

Best Practices Conference

2007

Recruiting and Retaining
Engineering and Computer Science Students
Second Annual Technology Workforce Development Workshop

March 5-6, 2007

Thompson Conference Center, The University of Texas at Austin

sponsored by the

**Texas
Engineering
and
Technical
Consortium**

and

**U.S. Department
of Education**



Best Practices Conference 2007

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Arturo Sanchez, Director, Workforce Development, Texas Instruments, Dallas

Acknowledgement

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The Coordinating Board gratefully acknowledges the help and advice of Dr. Roger Elliott in planning this conference.

Best Practices Conference 2007

Thompson Conference Center, The University of Texas at Austin
Auditorium, 1.110 – unless otherwise indicated

Monday, March 5, 2007

- 9:00 am **Check-in, Meet & Greet** (Lobby) – Complimentary coffee, tea, juice, pastry
- 9:30 am **Pre-Conference Corporate Reception**
- 10:00 am **Welcome and Introductions**
Ray Almgren, Vice President, National Instruments, Austin, and Chair, TETC Executive Committee
Ben Streetman, Dean of Engineering, The University of Texas at Austin
J. Strother Moore, Chair, Computer Sciences, The University of Texas at Austin
- 10:15 am **Keynote Address – The Wright State University Model for Engineering Mathematics Education: Increasing Student Retention, Motivation and Success in Engineering**
Speaker: Dr. Nathan W. Klingbeil, Robert J. Kegerreis Distinguished Professor of Teaching and Associate Professor, Mechanical & Materials Engineering, Wright State University, Dayton, Ohio
- 11:15 am **Presentation/Discussion Session 1 – Best Practices for Transitions to College (A)**
Moderator: Dan Marcek, Deputy Director, University Relations, Hewlett Packard, Brookline, NH
- Step Forward: Preparing Low-income High School Students for Academic Success in Electrical and Computer Engineering at University of Houston; Katherine S. Zerda, Frank J. Claydon, Stuart A. Long and John M. Matthews; University of Houston*
Reaching Out Across Disciplines: Learning from Each Other to Produce More Graduates in Computer Science; Steve Roach and Elsa Villa, The University of Texas at El Paso
Recruiting and Retaining High School Students in Computer Science through Personal Contact; John D. Fernandez, Texas A&M University-Corpus Christi
- 12:15 pm **Lunch Break – TETC Advisory Committee Annual Meeting and Introduction to TETC Program Evaluation Team** (Complimentary lunch buffet – room 3-102)
- 1:30 pm **Presentation/Discussion Session 2 – State Initiatives for Developing the Engineering and Technology and Science Workforce**
Introductions: Eric Fox, Senior Director, Government Relations, Lockheed Martin Aeronautics Company, Fort Worth, TX
Speakers: Phil Wilson, Deputy Chief of Staff, Office of the Governor
Laurie M. Rich, Special Advisor, Industry Clusters Initiative, Office of the Governor
Mark M. Ellison, Director of the Emerging Technology Fund, Office of the Governor
- 2:30 pm **Afternoon Break** (Complimentary refreshments)
- 2:45 pm **Presentation/Discussion Session 3 – Best Practices for Transitions to College (B)**
Moderator: Allyson Peerman, Global Community Affairs Manager, AMD, Austin, TX
- Successes and Ongoing Challenges in Effective Outreach, Recruitment and Retention during a Period of Declining Computer Science Enrollments; J. Moore, Greg Lavender and Calvin Lin; The University of Texas at Austin*
Innovative Programs for Increasing the Enrollment in Computer Science; Valerie Taylor Frank Shipman III and Joseph Hurley; Texas A&M University
Retention Tools for Engineering Students; Frank J. Claydon, Dorota Bernatek, Katherine Zerda and Stuart Long; University of Houston
Pair Programming Mentorships to Enhance the Computer Science Experience; Kay Robbins, Heather Hernandez and Kleanthis Psarris; The University of Texas at San Antonio
- 4:30 pm **Evening Break**
- 5:30 pm **Legislative Reception** (Sponsored by TETC corporate members) Legislative Conference Center, Room E2.002, Texas Capitol, Capitol Extension. Shuttle service provided.

Tuesday, March 6, 2007

8:00 am **Presentation/Discussion Session 4 – Best Practices in Retention**
Moderator: Arturo Sanchez, Director of Workforce Development, Texas Instruments, Inc., Dallas, TX

Creating Learning Communities at the University of Texas at El Paso to Increase Throughput; Benjamin C. Flores, Judith Munter, Sylvia Trillo and Nabil Ghariani; The University of Texas at El Paso
Retaining Female Engineering Students by Creating an Effective Women-in-Engineering Program; Julie Martin Trenor, Frank J. Claydon, Stuart A. Long and Rachel Danek Jones; University of Houston
Jonsson School Undergraduate Scholars Program; Simeon Ntafos, The University of Texas at Dallas
Results of the 2003-2007 The University of Texas-Pan American On-Campus Jobs Program; Heinrich Foltz and Edwin LeMaster, The University of Texas-Pan American Peer Teachers; Valerie Taylor, Joseph Hurley, Lawrence Petersen, Jennifer Welch, and Frank Shipman III; Texas A&M University

9:45 am **Morning Break**

10:00 am **Presentation/Discussion Session 5 – Best Practices in Course/Curriculum Re-Design**
Moderator: Suzanne Hays, Senior Manager, Raytheon, Dallas, TX

Early Introduction to Programmable Logic Devices and Tools in a Digital Laboratory Course; Mehdi Shadaram, Chirag Parikh, John Prevost, Parimal Patel and Wei-Ming Lin; The University of Texas at San Antonio
Improving Student Recruiting and Retention through an Interdisciplinary Computer Science Curriculum; Armin R. Mikler and David M. Keathly, The University of North Texas
More Graduates and Higher Quality Through Curriculum Redesign, Chanan Singh, Texas A&M University
Introduction to Electrical and Computer Engineering Course for Freshmen; Mohammad A. Saed, Texas Tech University
Online/Classroom Hybrid Computer Science Program: A Pilot Project, Jaspal Subhlok, Olin Johnson, Venkat Subramaniam, Ricardo Vilalta and Chang Yun; University of Houston

11:45 am **Lunch Break – Comments by chair of TETC Program Evaluation Team.** (Complimentary lunch buffet – room 2-102)

13:00 pm **Presentation/Discussion Session 6 – Best Practices in Consortium Building**
Moderator: Brad Beavers, Austin Site Manager, Intel Corp., Austin, TX

Increasing the Applicant Pool and Retention in Computer Engineering; Anthony P. Ambler, The University of Texas at Austin
Computer Science Scholars: Recruiting, Retention and Mentoring; Sadegh Davari and Elham Khabiri, University of Houston-Clear Lake, Mike Kent and Eva Brown, San Jacinto College Central Campus; Jim Meeks and Pamela Betts, San Jacinto College South Campus
Innovative Strategies to Establish a Pipeline with Local School Districts; Jonathan Bredow, The University of Texas at Arlington
What We Have Learned in Implementing the Infinity Project; Scott Douglas, Betsy Willis and Geoffrey Orsak; Southern Methodist University

2:15 pm **Capstone Discussion**
Moderator: Ray Almgren, Vice President, National Instruments, and Chair, TETC Executive Committee

3:15 pm **Closing Comments by Executive Director**

3:30 pm **Adjourn**

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Keynote Address

The Wright State University Model for Engineering Mathematics Education: Increasing Student Retention, Motivation and Success in Engineering

Speaker

Nathan W. Klingbeil
Associate Professor of Mechanical Engineering
Robert J. Kegerreis Distinguished Professor of Teaching
Wright State University
Dayton, OH 45435

Abstract:

The inability of incoming students to advance past the traditional freshman calculus sequence is a primary cause of attrition in engineering programs across the country. As a result, this presentation will describe an NSF funded initiative at Wright State University to redefine the way engineering mathematics is taught, with the goal of increasing student retention, motivation and success in engineering. The WSU approach begins with the development of a novel freshman engineering mathematics course, EGR 101 "Introductory Mathematics for Engineering Applications." Taught by *engineering* faculty, the course includes lecture, laboratory and recitation components. Using an application-oriented, hands-on approach, the course addresses only the salient math topics *actually used* in core engineering courses. These include the traditional physics, engineering mechanics, electric circuits and computer programming sequences. The EGR 101 course replaces traditional math prerequisite requirements for the above core courses, so that students can advance in the curriculum without having completed a traditional freshman calculus sequence. This has enabled a significant restructuring of the engineering curriculum, including the placement of formerly sophomore-level engineering courses within the freshman year. The WSU model concludes with the development of a revised engineering math sequence, to be taught by the math department later in the curriculum, in concert with College and ABET requirements. The result has shifted the traditional emphasis on math prerequisite requirements to an emphasis on *engineering motivation* for math, with a "just-in-time" structuring of the new math sequence. This presentation will provide an overview of the WSU model for engineering mathematics education, followed by an assessment of student performance, perception and retention through its initial implementation. It will also summarize the scope of the two major NSF awards (CCLI Phase 2 and STEP Type I) which are supporting the program.



Nathan W. Klingbeil is an Associate Professor of Mechanical Engineering at Wright State University, and holds the title of Robert J. Kegerreis Distinguished Professor of Teaching. He received his Ph.D. in Mechanical Engineering from Carnegie Mellon University in 1998. Prior to joining the Wright State faculty, he worked as a Materials Research Engineer at the Air Force Research Laboratory, Materials and Manufacturing Directorate.

Dr. Klingbeil's research interests are in the general area of mechanics of materials, with particular emphasis on fracture mechanics, the mechanics of bonded interfaces and fatigue crack growth. Much of his research has focused on mechanics and materials issues in layered manufacturing with metals, including residual stress-induced warping, interlayer debonding (initiation and growth of interface cracks), and prediction and control of microstructure in laser-based manufacturing processes. Dr. Klingbeil's research has been supported by both state and federal sources, including the National Science Foundation (NSF), the Dayton Area Graduate Studies Institute (DAGSI), and the Ohio Board of Regents (OBR).

