiences with faculty.

Conclusion

The IDEAL program successfully retained 25 of the 28 students in Cohorts A, B and C through their second year and retained the student added to Cohort C. The IDEAL program awarded students with an annual scholarship and provided curricular and co-curricular activities aimed at building community and fostering leadership development. IDEAL scholars' term and cumulative GPAs were on average 0.2 points greater than those of their peers, and two of the students in Cohort A graduated with Latin honors in May of 2014. Program components that included the weekly seminars, the engineering living and learning community and block scheduling were well received by IDEAL scholars and helped to build students' connections with faculty, peers and SMU. IDEAL scholars used the leadership skills gained in the program as demonstrated by their involvement in campus organizations, leadership roles in organizations and participation in engineering/computer science internships. At the conclusion of the 2013-14 academic year, the final cohort of students completed the program. The program directors are currently working towards institutionalizing aspects of the program and expanding them to a larger population of students.

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