How Many Engineers Does it Take?
A Recruitment and Retention Program

Abstract

This paper reports on the first year of a five year NSF STEP program to increase the number of students graduating in engineering at the University of ____. The recruitment portion of this project includes outreach, public relations, and improved advising. The outreach program utilizes university students to visit local high schools to mentor high school students and work with teachers (including education students) to prepare engineering-based teaching modules with hands-on components to meet major portions of the state core curriculum. Education and public relations efforts aimed at students, parents, teachers, and counselors are also a major portion of this effort. Retention efforts include better advising, tutoring, peer mentoring, and a service learning program that spans departments and years.

This year we will report on the creation, training, and special team issues involved in undergraduates working with high school students and teachers, development of the initial hands on modules for the state core curriculum, teen-oriented public relations efforts created by a university public relations class, and advising issues identified at both the high school and college level.

Motivation

In 2000, ____'s visionary governor challenged ___'s higher education system to double the number of engineering and computer science graduates, and provided "Engineering Initiative" support funds for engineering education infrastructure. Since 2000, eng/CS graduates have increased by 46%, and a number of independent recruitment and retention programs have sprung up across the state. This proposed project supports that vision by providing a catalyst to integrate the most successful of these programs via a university/community college/high school partnership that will captivate the imaginations of high school students at an early age, mentor them through a pre-engineering curriculum, and seamlessly transition them through to successful college graduation in their selected engineering discipline. Once entering the university program, this program will help them gain confidence as tutors/mentors, collaborating in curriculum module development and team engineering projects, and participating in service learning community engineering projects. We believe this approach will be favorable to dramatically increasing the number of students, both underrepresented and traditional, in our engineering program.

The goal of this project is to establish a sustainable high school / 2-year college / University of ___ transition process that will nurture students and increase the number of engineering/computer science graduates at the University of ____ by at least 180 per year. This accomplishes the University of ____ portion of the statewide goal of doubling the number of engineering/CS graduates from 2000 to 2011, but also will substantially increase the number of high school students that select and successfully accomplish college degrees at other institutions

in Utah and other states in engineering and other STEM fields. Our goal will be achieved through a student-centered initiative by

- ***Establishing stronger partnerships between the University of ____ College of Engineering and potential feeder populations*** including Academy for Math, Engineering and Science, MESA-STEP, International Baccalaureate programs, Project Lead-the-Way, and ___ Community College. This is being done through a college-wide outreach effort, outreach efforts by each department, and involvement with guidance counselors from high school through university. A major effort is underway to integrate with high school science teachers by developing and providing engineering demonstration modules that fit the core high school curriculum.
- ***Nurturing these partnerships by establishing a "Community Impact" service learning community***, which includes classes and interdisciplinary team projects that integrate HS, undergrad and grad students in the planning, preparation, and presentation of hands-on modules of real-world engineering experiences. This mentoring/team-based/service-oriented "active learning" community will be effective in attracting high school students to STEM and helping them transition between schools to achieve their 4-year degree.
- ***Fully assessing why students do or don't choose engineering/computer science*** using a state-of-the-art choice-based market survey to complement our more traditional assessment methods. Applying this assessment to guide us over a 5-year program towards best practices that can be implemented for STEM enhancement.

Year 1 Approach

We have established a team in each of the 7 engineering departments consisting of four university undergraduates, a faculty advisor, one community college undergraduate, one high school teacher and multiple high school students (from AMES, MESA clubs, IB programs and Project Lead the Way). We are currently in the midst of a 9-month effort with each team to design, construct, de-bug and demonstrate (in multiple high school venues) a curriculum-appropriate module that provides a hands-on engineering experience to high school students. The modules will also be used as part of a summer camp (in some cases, several summer camps) for high school students and teachers. Private industry has already begun to step up to 'adopt-a-module' where they purchase the equipment for this demonstration and donate it to multiple high school teachers.

Each module is quite short (1 class period), although multiple modules may be combined together for a more extensive project. Each module will demonstrate one core curriculum topic defined by the teacher on the team. All modules include handouts and information on how the concept being taught pertains to a specific type of engineering. Links to the college, pre-engineering sites, and related engineering applications are included. Photos of college students or professional engineers working on a related engineering project (females and/or minorities appear on each sheet) are included. Each module will have three 'levels', and can be used depending on how much time the teacher has for this module.
Level 3: Full, hands on project. The students do the testing, record the data, and analyze/report it. We will include handouts that walk the students through the analysis and reporting in detail. Some teachers want this, and others do not.

Level 2: In Class Demo. The teacher demonstrates the thing in class, collects the data. Each student analyzes it individually or in small groups.
Level 1: Video of the demo, taking the data, and (separately, in case the teacher doesn't want to use it), analyzing the data. This would be very quick, like 5 minutes, free, and require no equipment or special skills.

Example modules include demonstration of projectile motion using an electromagnetic ring launcher, biosensor systems, AM radio, computer game simulations, etc. High school classes targeted are Algebra II, Trigonometry, Pre-Calculus, Calculus, HS Physics, AP Physics, and Chemistry (for Chemical Engineering).

Assessment

Assessment of this project is based primarily on the hoped-for increase in engineering students and eventually engineering graduates, since the overall goal is to increase these numbers. Interim assessment to help us determine if we are on the right track includes pre- and post-assessment of our high school visits, especially visits that utilize our core curriculum teaching modules, interviews with our high school teacher team members, student team members, and high school participants. We are in the midst of developing an choice-based market survey to determine why students do and don't choose engineering. This survey will be given to both engineering students and non-engineering students at the university.

Challenges

Challenges this year have included recruitment of teams, determining what types of demonstrations are effective in classes (too long, too short, too boring, too hard, too specific, not specific enough, too few, too many, too expensive, too dangerous, …..), and fostering partnerships with the schools. Teams have experienced fewer team-cohesion challenges than we expected, but have often had less time to work on the projects than we had hoped. We have also identified some fairly challenging advising issues at all levels and are working to address them. We also learned that teachers were often more interested in receiving continuing education credits than cash, and are working to facilitate this in future years. We are establishing a service learning program for engineering students, which will provide credit for them in future years, as well. This is one avenue for sustainability of this project over the long term.

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