In addition to his scientific research, Dr. Klingbeil is actively involved in engineering education reform. In particular, he is currently leading an NSF funded project to redefine the way engineering mathematics is taught, with the goal of increasing student retention, motivation and success in engineering. The project has involved the development of a novel freshman engineering mathematics course EGR 101, as well as a substantial restructuring of the engineering curriculum. Dr. Klingbeil has received numerous awards for his work in engineering education, and was named the 2005 Ohio Professor of the Year by the Carnegie Foundation for the Advancement of Teaching and the Council for Advancement and Support of Education (CASE).

Presentation/Discussion Session **1**

Best Practices for Transitions to College (A)

Moderator

Dan Marcek, Deputy Director, University Relations, Hewlett Packard,
Brookline, MA

Step Forward: Preparing Low-income High School Students for Academic Success in Electrical and Computer Engineering at the University of Houston

Katherine S. Zerda, Frank J. Claydon, Stuart A. Long and John M. Matthews
Cullen College of Engineering, University of Houston

Abstract

The “Step Forward” program was initiated at the University of Houston (UH) with a TWD grant (grant #003652-TYT06-0002) in the fall 2006 semester. The program is designed to engage low-income high school students in (1) mentoring, (2) activities that promote math, science and engineering, and (3) provide internships. Step Forward Scholars from the UH Cullen College of Engineering, majors in electrical and computer engineering, serve as mentors to the high school students throughout the academic year. During the initial semester of the program 63 students from Wheatley High School in Houston’s Fifth Ward community joined the Step Forward program. In the fall of 2006, nineteen UH engineering students mentored the Wheatley students. One of those mentors also had the opportunity to intern with Schlumberger. In spring 2007, 21 UH mentors are working with the high school participants. Additional high school participants have also been recruited in the current semester through the formation of a Wheatley High School FIRST Robotics team, mentored by the UH Step Forward Scholars.

Purpose

The goal of the Step Forward program is to encourage low-income students in their math and science studies, and to introduce them to the field of engineering. Many of the high school students in Fifth Ward schools come from families whose members have not been engaged in higher education. Many are from single-parent households. Students often do not value math and science courses, and are not aware of careers that require strong math/science backgrounds. Our intent is to bring these students into mentoring relationships with successful first-generation-in-college engineering students with whom they can identify. In this way we hope to encourage the high school students to consider pursuing university degrees, particularly in the electrical engineering and computer fields.

Implementation

The Step Forward program goals are being addressed through weekly visits of the mentoring teams to Wheatley High School. During a one-hour classroom period each Friday, mentors and students work together on either math/science homework assignments, or on challenging problem-solving activities. Every 4-5 weeks, the group participates together in a special activity (usually on Saturdays) designed to engage students with math-, science-, or engineering-related programs. In the first semester of the Step Forward program, the special event sessions included (1) a Math and Science Olympiad, featuring team-based competitions combining thinking and physical team challenges, (2) a field trip to Texas A&M University for “Discover Engineering Day”, (3) SAT test preparation and study skills sessions, and (4) a holiday luncheon at the University of Houston.

In spring 2007 weekly Friday tutoring and mentoring sessions continue, but UH mentors are also dedicating after-school and weekend hours to coaching the Wheatley FIRST Robotics team in the design and construction of their robot for regional competition. Step Forward participants from Wheatley High School’s senior class, as well as the members of the FIRST Robotics will join their mentors at the Annual Program for Mastery in Engineering Studies (PROMES) Awards

Banquet in the Cullen College of Engineering on March 1, 2007 for special recognition of their program participation.

Evaluation

Wheatley High School (Houston Independent School District) has failed to meet Adequate Yearly Progress (AYP) goals for two or more years, and is therefore classified as a school in need of improvement. The student body is 58% African American and 41% Hispanic. Ninety-two percent of students qualify for free or reduced-price lunch programs. Thirteen percent of students have limited English proficiency. These factors and the proximity to the University of Houston make Wheatley an obvious outreach partner for Step Forward.

After one semester of program development, we are pleased with progress. The first-semester mentoring team included 10 males and 9 females. Eight mentors self-identified as Black, nine as Hispanic, and two as Caucasian. Several are first-generation-in-college. Step Forward mentors have expressed satisfaction with their role in guiding the younger students: "...I might be that extra help the students need to succeed academically..." "I never had a mentor in high school to talk with about different career paths I could take. For this reason I want to be a mentor to these students." "It is very important for me to promote engineering to low-income students, as I was one."

The enthusiasm of the mentors is matched by the Wheatley students. Since the initial selection of participants, more students have asked to join Step Forward. We have added 8 students for the current semester. Many of the high school students have expressed a desire to apply for summer engineering programs at the University of Houston in 2007, including Girls Reaching and Demonstrating Excellence (GRADE) day camp and the Mentoring and Enrichment Seminar in Engineering Training (MESET) residential camp. We see these two programs as excellent ways to build upon the newly-emerging STEM-related interests of Step Forward participants.

Recommendation for Adopters

- An initial difficulty was finding a time during the school day when mentors could meet with high school participants without disrupting the high school schedule. Engage early with school and district administrators to gain support for programs and to identify potential meeting times. Survey high school counselors/contacts in planning weekend or other after-school events. Be aware of the local school district calendar when scheduling activities.
- Seek out ways to engage students in existing community programs which support math, science and engineering. Leveraging the FIRST Robotics program and the Discover Engineering Day has proved very successful for us in inspiring and exciting students, and we didn't have to "reinvent the wheel". We intend to leverage existing Engineering Week activities this semester.
- Include frequent opportunities for the high school students to visit university campuses. The Wheatley students especially enjoyed and valued their trips to UH and Texas A&M University last semester.

Sources of Additional Information

- Summer engineering programs at the University of Houston: <http://www.egr.uh.edu/camps>.

Contact Information: Katherine S. Zerda, email: kzerda@uh.edu, phone: 713-743-4222.

Reaching Out Across Disciplines: Learning from Each Other to Produce More Graduates In Computer Science

Steve Roach and Elsa Villa

Computer Science, The University of Texas at El Paso

Abstract

Peer teaching and peer mentoring is in use at many colleges and universities in the United States in an effort to improve undergraduate education. At the University of Texas at El Paso (UTEP), peer-led team learning (PLTL) is being used in the Departments of Chemistry, Mathematics, and Computer Science (CS). In CS, we have incorporated active learning and cooperative learning in the PLTL sessions. Early evaluation of the data suggests that this approach is effective in improving the competency of students and reducing the failure rate in the early CS sequence.

Purpose

The retention rate at UTEP for students in the introductory, three semester CS sequence has remained a steady 40%; that is, 60% of the students who enter CS1 do not persist past CS3. This situation indicates that students lack the ability to think critically and are not grasping the conceptual understanding needed to successfully complete the critical first three semesters. By shifting to a constructivist and discursive approach to teaching and learning, students enhance their metacognitive skills through inquiry-based learning using cooperative learning arrangements. Metacognition requires students to evaluate and become aware of their own cognitive processes and use this knowledge to process theories and solve problems. This self-monitoring of learning empowers students to deepen their understanding of more complex concepts in the CS discipline as they learn to use the intellectual tools of guided inquiry: questioning, exploring and investigating.

To improve retention and to enhance the competency of students who do persist, we have instituted a program based on *PLTL*, where students meet weekly with peer leaders using inquiry-based methods to solve problems related to the course work and develop professional and interpersonal skills. Research on our campus and elsewhere has shown that this approach is effective in improving student retention, decreasing time to graduation, and improving student GPAs. Through participation in PLTL sessions, students learn the skills needed to inquire, explore, and expound on technical issues. Session problems can frequently be solved (at least in part) with pen and paper. Often, once a sketch of a solution is obtained, verification of the solution can be achieved by implementation.

Implementation

PLTL is based on the idea that *peers*, i.e., other students who have recently completed the course, can assist students in learning. In CS at UTEP, we recruit students with an interest in helping other students. These are not necessarily the students with the highest grades in the courses, but are instead students recruited based on their willingness and ability to work in teams dedicated to problem solving. Our view is that as peers, the students leading the sessions are not domain experts: they are not responsible for providing answers. Their job is to create the environment necessary for students to learn through inquiry and discourse. PLTL sessions are conducted using the cooperative learning paradigm. Five basic elements must be present for a group to function cooperatively: positive interdependence, face-to-face promotive interaction, individual and group accountability, professional skills, and group processing. Positive interdependence ensures that each member of the group has a personal

stake in the success of the group. Promotive interaction is the result of students sharing ideas and resources with each other and working together to bring out the best in each other. Individual and group accountability holds each student responsible for making tangible contributions to the team effort and each team responsible for delivering the required work. Faculty mentors should not assume that students come with the necessary skills to work in groups. It is not sufficient to simply put students together in a group setting and assume that they will learn to work effectively together any more than it is sufficient to give elementary school students a set of mathematics problems and assume that they will learn to add and subtract. The professional skills component of cooperative learning attempts to teach students how to work together in teams. Group processing encourages students to reflect on how well they are achieving their goals and how well each group is functioning. This reflection will guide the group members to determine how their group must change.

Evaluation

Our early assessment consists of questionnaires delivered to the students taking the introductory courses and an evaluation of the grades and pass rates. In CS1, the retention rate rose from 70% to 75% since the incorporation of PLTL. If we ignore students who voluntarily withdrew, the fail rate (students who received a D or an F) dropped from 18% to 13% since the incorporation of PLTL in CS1.

The evaluation of the student questionnaires is difficult. In CS1, approximately 60% of the students recommended that PLTL be used in the future for CS courses. However, the student perception of effectiveness appears to be highly dependent on the particular peer leader. Some peer leaders have nearly 93% of their students indicating that the PLTL sessions helped them understand the course material. For other peer leaders, this rate drops to as low as 45%. We are in the early stages of collecting data on the efficacy of PLTL in CS. None of the differences in measures is statistically significant, and we have not yet evaluated all of the data related to the introductory sequence.

Recommendations for Adopters

The most important aspect of using PLTL in the undergraduate classroom is the training of the peer leaders. It is inappropriate to assume that receiving good grades in a course enables someone to understand and be able to use active engagement and lead group exercises. These skills are distinct, and our peer leaders have found the continuous training to be beneficial. In CS at UTEP, PLTL leaders attend weekly training sessions where they learn and practice cooperative learning techniques, pedagogy, and learning styles. They deliver, observe, and critique lesson plans and sessions, guided by faculty mentors. Frequent topics of discussion are how to get students engaged in the topic matter and how to use Socratic questioning instead of answer giving. Experience has shown that without persistent effort and focus, students (as well as faculty) will revert to the type of teaching they experienced.

Sources

The Peer-Led Team Learning project at the City University of New York (www.pltl.org) is the primary repository of information about the NSF-funded peer lead team learning project. The Cooperative Learning Center at the University of Minnesota (www.co-operation.org) has a plethora of information about methods, training, and research related to the cooperative learning paradigm.

Contact information

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Recruiting and Retaining High School Students in Computer Science through Personal Contact

John D. Fernandez, Computer Science, Texas A&M University – Corpus Christi

Abstract

Texas A&M University – Corpus Christi has experienced the same reduction in student enrollment in its computer science (CS) program as other institutions around the country. However, with the implementation of a recruiting program that reached out to high school students, the number of freshmen declaring CS as a major increased significantly. With the increase in enrollment, more effort is being directed towards retaining students through tutoring, mentoring and involving students on various research projects. It is imperative that the next generation of U.S. women and minorities be educated for the technology leadership positions of the future.

Purpose

Available information from a variety of governmental and private sources indicate an increase in the demand for computer science (CS) and information technology (IT) professionals in the coming years. All thirteen of the computer-related careers tracked by the Department of Labor are projected to show an increase in demand by the year 2014. According to the Bureau of Labor Statistics, computer and mathematical science occupations are projected to increase by almost 30% by the year 2014. When compared to other science and engineering occupations, the projected employment growth for CS professionals is even more startling. Unfortunately, other recent studies and surveys show a decline in the number of undergraduate students who are declaring computer science as a major.

Over the past four years, Texas A&M University – Corpus Christi has worked to address these issues using a three-pronged approach. First, faculty and students have worked together, through grant funding, to implement a recruitment program aimed at reaching out to high school students. Second, grant funding has also been used to set up paid undergraduate fellowships and to implement a tutoring program targeted specifically for undergraduate computer science students in an effort to increase the retention rate of computer science majors. Finally, a mentoring program has been implemented to help the incoming freshmen make it through the introductory courses.

Implementation

The decline in the number of incoming freshmen who declare CS or IT is troubling. The under-representation of women and minorities is also a cause for concern. One of the ways in which A&M – CC has addressed this problem is through a recruitment program involving both students and faculty. The program was initially set up in September 2003 through funding made available from the National Science Foundation (NSF) and supplemented by the Texas Engineering and Technical Consortium in early 2004. The principal component of the program was for undergraduate students to visit local high school and to talk about their own experiences in college and in CS.

The recruiting team and CS faculty also participate in Island Day Fairs. Island Day Fairs are university-sanctioned events that provide high school students and their parents with an opportunity to visit the university, explore different programs offered by the university, and talk

one-on-one with both current students and faculty members. The display board built by the team is used at these fairs and has received many compliments from attendees.

Two programs have been put in place in an attempt to address the retention issue. First, part of the TETC state grant was earmarked to fund undergraduate research fellowships for students to work closely with a faculty mentor. There are 15 fellowships awarded each semester, each paying \$1,000. The second program implemented involves using students as tutors for students who are struggling.

Evaluation

In the fall semester of 2005, the number of incoming freshmen who declared computer science as their major increased by 12%. This was the first significant increase in five years. From an all-time low of 57 incoming freshmen declaring CS as a major in 2004, the number of majors has increased continuously. The result of research fellowship program has been positive in several aspects. The most obvious is that it gives the student researcher an opportunity to earn money while working in an area related to his/her field of study. Another benefit has been that the students have become more energized about not only finishing their undergraduate degrees, but are more interested in pursuing graduate degrees when they have an opportunity to participate in real, hands-on research.

Recommendations for Adopters

The first step taken was to hire a graduate student who would act as a supervisor of the recruiting team and as a liaison between the team and CS faculty. The graduate student was responsible for interviewing, hiring, and training undergraduate students who would work as recruiters. One important consideration in hiring the recruiters was to create a team that would accurately reflect the diversity of the population in south Texas. The recruiters not only reflected the diverse population of the area, but also represented a range of interests in the field of computer science running the gamut from the more traditional computer programming area to the more art-oriented graphics design field.

Once the recruiting team was assembled, they began to brainstorm to find a variety of ways to deliver their message to both high school students and parents. Among the ideas implemented were producing a brochure describing the CS field and showing pictures of students involved in activities on campus, creating a PowerPoint presentation to be used in recruiting visits to high schools, setting up a Web site used to present information about the CS program and as a means of communication with interested students and parents, creating a display board which includes various computer components to be used at presentations, and going out to high schools, junior colleges, and other pre-college programs to give in-person presentations about the CS program at A&M – CC. These in-person presentations are followed up with the recruiters making phone calls to students who expressed an interest in the program.

Contact Information

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Presentation/Discussion Session **2**

State Initiatives for Developing the Engineering and Technology and Science Workforce

Introductions

Eric Fox, Senior Director, Government Relations, Lockheed Martin Aeronautics Company, Fort Worth, TX

Speakers

Phil Wilson, Deputy Chief of Staff, Office of the Governor

Laurie M. Rich, Special Advisor for the Industry Clusters Initiative, Office of the Governor

Mark M. Ellison, Director of the Emerging Technology Fund, Office of the Governor

Presentation/Discussion Session **3**

Best Practices for Transitions to College (B)

Moderator

Allyson Peerman, Global Community Affairs Manager, AMD, Austin, TX

Successes and Ongoing Challenges in Effective Outreach, Recruitment and Retention during a Period of Declining Computer Science Enrollments

J. Moore, Greg Lavender and Calvin Lin

Department of Computer Sciences, The University of Texas at Austin

Abstract

At the University of Texas at Austin, beginning in 2002 with the initial round of TETC grants, we initiated outreach, recruitment and retention programs aimed at under-represented populations. Prior to that time, the CS Department had devoted almost no effort at outreach, recruitment and retention of any populations as the faculty were primarily focused on the graduate program, while the undergraduate program was overwhelmed by unrestricted enrollments, hitting a 10 year maximum at approximately 2500 declared CS undergraduates in 2000. Undergraduate CS enrollment is currently 852. As of Fall 2006, partly as a result of our proactive outreach programs, there is an increase in declared CS majors for the first time since 2001.

Purpose

Since 2000, enrollments in Computer Science programs have declined 60% nationwide due to a number of factors, primarily the abrupt demise of the over-hyped “dot com” era and the associated economic downturn. At the same time, negative publicity regarding layoffs in the IT sector and the off-shoring of jobs to developing countries such as India and China led parents and students to believe that job opportunities for college graduates in Computer Sciences had evaporated. The economic downturn was short-lived and today IT employers are hiring again en-masse. The US is now in the position of having more jobs available in the IT sector than qualified employees, and a greatly diminished pipeline of university students in computer sciences to fill those jobs. Our TETC funded efforts have focused on increasing enrollments.

Implementation

Starting in 2000, the CS department created a “Pre-CS” program in an effort to establish an introductory curriculum consistent with the curriculum guidelines proposed by of the ACM Curriculum Report, and to provide a mechanism for quality control over admission into the CS major. This program has proven to be a key innovation in terms of both curriculum alignment and helping students acquire the necessary mathematical and technical foundations on which to become successful CS majors. The Pre-CS program also leads to early identification of students who are not likely to be successful CS majors and to pro-actively enable academic advising to assist those students in finding another suitable major field of study, rather than staying in the major for 3 or 4 years attempting to earn a CS degree and repeatedly failing required courses. The Pre-CS program has also allowed us to focus our best teachers on those courses that will have the most positive impact early in a student’s educational experience. We also created mentoring programs to provide proactive mentoring assistance. To help students whose high school preparation is not as strong as others, we created special sections which are smaller and provide focused attention to help such students strengthen their academic skills before they enter the more challenging required courses.

Using the foundation we created in 2000, we began to build our efforts in four areas: 1) outreach to high schools to attract more women into CS, 2) creation of a Foundations of Logical Thought course to help retain students from all regions of Texas admitted to UT without sufficient logical thinking skills to obtain those skills in a small class setting with an excellent teacher, and 3)

creation of an honors program to attract the best students in Texas who were likely to otherwise go out of state to other top academic institutions rather than matriculate at any Texas university, 4) a UT CS Roadshow aimed at student driven outreach to middle-schools and high schools to promote Computer Science in general.

The outreach program aimed at attracting more women is called "First Bytes" and initially consisted of a free one-week residential summer computer science "camp" for 50 high school women selected from across Texas from among approximately 200 applicants. In summer of 2007, we will be hosting First Bytes Version 5.0. In 2006, we expanded First Bytes to include the 1st annual First Bytes CS Teachers Workshop, in an effort to build relationships with CS teachers from across the state that are identified as active in statewide high school CS initiatives. In Summer 2007, we will host the 2nd annual First Bytes CS Teachers Workshop. The First Bytes program has won two university outreach awards and has gained statewide recognition among students, parents, and high school teachers and administrators as a way for young women, who are trying to decide whether they want to study CS at the university level, to experience firsthand the richness and excitement of the field. See the URL given below.

Our restructured introductory curriculum, including the new courses we developed to help prepare students for the rigors of a CS program of study, has achieved the goal of helping students figure out early whether CS is appropriate for them, and if so, to ensure that they are adequately prepared for upper division courses. The Pre-CS program is now a model being considered and adopted by other departments in our college. Our percentage of African-American and Hispanic students is on par with the percentages of the University of Texas at Austin as a whole. Challenges remain, however, in attracting more minority students into CS, and we continue to listen and learn from others about effective strategies beyond what we are already doing. See the enrollments information at the URL given below.

Our Turing Scholars honors program graduated its first class of students in May 2006. The program is now mostly funded by the instructional budget for the department, with the exception of scholarships, which are co-funded by TETC grants as well as private and corporate donations. Our biggest challenge remains raising adequate scholarships to recruit the very best students and keep them in Texas. See the Turing Scholars page at the URL given below.

Finally, the most unexpected effect of these programs has been the change of culture in our department with respect to faculty participation in outreach, recruiting and retention efforts, more involvement at the undergraduate level, and sensitivity to the broad range of issues that we face in increasing enrollments in CS, and recruitment, retention and graduation rates of under-represented populations at both the undergraduate and graduate level. The TETC program and the support of our Dean and Chairman were instrumental.

Sources of Additional Information

UT-Austin CS Enrollments - <http://academics.cs.utexas.edu/undergraduate/current>

Turing Scholars - <http://academics.cs.utexas.edu/undergraduate/honors>

First Bytes - <http://www.cs.utexas.edu/users/firstbytes>

Contact Information

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Innovative Programs to Increase the Enrollment in Computer Science

Valerie Taylor, Frank Shipman III and Joseph Hurley, Computer Science, Texas A&M University

Abstract

The Department of Computer Science at Texas A&M has established goals based on better retention of lower level students, increased promotion to upper level, and better recruitment of students to major in a degree program within the department. We have implemented two strategies to address this issue: [1] the development of an annual CS contest for high school students, and [2] the development of a freshman level course to excite students about computer science.

People often associate the field of computer science with that of programming or being a programmer. The CS curriculum, however, is not limited to programming; the curriculum focuses on providing students with a solid foundation in algorithms, computer systems, and software in addition to allowing students the opportunity to study areas such as robotics, artificial intelligence, human-computer interfaces, and software. To address this issue with respect to high school students, we organized the first annual CS Contest, called **CS Contest: Interface 2006**, which took place on October 7, 2007 at Texas A&M University. Forty-seven students among six student teams representing **Bryan High School, The Woodlands College Park, Hyde Park Baptist** in Austin, and **Montgomery High School** were presented with the problem of refining and personalizing online poker. The teams spent the morning in individual labs designing interface prototypes, writing user/task analyses and preparing oral presentations. Winning first and third places were The Woodlands **Hi-Jenks** and **Nordt-Stars** teams; Second place went to Montgomery's **MHS1** team. For 2007, the focus is on graphics.

To address the misconception issue with respect to freshman students, we have developed a new one-credit seminar course that includes speakers from industry and academia talking about how computer science concepts are used in end products and research. For example, one speaker talked about how algorithms are important with graphics and game development. This class was introduced into the curriculum in Fall 2006 and has been very well received by the students.

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Retention Tools for Engineering Students

Frank J. Claydon, Dorota Bernatek, Katherine Zerda and Stuart Long
Cullen College of Engineering, University of Houston

Abstract

To better prepare students for the challenging engineering curriculum, we created a weeklong camp that uses collaborative learning pedagogy to teach critical engineering concepts. Students continue to practice these techniques through weekly, course-specific workshops. Since its inception, pass rates for engineering courses are 30% higher for program participants versus non-program participants.

Purpose

Far too often, students who enter college aspiring careers in engineering manage to progress through calculus, chemistry, and physics but do not “survive” their engineering courses. Traditional remedial and counseling approaches have rarely achieved significant results in assisting these students through the engineering curriculum. To address this issue we created Redshirt Camps in combination with engineering course specific workshops. The objective of the camps is to “redshirt” or “prepare” our rising sophomores and transfer students for the rigors of the second year of study and beyond in engineering. The idea behind the Collaborative Learning Workshop Program is that under the guidance of a skilled facilitator engineering students can learn core engineering principles more efficiently and effectively by working together with their peers. Instead of providing remediation, Redshirt Camp plus engineering workshops constitute a novel academic program that promotes academic excellence and fosters leadership skills.

Implementation

Redshirt Camp: The camps are led by the authors with the assistance of a Teaching Fellow, and six dedicated graduate teaching assistants. The one-week camps are held in August and January of each year. All engineering rising sophomores and incoming transfer students are invited to participate in one week of camp at no cost to the student. Modules that are covered in camp include problem solving, vector calculus, linear algebra as applied to their calculator, time management and team building.

Workshops in Addition to Traditional Lectures: To continue the general techniques and principles taught at Redshirt Camp, we offer Collaborative Learning Workshops, held for two to three hours once a week throughout the semester. Once students embrace the notion of working together, forming groups outside of class to do homework problems and to prepare for examinations, they will discover that pooling their knowledge will result in the whole (a given group) being greater than the sum of the parts (individual students). Workshop facilitators are in direct communication with the faculty of the corresponding course lecture sections throughout the semester in order to ensure continuity with the lecture material. Students are required to take responsibility for their own educational enrichment and are held accountable. Workshop attendance and promptness is required.

Evaluation

Our Redshirt plus Engineering Workshop program has seen an overall participation rate of 25% of enrolled students in 10 targeted engineering courses. Over the past eight semesters (Fall 2002-Spring 2006), we have seen an average 30% increase in pass rates for our “Participant” group. Additionally, there has been no statistical difference in GPA’s between participants and non-participants, meaning students have not self selected based on prior academic performance. Therefore, we believe that Redshirt Camp plus Engineering Workshops can and do improve retention rates.

Recommendation for Adopters

Make it Real: One of the reasons why students lose interest in core engineering courses is that these introductory courses are often seen by students as abstract with limited examples that relate content to students' lives. Therefore, each of the modules in Redshirt Camp and our Collaborative Learning Workshops focus on real world examples. We emphasize collaboration over competition. Students often lose confidence in applying their math and science abilities in engineering courses due to the competitive nature of many classrooms. We believe students are much more likely to thrive in collaborative environments where there is social interaction. Instead of competing for who will be the first one to solve the largest number of problems, our programs provide students with tasks and projects that build the essential teamwork skills that lead to success in the classroom.

Students give overwhelmingly positive feedback about the worthiness and need of such retention programs. It is not uncommon for students to ask for similar programs in other courses. Our recommendations are follows: 1) advertise opportunities within courses that precede your targeted courses, 2) cajole undergraduate advisors to email program opportunities to your targeted student audience, 3) train workshop facilitators specifically on how to facilitate collaborative learning – avoid duplicating the lecture environment, and 4) maintain and enforce strict attendance standards for program participants.

Cost Estimates: Redshirt Camp (six graduate students @ one month each, \$9,000; four faculty @ 0.5 months each, \$20,000; one teaching fellow @ one month, \$5,000; 100 participant scholarships @ \$150 each, \$15,000) Total Costs, \$49,000.

Cost Estimates: Academic Workshops (six graduate students @ nine months each, \$81,000; four faculty @ 0.5 months each, \$20,000; one teaching fellow @ nine months, \$45,000) Total Costs, \$146,000.

Sources of Additional Information:

Title	Venue	When	Authors
Summer Camp and Course Workshops for Sophomore Level Electrical and Computer Engineers	ASEE Annual Conference Presentation and Paper	June 03	David P. Shattuck, Frank J. Claydon, Stuart A. Long, Betty J. Barr, Jennifer L. Ruchhoeft, and Lorena I. Basilio
Collaborative Learning as a Tool for Retention of Engineering Students: An Update on the Success of Engineering 'Redshirt' Camps and Collaborative Learning Workshops at the University of Houston Cullen College of Engineering	ASEE Annual Conference Presentation and Paper	June 05	David P. Shattuck, Betty J. Barr, Jennifer L. Ruchhoeft, Julie Martin Trenor, Stuart A. Long, and Frank J. Claydon

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Pair Programming Mentorships to Enhance the Computer Science Experience

Kay Robbins, Heather Hernandez and Kleanthis Psarris

Department of Computer Science, The University of Texas at San Antonio

Abstract

Despite strong demand for computer science graduates, enrollment in computer science has dropped dramatically nationwide. The UTSA computer science program has additional impediments to retaining its majors. UTSA's overall enrollment is 43.6% Hispanic and 7.1% black. Many of UTSA's 28,379 students are first-generation college students and/or are from economically disadvantaged families. A significant number of the high schools in the San Antonio area do not offer computer science classes. An assessment of our students' diverse needs indicated a general under preparation for the first required courses in computer science. We also noticed that hidden in the overall decline of CS majors was a more precipitous decline of women and minorities relative to the overall number of majors. We started a pair mentorship program to provide a more collaborative, individualized approach.

Purpose

The Department of Computer Science has experienced a loss in majors similar to that observed across the country. The overall drop in enrollments masked an equally disturbing trend --- the numbers of women and minority CS majors appeared to be dropping more rapidly than the overall decline. One of the investigators (KR) taught both Introduction to Computer Science and Data Structures in the Fall of 2004. She noticed that there were virtually no women in either section of her courses and few in the Introduction to Programming course that preceded it. This informal observation was borne out in subsequent graduation rates as shown in Table 1. In spite of implementing curriculum reform, hands on laboratories and peer tutoring, we were not attracting and retaining underrepresented groups in proportion to their presence in the UTSA student body. Furthermore, this has been a relatively recent decline.

Year	Total	Male	% Male	Female	% Female	Hispanic	% Hisp
2000-01	52	39	75.0%	13	25.0%	7	13.5%
2001-02	56	43	76.8%	13	23.2%	8	14.3%
2002-03	52	42	80.8%	10	19.2%	17	32.7%
2003-04	70	57	81.4%	13	18.6%	28	40.0%
2004-05	61	54	88.5%	7	11.5%	25	41.0%
2005-06	55	48	87.3%	7	12.7%	16	29.1%

Table 1: Graduation rates for the UTSA undergraduate CS program.

Based on these observations, we felt we had to do more. Research on underrepresented students generally points to the need for a more collaborative learning environment to support these students. With this in mind, we developed the CS Pair Mentoring Program. The mentorship program is motivated by the ideas of pair programming from the extreme programming movement. When an inexperienced programmer is paired with a more experienced programmer under this paradigm, the inexperienced programmer develops more rapidly. This surprising observation has changed the way software is developed at many companies. The CS Pair Mentorship hooks up successful advanced students (mentors) with beginning CS students (mentees) to engage in pair programming. Engaged in active learning and collaboration from the beginning, these students will hopefully go on to later courses with a firm foundation and a support infrastructure.

Implementation

Our original TWD grant included a scholarship and informal mentoring program for upper division students, but we felt that simply giving a scholarship to a student did not achieve the goals we had envisioned. We replaced the scholarship program with a pair mentorship program, which had a multiplier effect as well as enhanced career development and leadership opportunities for the participants. CS Scholars/Mentors are supported at a rate of \$500 per month during the academic year. The students are expected to get an internship in local industry or to work as research assistants for faculty during the summer.

We targeted students in the beginning 4 programming courses. Student participants (mentees) spend two hours per week pair programming with a mentor (an upper division student/mentor). Each mentor is responsible for two inexperienced students, matched where possible by gender and ethnicity. At the beginning of the semester, the mentor assesses the areas that the mentee did not do well in the previous course and selects programming exercises to work on with the student to assure mastery of the previous material. Later in the semester, the mentor selects current laboratory assignments and lecture case studies that the inexperienced student is having trouble with. The mentors meet periodically to share experiences.

Evaluation

We track placements of the scholar/mentors as shown in Table 2. We also tracked the GPAs and success rates of participants. It is too early to tell if the Pair Mentorship Program will make a difference, but anecdotal evidence indicates that the overall reaction is positive. CS major and mentee Gloria Serna has high marks for the program. "I would not have advanced this far without my mentor, Heather Hernandez," Gloria explains. "Whether Heather had an hour or 20 minutes to spare time... I would learn something new and take it home to practice. My mentor has given me a brain to pick, an ear to listen, and a push in the right direction."

Mentees	White	Black	Hispanic	Asian/PI	Am Ind	Internat	Male	Female
Total	29(42%)	4(5.8%)	29(42%)	2(2.9%)	1 (1.5%)	4(5.8%)	51(73.9%)	18(26.1%)
Full year	10(40%)	0	12(48%)	2(8%)	0	1(4%)	18(72%)	7(28%)
Current	8(42%)	3(16%)	6(32%)	0	1(5%)	1(5%)	13(68%)	6(32%)
Mentors	14(60.9%)	0	8(34.8%)	1(4.4%)	0	0	17(73.9%)	6(20.1%)

Table 2: Participation of mentees and mentors in the UTSA CS Pair Mentorship Program

Recommendations for Adopters

Requiring upper division students to mentor beginning students in a formal arrangement as part of a scholarship is a win-win situation. The upper division students become more involved and develop their leadership skills. We had originally conceived of mentorship for students who were having trouble, but found this carried too much of a stigma. We eliminated any requirements for mentees. We would like to have more students participating in the mentorship program and feel this may be an attractive program for industry funding, as many employers have indicated to us that they would like to see CS graduates improve their soft skills as well as technical skills.

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Presentation/Discussion Session **4**

Best Practices in Retention

Moderator

Arturo Sanchez, Director of Workforce Development, Texas Instruments, Inc., Dallas, TX

Creating Learning Communities at The University of Texas at El Paso to Increase Throughput

Benjamin C. Flores, Judith Munter, Sylvia Trillo, and Nabil Ghariani
Electrical Engineering Department, The University of Texas at El Paso

Abstract

Recently, we changed teaching and learning strategies in two sophomore Electrical Engineering courses with the aim of turning them into gateway courses. The student groups primarily impacted by this project were the cohorts enrolled in Digital System Design I and Electric Circuits. Since these courses are essential for students to move on to the upper division curriculum, we organized students in small groups, each headed by a peer facilitator who led active learning sessions organized as weekly workshops that were approximately two-hours long. We also conducted a two day workshop on cooperative learning prior to the beginning of the semester for faculty and peer facilitators who were participating in the project. For quality control purposes, the peer-facilitators reported on the effectiveness of each session and any new improvement needed for future sessions on a weekly basis. Some of the benefits students experienced during the intervention were increase in grades, retention in the program, exposure to organized team work, and the development of a positive outlook on their education and in their future careers.

Purpose

For most of the latter part of the 20th century, undergraduate Electrical Engineering curricula in US institutions had a number of freshman, sophomore and even junior level courses that served as quality control filters. These gatekeeper courses have had an unfortunate impact on graduation rates and the length of time to graduation. Recently, cooperative learning strategies such as those promoted by Felder have been implemented in many engineering schools. The overall goal has been to improve the quality of education.

At our institution, we have had a number of programs dedicated to the retention of entering students in Science and Engineering. The main thrust in these programs has been the development and implementation of learning communities for students with similar levels of mathematics and communication skills. Learning communities have had a positive impact on the retention (up to 80%), cumulative grade point average (above 2.8/4.0), number of credit hours attempted (13 hours), and number of credit hours earned (11 hours). Encouraged by these results, we set to address the sophomore slump experienced by electrical engineering majors with the aim of improving the second and third year retention rates.

Implementation

Typical enrollment in Digital Design I and Electric Circuits varies between 40 and 75 students per section per semester which is not conducive to team work activities in the classroom. Consequently, faculty interaction with the students and among students themselves tends to be limited even when using an informal cooperative learning approach. To improve interaction, we implemented Saturday workshops led by peer facilitators (junior and senior EE majors) to promote organized active learning (i.e. peer led team learning) in each course. By design, the Saturday workshops focused on problem solving and hands on analysis/design activities. Peer facilitators conducted the workshops by setting teams of three or four students per table,

Retaining Female Engineering Students by Creating an Effective Women-in-Engineering Program

Julie Martin Trenor, Frank J. Claydon, Stuart A. Long and Rachel Danek Jones
Cullen College of Engineering, University of Houston

Abstract

The Women in Engineering Learning Community for Maximizing Excellence (WELCOME) was established at the University of Houston (UH) with a TWD grant (grant #00362-EE2005-2000) in the Fall 2005 semester. The mission of WELCOME is to create and maintain a climate which allows women in the Cullen College of Engineering to reach their full potential, to persist to graduation, and to be sustainable in the workforce. The program offers a strong supportive community, opportunities for professional, academic, and personal development, and mentoring programs for both lower and upper division students. Since its inception, 48% of enrolled female students have participated in one or more program activities.

Purpose

The mission of WELCOME is to create and maintain a climate which allows women in the Cullen College of Engineering to reach their full potential, to persist to graduation, and to be sustainable in the workforce. While other University of Houston engineering retention programs focus on improving academic preparation for both male and female students, WELCOME aims to primarily address the issue of isolation reported by female students at UH and in the women-in-engineering literature. A survey of female engineering students signaled the need for community-building programs that equally address the needs of both upper and lower division students.

Implementation

Program goals have been achieved by offering mentoring programs, a seminar series, and retreats. With a commuter-based student population in a large metropolitan area, we effectively designed electronic-based mentoring programs which address these challenges and allows for frequent communication without additional commuting for face-to-face visits. The program consists of student mentoring (first year students paired with upper division students) and professional mentoring (upper division students paired with working female engineers in the local community). Seminars and periodic retreats provide forums for female students to gather and discuss issues relevant to their academic, professional and personal lives. Seminar topics vary between upper and lower division student interests, from help in transitioning to college to preparing for the working world. Ongoing adjustments to the seminars including continual adjustment of topics, as well as the days and times they are offered. Experience has shown that offering seminars at lunch time with lunch provided helps to increase attendance. To help ensure relevance of WELCOME program offerings, a student advisory board was created.

Establishing program visibility has been a key accomplishment of the program's first 18 months. A logo, website and brochure were developed. Tee-shirts and water bottles (funded from another source) were purchased and given to students at no charge. To encourage participation by incoming students, a postcard promoting WELCOME was sent during their summer prior to attending UH, which gave an opportunity to sign up for a peer mentor before classes started.

Evaluation

We are pleased with the momentum the program has developed in a short amount of time and define our success in this first 18 month period by the large number of students who participated in WELCOME: 48% (N=168) of enrolled female undergraduate engineering students participated in one or more WELCOME activities, 22% (N=77) participated in the student or professional mentoring program, and 45 working professionals from 20 different Houston-area companies participated as professional mentors. Fifty nine percent of female engineering undergraduates enrolled in Fall 2006 reported belonging to an ethnic minority group, and an additional 13% are classified by the university as international students. WELCOME participants are reflective of this ethnic diversity.

The success of the program is evident in the comments of participating students: “I realized that I was not the only person with doubts and uncertainties about engineering as a career. At such a large university, it can be overwhelming sometimes. For these reasons, being involved in women-in-engineering activities provides a sense of community for female engineering students. Help and support become easier to access through this network.”—Cuc, freshman; “I have gained a sense of community that I really did not have before I knew about the WELCOME program.” —Brandy, sophomore; “WELCOME has allowed me to transition from freshman/sophomore level to junior/senior level more confidently. I am more confident in my ability to become a Professional Engineer. All of these activities create a bond between the engineering students. My (professional) mentor has assisted me a lot. I feel as though I can ask her anything in regards to school, work, or even everyday decisions.”—Tomica, senior; “Even though I have graduated, my (professional) mentor and I still keep in touch. She has helped me get to where I am today. I still go to her for questions and guidance. I want to thank WELCOME for the opportunity to meet her.”—Cris, 2006 graduate

Recommendation for Adopters

- Ensure that you are investing your energy in the activities that are most needed/wanted by students: use student surveys and create a student advisory board to determine what students need/want and create buy-in.
- The biggest initial challenge may be creating a program identity among students. Be sure to allocate costs for promotional items such as t-shirts and printing costs. Students are your best advertisement— identify the leaders and enlist their help.
- Use your alumnae base. You really only need a couple of strong supporters to help you gain visibility among the alumni.
- Avoid re-inventing the wheel. Great resources and ideas are available through Women in Engineering Programs and Advocates Network (WEPAN), the Assessing Women in Engineering Project (AWE), and engineering education conference proceedings and literature.

Sources of Additional Information

- WELCOME website: www.egr.uh.edu/welcome
- Publications: “Establishing a Women in Engineering Program at an Urban University,” Julie Martin Trenor, Chidiogo Madubike, Frank J. Claydon, Proceedings of the 2006 WEPAN Conference, June 2006, Pittsburgh, PA
- Copies of mentoring program application forms, contracts, mentor/mentee responsibilities forms are available by contacting Julie Trenor
- WEPAN: www.wepan.org, AWE: www.aweonline.org

Contact Information: Julie Martin Trenor, email: jmtrenor@uh.edu, phone: 713-743-3299

Jonsson School Undergraduate Scholars Program

Simeon Ntafos, Erik Jonsson School of Engineering and Computer Science
The University of Texas at Dallas

Abstract

This program provides a holistic approach to attracting and retaining qualified students to degree programs in the Erik Jonsson School of Engineering and Computer Science (ECS) at UT-Dallas. Besides financial support, participants are involved in outreach, mentoring, undergraduate research, and industrial internships and will be much better prepared to transition to a permanent position in industry or continue on to graduate school than with a traditional scholarship program. The program targets minorities.

Purpose

Scholarships are a proven approach to attracting and retaining top students. However, they do not address the pipeline problem and they do not provide direct support for a career path after graduation. Both of these are especially significant obstacles in attracting and retaining minority students.

The Jonsson School Undergraduate Scholars Program uses a combination of the TETC-TWD-TYT grant award, scholarship funds, external research funding to ECS faculty, and support from local industry (additional scholarship funds and/or internship programs) to better address the recruitment and retention of high quality students to ECS majors. The program specifically targets minority students.

At steady state, the program provides support for four years to qualified full-time students and involves the participants in different activities as they progress in their studies.

- (a) in the freshman year, each student receives \$2,000 and is expected to be involved in outreach activities to attract more middle, high school students to STEM fields;
- (b) in the sophomore year, each student receives a \$2,000 award and is expected to be involved in mentoring ECS freshmen and/or outreach activities;
- (c) in the junior year, each recipient receives either a \$2,000 award and is involved in a research project supervised by a faculty member or a \$1,000 award (from UTD) and does an internship with industry;
- (d) in the senior year, each recipient will continue working on research with a faculty member for up to 20 hours per week (funded by the faculty member's research grants) or on an industrial internship for up to 20 hours a week (funded by the company). The student will continue to receive the \$1,000 award from UTD.

Upon graduation, students in the program will be in excellent position to continue on to graduate school or obtain a permanent position in industry.

Implementation

One component of the program, peer mentoring, is a strategy we have employed for several years in various forms. It started several years ago with using seniors in place of graduate Teaching Assistants to help with the first-year programming courses. We found that freshmen related much better to advanced undergraduates that had gone through a similar experience. In 2005, we expanded the mentor program to cover most of the major required courses in ECS degree programs. Mentors were assigned to help small groups of students with specific classes (study group model). The feedback from mentors and students was very positive but finding mutually convenient times for each group to meet proved more of a problem than was expected and the approach used just did not have the scope required to address the number of students in need of help (DFW rates in the 30% plus range for several entry level classes and classes in

the major). Starting in Fall 2006, we moved to a “mentor-lab” model with mentors available at a specified time and place to provide help with six groups of classes (First-Year Programming sequence, Calculus sequence, post-Calculus Mathematics classes, Discrete Mathematics classes, and Upper-Level CS, Upper-Level EE classes).

The undergraduate research experience and industrial internship components are based on the experience gained from several summer research participation programs and our very successful Industrial Practices Program (IPP), the largest co-op program in Texas and one of the largest in the U.S. The main issue there is sustaining the program long term; we have initiated discussions with our industrial partners to have them fund the first two years of the program and then hire interns from that pool (an approach similar to the Industrial Scholars program at the University of Houston). The outreach component is relatively new for ECS and still a work in progress; it involves helping prospective students and visiting high and middle schools.

Evaluation

While it is too early to evaluate the overall effect of the program, initial indications are very positive in terms of retention among students receiving awards (all remained as ECS majors from Fall 2006 to Spring 2007) and the number of students reached by the mentoring efforts (e.g., the Programming group had 219 mentoring sessions in September of 2006, 320 sessions in October, and 322 in November 2006; numbers were lower at the upper level groups where 10-15 sessions per week were typical).

The cost per participant is 2,000 per year currently funded by scholarship funds (50%) and TETC-TWD-TYT (50%). As we progress, the TETC funds will be further leveraged with research funding from faculty and support from industry. Current TETC funding recipients are 30% Female, 10% Black, 6% Hispanic. In terms of awards to incoming Fall 2007 freshmen, at this stage we have 33 offers out, all to gender and/or ethnic minorities (22 Female, 12 Hispanic).

Recommendations for Adopters

The approaches we used to implement the various components of the program and costs involved are discussed under previous sections. In general, getting a program like this going requires much more work than a traditional scholarship program. The expectation is that there will be a multiplying effect due to the outreach and mentoring components.

Sources of Additional Information

The announcements, application forms for this program can be found at <http://www.utdallas.edu/~ntafos>.

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Results of the 2003-2007 The University of Texas – Pan American On-Campus Jobs Program

Heinrich Foltz and Edwin LeMaster
Electrical Engineering, The University of Texas - Pan American

Abstract

From Spring 2003 through Spring 2007, the University of Texas - Pan American implemented a TWD-funded project to provide on-campus jobs to electrical engineering students. The primary purpose of this project was retention, through financial support, engagement with faculty, and reduced competition for student time from outside commitments. This paper will focus on assessment of the results obtained, which show very substantial improvements in retention statistics for participants and significant effects on retention for the department as a whole. Cumulative (not single year) retention for participants was 95% as students in good standing and 88% as EE majors.

Purpose

The University of Texas - Pan American has a student body that is primarily commuters (90%), with financial need (79%), who are the first generation from their family in college (69%). Retention of electrical engineering students has been adversely impacted by financial considerations, low contact between students and faculty during the freshman year, and time conflicts caused by outside employment. We implemented a program to address all three issues by offering new students employment in the department under the supervision of faculty and staff. Students at UTPA are frequently under pressure to maintain employment regardless of whether they receive loans or grants; therefore, an employment program was felt to be more effective than stipends or scholarships. The main purpose was increasing *engagement*, that is, getting students to view coming to the university as their primary daily activity.

Implementation

The program was advertised through the department website and direct contact during academic advising. Employment was offered on a first come, first serve basis without regard to GPA or work background, to any new student (freshmen, sophomores still in entry level courses, and transfer students). The following employment conditions were set: (1) full time enrollment, (2) major in electrical engineering, and (3) no off-campus employment. Students were generally employed at \$7.50/hr for 5-20 hours per week, with hours adjusted to meet student needs. Once students were hired into the program, they continued to be supported until graduation or the termination of program funding. Work assignments included research projects, computer technical support, computer lab monitoring, grading for lower-division classes, tutoring of other students, assisting lab technicians, and clerical work. Faculty, technical staff, and clerical staff all served as supervisors.

Evaluation

The tables on the next page show an analysis of retention results for the program. A total of 68 students participated. Table I shows raw retention results for cumulative retention and single year retention. Table II shows a comparison to the general population of EE students. There is a marked improvement, particularly in long-term cumulative retention, although a direct comparison is not possible because some TWD students are still in progress. Table III shows

that the TWD program in electrical engineering has resulted in overall statistics, for all EE students, significantly higher than comparable engineering and CS departments without similar programs. To date twenty-five TWD-supported students have graduated, and many are working or have accepted offers with Texas corporations including Texas Instruments, IBM, Motorola, Raytheon, and Halliburton. Four other graduates are currently in graduate school.

Table I: Retention for All Participants in Program

Category	Cumulative		Single Year	
	N	%	N	%
All Participants	68		46	
Good Standing, Graduated, Transferred	61	90%	43	93%
Good Standing or Graduated at UTPA	59	87%	43	93%
Good Standing or Graduated at UTPA as Electrical Engineering Major	46	79%	43	93%

Table II: Comparisons to General EE Student Population

Category	Single year	Cumulative
TWD On Campus Students	93%	79%
All EE Students	81%	44%

Notes: TWD single year results taken from single year of initial cohort. All EE students is weighted average for all freshmen and sophomores. Cumulative result for All EE students is net retention Freshman to Senior, TWD includes students in progress.

Table III: Departmental Comparisons - All Students

Major	Freshmen, 1 year	Sophomore, 1year	Net Retention
Electrical Engineering	75.3%	89.1%	43.8%
Mechanical Engineering	66.7%	80.3%	40.5%
Manufacturing Engineering	61.0%	78.9%	39.4%
Computer Science	68.1%	76.1%	31.0%

Comparison of EE to other majors not supported by TWD On Campus Jobs, showing that effects are significant for total EE population even though only a fraction have TWD support.

Recommendations for Adopters

From our experience over the last four years, the following recommendations can be made:

- To maximize opportunities for students who have completed few technical courses, technical and clerical staff can be assigned as supervisors in addition to faculty.
- Supervisors should be clearly informed that the primary purpose of the program is student retention, rather than work productivity, and that this should be taken into account when setting schedules and expectations.
- Departments should plan for a substantial increase in clerical work due to the large number of time cards and employment documents that will need to be processed.

Sources of Additional Information

[1] "Engineering Retention Enhancement Through On-Campus Jobs", *TWD Best Practices Meeting*, Dallas, TX, June 10-11, 2006. Abstract and slides available through our website.

[2] UTPA Electrical Engineering Website: ee.utpa.edu

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Peer Teachers

Valerie Taylor, Joseph Hurley, Lawrence Petersen, Jennifer Welch, Frank Shipman III
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Abstract

Peer Teachers is an excellent program that has been implemented in the Department of Computer Science at Texas A&M University. The program entails having students, who have recently taken a course and earned a grade of A, participate as Peer Teachers to help with lab instruction and course assignments. The Peer Teachers are not involved in the grades for the course, thereby providing a non-threatening mechanism for students to ask any questions. This program has been in place since 2002 and has been very well received by students and faculty. We are now engaged in an assessment of the effectiveness of having Peer Teachers in the lab/classroom versus not having them.

Purpose

Peer Teachers are successful students (as determined by the GPA), who are paid \$10/hr for up to 10 hours per week to assist students in courses previously taken, in terms of labs and classroom exercises. Peer Teachers also provide supplemental instruction during the evenings and on weekends for students who require such assistance. Peer Teachers address two major goals. The primary goal is to improve student learning and reduce anxiety. Students typically attend lectures followed by practical work in labs. Students have reported that one of the principle reasons for leaving the computer science or computer engineering majors is the frustration of dealing with difficult lab assignments, with insufficient assistance. Experience has shown that one Teaching Assistant has difficulty getting around to 17 to 22 students in lab and effectively assisting them; and also that some students are reluctant to ask questions of their TA because the TAs have input into their grades. In contrast, Peer Teachers do not grade student work.

The secondary goal of Peer Teachers is to provide a positive reinforcement of concepts through the teaching of others. Peer Teachers have an opportunity to explain concepts learned in previously taken courses to the students currently enrolled in the courses. This teaching experience allows Peer Teachers to gain in-depth learning, which aids in learning more advanced concepts taught in future courses.

Implementation

Peer Teachers in our program must have earned an A in the course they are assigned as a Peer Teacher and must maintain at least a 3.0 grade average overall. Generally, the students selected as Peer Teachers for a given course correspond to the student who took the course one year prior. Prior to making the final decision about an offer, we interview each student. We provide a one day orientation for Peer Teachers during which we discuss the requirements of the position and discuss some techniques for being an effect tutor. Once a student has agreed to be a Peer Teacher, he or she is required to meet with the faculty to work out the details of his or her responsibilities for the assigned course. Peer Teachers generally meet with the course instructor on a weekly basis to insure good coordination between Peer Teacher and Instructor. Peer Teachers are assigned at the beginning of each semester.

The Peer Teacher program began in the introductory courses, focused on programming and data structures. The program has been so successful in terms of student and faculty feedback, that we have extended the program to our entire undergraduate courses offered in computer science, for which we are able to find Peer Teachers. Hence, because of the demand, students can participate in the program multiple times.

Evaluation

Originally, the Peer Teaching program has been considered a service, rather than a research project. The Peer Teachers were made available to all students taking a course. Survey data was collected at the end of each semester regarding student assessment of the program. The results have been uniformly positive in terms of the Peer Teachers assisting with learning concepts and the opinion that the program should be continued in the future.

We collected information on the frequency at which students change majors, comparing students with Peer Teachers to students from previous years without Peer Teachers. We did not find much difference, which was expected given that many factors affect one's decision to change majors during the freshman and sophomore years. We also collected data on final grades, for which the results were non-conclusive. Data has been collected on lab scores assigned to students with and without Peer Teachers. The preliminary data on assignments from one class (CPSC 206) demonstrated a 6.2% increase in assignment scores. Further, we have found in another course (CPSC 410) that the Peer Teachers aided in transitioning to a new course project; the Peer Teachers allowed the instructor to focus on a very aggressive project for the course.

Until now we have not conducted an assessment comparing classes with Peer Teachers to students without them. During Fall '06 and Spring '07 we are assigning Peer Teachers to some sections and not to others for a portion of the course and looking at a comparison of student performance. When we conclude with this comparison we hope to have a better idea of how much the Peer Teaching program is actually working for the students involved.

Recommendations for Adopters

The Peer Teachers program is a very positive program that helps students enrolled in the courses as well as the Peer Teachers aiding in the learning of concepts. To be effective, it is important to require that Peer Teachers to have earned a grade of A in the assigned course. This aids in the credibility of the program with respect to the students enrolled in the courses.

We have found that the training of Peer Teachers is important and should not be eliminated. We have developed a handbook to assist in this training. This handbook is available upon request. Further, the weekly meetings are also critical. It is also important that the Peer Teachers not grade the students they are assisting. This improves the level of comfort students have when asking questions and seeking assistance. Lastly, the salary is an important component, as it is important for the Peer Teacher to be an employee, not a volunteer, to maintain consistency in the program.

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Presentation/Discussion Session **5**

Best Practices in Course/Curriculum Re-Design

Moderator

To be arranged

Early Introduction to Programmable Logic Devices and Tools in a Digital Laboratory Course

Mehdi Shadaram, Chirag Parikh, John Prevost, Parimal Patel, and Wei-Ming Lin
Electrical and Computer Engineering, The University of Texas at San Antonio

Abstract

The undergraduate digital curriculum in the Department of Electrical and Computer Engineering at The University of Texas at San Antonio was analyzed about three years ago and subsequently revised by introducing a new Logic Design Laboratory course early in the curriculum. This paper discusses the content of the new laboratory course, including the CAD tools used and the programmable logic devices (PLD) as well as integrated circuits (ICs)-based laboratory assignments, and exemplifies some of the project work done as part of the first-time offering during Fall 2006.

Purpose

The objective of the funded project is to promote the Technology Workforce Development Act by increasing the number of high-quality graduates who are technically competent and competitive in the nation. To achieve this, two strategies have been employed: (i) Student Retention and (ii) Curriculum and Laboratory Improvement. The purpose of this paper is to present the effort made in the second strategy.

Implementation

Prior to developing the proposal, the sophomore-level course, EE 2513 (Logic Design) did not have any laboratory component. Starting Fall 2003, we adopted a new edition of the textbook, which includes hardware modeling concepts. The course material was revised to add at least two laboratory assignments in the course. These laboratory assignments were conducted during the recitation sessions and used simulation tools (SimuAid and LogicAid which come with the textbook). Upon funding of the proposal, we extended those assignments to include Xilinx CPLD-based evaluation kits, using which students designed combinational network and verified their designs through hardware. The three experiments were carried out during the recitation sessions along with a demonstration of experiment on sequential circuits.

Starting Fall 2006, we have introduced a new course titled Logic Design Laboratory (EE 2511) to complement with the corresponding theory course Logic Design (EE 2513). The course objectives are: (i) to implement the concepts learned in the Digital Logic Design course using 7400 Logic chips, (ii) to implement the concepts learned in the Digital Logic Design course with CAD tools, and (iii) to develop models in VHDL which can be synthesized, implemented, tested and debugged using CPLD- and FPGA-based kits. In order to achieve these objectives the topics covered include: (i) schematic captures, (ii) gate-level and timing simulation, (iii) Implementation of design using discrete ICs (7400, 7404, 7408, 7411, 7432, and 7-segment LEDs), (iv) VHDL coding and behavioral and timing simulation, and (v) VHDL coding for synthesis and implementation of fairly complex circuits in Xilinx CPLD and FPGA kits.

The students were provided tutorials on Logic Reduction using LogicAid, Simulating Combinatorial Circuit using SimuAid, Entering Schematics using SimuAid, VHDL Modeling, simulating, Synthesizing, Implementation using Xilinx ISE and ISIM simulator as well as ModelTech's ModelSim simulator. The hardware kits that they used consist of FreeScale MCU

Project Board 2 (to build circuits using discrete ICs and 7-segment LEDs), Xilinx's CoolRunner XPLA3 CPLD-based kit for combinatorial circuit design, and Xilinx's Spartan3E-based starter kit for sequential circuit design experiments. During the entire semester they conducted five tutorials and seven laboratory assignments in addition to mid-term and final projects. Students were asked to write a formal report and to give a formal presentation as part of the final project to enhance both written and oral communication skills.

Evaluation

This laboratory course's software and hardware tools were in part supported by generous donations from FreeScale in form of project boards and from Xilinx in form of Spartan-3E kits, ISE software and ISIM simulator under Xilinx University Program. The textbook, Logic Design by Charles Roth, used includes LogicAid and SimuAid programs. The only cost to the department was for ICs and bread-boarding wires. In Fall 2006, sixteen students were enrolled and in the current semester (Spring 2007) there are 22 students enrolled. During Fall 2006 students enrollment in the class included 8 Hispanics and 1 female, while Spring 2007 class includes 11 Hispanics and 1 female.

Recommendations for Adopters

As can be seen from the Implementation section, the newly developed laboratory course is a success. It has enabled us to modify the subsequent course (EE 3563) content. Now we use VHDL modeling starting first week of the semester and use Spartan 3E kits past mid-semester where students implement complex finite state machines. We recommend pushing the tools usage, hands-on experiments using ICs, and programmable devices-based kits early in the curriculum to stimulate interests and validate principles with tutorials, demonstrations, and actual exercises.

Sources of Additional Information

Information related to the course syllabus and content may be obtained by contacting the Department of Electrical and Computer Engineering at UTSA. Copies of various tutorials and detailed laboratory assignments may be obtained from Professor Parimal Patel (e-mail address is provided below). The changes made to the digital curriculum and related information may be obtained from manuscript (titled: Logic Design Laboratory: An Early Introduction to Programmable Devices and Tools) submitted to 2007 ASEE-GSW Conference, March 28-30, 2007.

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Mr. Chirag Parikh, Ph.D. student and TA for the class
Mr. John Prevost, Undergraduate student who has gone through the class

Improving Student Recruiting and Retention through an Interdisciplinary Computer Science Curriculum

Armin R. Mikler and David M. Keathly
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Abstract

The overall intent of the strategies presented is to broaden the skills and reach of our current and future computer science graduates by exposing them to non-traditional applications of the skills and techniques they have mastered in their undergraduate studies. As an ancillary benefit, this program also appeals to students that would not have traditionally pursued a career in computer science, especially those from underrepresented groups that might otherwise opt for more rigid and traditional science programs. Additionally their experiences benefit a host of academic, commercial and governmental concerns by creating a pool of individuals with cross-disciplinary talents and heightened willingness and ability to collaborate with potential colleagues and co-workers from a wide variety of diverse, yet synergistic, disciplines.

Purpose

Upon entering the university, students have historically chosen and pursued an academic path from a small set of diverse disciplines, including science, arts, and engineering. Particularly for students with diverse background, this choice is often difficult, especially early in their academic career. However, it is generally considered imperative to “be on track” early, so the students’ academic metamorphosis can follow an often rigid regime. In spite of students’ interest, rigid sequences of courses with intrinsic systems of course prerequisites make the pursuit of interdisciplinary knowledge time consuming and impractical. Academically, this has led to a segregation of scientific domains, which we are now seeking to overcome.

Implementation

The implementation of this effort was undertaken in the form of two strategies as follows:

Strategy 1: The ever-increasing amount and complexity of scientific data has resulted in the integration of computing in the natural sciences. Driven by the need to analyze volumes of scientific data and the necessity to conduct large scientific simulations as part of the scientific process, computational science has emerged. Biology, Chemistry, and Environmental Science, are examples of scientific domains that have integrated computational methods in their repertoire. However, the corresponding curricula in these scientific domains generally do not include courses which would expose students rigorously to any of the Computer Science paradigms. In order to facilitate and accelerate interdisciplinary research, academic programs must integrate interdisciplinary training early in the curricula and not as an after-thought. In our initial efforts we developed the outlines for a sequence of 8 courses that would provide the essential elements of a computational science education including the study of several depth areas from the sciences that would be accessible to a variety of students.

Strategy 2: The second strategy encompassed the design of the first two undergraduate courses from Strategy 1. The first course provides a survey treatment of the applications of computational paradigms in the natural and physical sciences. Team projects, guest lectures and research are integrated into the course to encourage interdisciplinary collaboration among the students from different departments and backgrounds. The course is offered with basic and

minimal prerequisites in order to widen its appeal, introducing students to topics including: agent-based simulation of societies and population, mathematical modeling in Chemistry, Biology and Epidemiology, high performance computing, and Data Visualization. The second course, Bio-Computing, pilots the establishment of a series of courses each targeting a specific scientific focus area. Newly created concentrations such as bioinformatics have begun to appear at universities and other research institutions to explore interdisciplinary approaches combining aspects of biology and computer science, and thus made this a logical launching point for the second and more specialized course in this new curriculum.

Evaluation

The first course, a Survey of Computational Science, has now been offered for two semesters. It has proved to be a popular course that has filled on each occasion, drawing students from Computer Science, Business, Biology, Chemistry and even our Texas Academy of Math and Sciences (TAMS) program for high school students. The Bio Computing course, offered under concurrent listings at both the undergraduate and graduate levels in Computer Science and Biology also drew a healthy mix of students from these departments at all levels. In addition, the popularity of these courses and topics at the graduate level has fostered the creation of two unplanned courses, one in Bioinformatics and another in Advanced Computational Epidemiology. Students in these courses have addressed contemporary issues such as the Avian Flu, Pandemic Flu, Bio-Terrorism, and vector-borne disease such as West Nile Virus. Several natural science students have undertaken computer science minors in order to pursue further interest in computational sciences during the period of this effort. Finally, the courses have been popular with traditionally underrepresented populations including women, who accounted for approximately 25% of the enrollment in the courses.

Recommendations for Adopters

The motivation to incorporate interdisciplinary curricula into existing programs is clearly mandated by the nature of the problems we seek to address, as well as by the organizations that employ our graduates. Each university must find those domains in which collaboration is most beneficial within their own infrastructures, but it is imperative that they implement appropriate programs in their own best interests as well as those of their students. Collaboration and cooperation among the faculty in the departments involved is essential to the success of these courses in attracting students, defining appropriate and relevant problems to investigate, and providing the needed expertise to develop and present the curriculum.

Sources of Additional Information

Course descriptions and other information regarding the courses developed can be found on the faculty member websites at www.cse.unt.edu/~mikler and www.cse.unt.edu/~dkeathly.

Contact Information

Dr. Armin R. Mikler can be contacted by email at mikler@cse.unt.edu and David M. Keathly at dkeathly@cse.unt.edu. Both can be reached by phone at (940) 565-2767 or by postal mail at University of North Texas, Computer Science and Engineering Department, PO Box 311366, Denton, TX 76203-1366

More Graduates and Higher Quality through Curriculum ReDesign

Chanan Singh, Electrical & Computer Engineering, Texas A&M University

Abstract

Curriculum and instructional enhancement were originally adopted as a core strategy in our TWD projects for higher retention leading to an increased number of graduates. The strategy has resulted in more intensive involvement of research-active faculty, investment from the department and the college and an increased emphasis on undergraduate education, all resulting in enhanced quality of education and an increased number of graduates. Design and implementation of such a strategy require, at least in the beginning, release time for faculty and Graduate Assistant support. Curriculum redesign takes into consideration the talent spread of students and feedback from the ABET process loop. The philosophy of “understand and apply” rather than “memorize and reproduce” is central to an effective curriculum redesign.

Introduction and Purpose

In 2001, while responding to the TWD request for proposals for increasing the number of electrical and computer engineering graduates, we considered several options. Increased enrolment was not viable as faculty and other resources were already stretched. Thus the core strategy we chose was to make the yield higher - enhance retention. We proposed several strategies but at the core of all was enhancement of curriculum and improved methodology of instruction, including mentoring of students. The basic premise was that if the students could be interested and challenged, they will stay and more will come.

Strategy

Our strategy has been evolving and adapting continuously. The curriculum changes have been made in three phases, which were initiated sequentially but are running concurrently. Initially we focused on our gateway courses (100 and 200 level). These are critical in securing the attention of freshmen and showing them a roadmap. The idea is that if there is realization of a worthy goal, the journey can be meaningful. This was then followed by enhancements of the junior level courses (300 level). The final phase was to focus on electives, to improve the existing ones as well as create new ones including honor sections. Essential to the success of all this has been identification of faculty champions and providing them with time and resources to effect changes. In this process the quality of education has been enhanced. The curriculum-redesign has been further strengthened through the ABET feed back loop.

Implementation

Phase 1: In the first phase the following courses were targeted:

ENGR 111-the first course in engineering: It is our experience that a first course in engineering tailored for electrical or computer engineering has a beneficial effect on motivating freshmen and thus retaining a higher fraction through the rest of their study period. Students are shown what electrical and computer engineers do, taught basic technologies and presented a four year road map of their education. We also emphasize the role of design in engineering and calculations are tied to measurements. We continue to integrate the lab exercises and the lectures to emphasize the importance of math, science and theory to practical application of engineering. Instead of previously used Tekbots, we now use LEGO NXT robot kits as these have better characteristics and more predictable behavior. The students find it is easier to reproduce the lab results on this new platform.

ELEN 214-Electric Circuits: The instructional philosophy of the course has been significantly altered by introducing more engineering design in the curriculum and adopting WebCT based interactive homework submission system. More challenging and industry related experiments

have been introduced in the laboratory portion of this course. A design studio has been introduced with several open-ended, realistic, top down electrical engineering circuits problems that have numerous solutions, and often have missing information or too much information. Starting fall'07, e-instruction student response systems called Clickers will be deployed in the classrooms to engage the students in the learning process more effectively.

Phase II: Phase two targeted mostly the courses taken by juniors, ie, the 300 level core courses, ie, Linear Circuit Analysis (ELEN 314), Electronics (ELEN 315,), Electric and Magnetic Fields (ELEN 322). Capstone Design (ELEN 405) has also been enhanced and is central to ABET evaluation process.

Phase III: Expansion of Electives and Honor Sections. The curriculum should satisfy the spread of the intellectual talent of students. So, we have started honor sections of certain courses to satisfy this need. Several electives like ELEN 472, ELEN 452 and ELEN 459-460 have been strengthened and a number of new electives at the senior level are being introduced, to expand educational possibilities in the new technology areas like the nano and bio technology. A more flexible curriculum attracts more students and enriches the quality of their education.

Evaluation

The success of this strategy can be judged from the graduation rate – our main objective. The number of graduates (Table1) has increased steadily. Decrease in fall 2006 is due to the decline in enrollment. which is a national phenomenon although we appear to be relatively less effected.

Table 1: Number of Graduates

Year	Graduated
Fall 2001	126
Fall 2002	147
Fall 2003	196
Fall 2004	204
Fall 2005	188
Fall 2006	154

Feedback from the faculty teaching higher level courses is positive. For example, the faculty teaching an advanced course on analog VLSI (ELEN 474) report that students are doing remarkably better due to improvements in ELEN 325 laboratories.

Recommendations for Adopters

Curriculum redesign is an effective strategy for improving the retention of students and simultaneously enhancing the quality of education. Considerations for curriculum redesign should include the talent spread of the students, the on going ABET process and engagement of faculty champions. Even the best curriculum without faculty enthusiasm is dead. Research active, senior faculty teaching early gateway courses is an effective strategy to excite and interest students and generate a healthy educational ambience in the program.

Sources of Additional Information

Additional information can be obtained by contacting the individual faculty champions whose names and emails will be provided in the PowerPoint presentation.

Introduction to Electrical and Computer Engineering Course for Freshmen

Mohammad A. Saed, Department of Electrical and Computer Engineering
Texas Tech University

Abstract

This paper describes a project – oriented freshman course to introduce students to several areas in Electrical and Computer Engineering. In addition to an overview of the discipline, students gain important skills in software tools and hardware implementation. The lectures are augmented with weekly discussion (lab) sessions during which students work on their projects, supervised by graduate students with assistance from peer mentors. Students are required to take this course in their first semester to ensure early exposure to the discipline and to provide the opportunity for immediate contact with Electrical and Computer Engineering faculty. In addition to programming, a simple overview of signal processing, communications, electric circuits, and digital systems are introduced with minimal mathematical background.

Purpose

The purpose of this introductory course is to ensure immediate exposure of students to electrical and computer engineering and to provide immediate contact with electrical and computer engineering faculty to help improve retention. In addition to providing an interesting hands-on overview of the discipline, students are taught important skills that they will find very useful throughout their studies. The course also provides a good transition to other courses such as computer programming, digital design, and electric circuits.

Implementation

At Texas Tech, the course consists of 3 hours of lecture per week in addition to weekly discussion (lab) sessions. The lectures are taught by full-time faculty while the discussion sessions are done by graduate teaching assistants. The lectures are taught in an interactive and engaging manner by providing each student with laptop PCs loaded with necessary software. Peer mentors are available during the lectures and discussion sessions to help students. The peer mentors are undergraduate students who passed the same course with excellent grades in the previous semester. Weekly projects relevant to the material taught are assigned by the faculty. In addition to software projects, we are now incorporating hardware projects using National Instruments Educational Laboratory Instrumentation Suite (NI ELVIS). The course starts by introducing programming using MATLAB since it will be used to demonstrate concepts in signal processing and communications. Another purpose for this component is to teach programming skills since typically about half of the students in the class were never exposed to computer programming with any language in high school. Signal processing concepts are then introduced somewhat qualitatively without the mathematical rigor necessary in upper division courses. Concepts such as time and frequency domains, spectrum, Fourier series, Fourier transform, and sampling are introduced gradually using trigonometry and complex variables. Introductory communications principles such as AM modulation are then discussed. Electric circuits, analog or digital or both (if time allows), are then introduced. In the past, we used PSpice to carry out simulations. Starting this semester, we will emphasize hardware implementations using the NI ELVIS systems. Simulations will be performed using NI Multisim (Electronics Workbench).

Evaluation

The first version of this course was introduced in fall 2004. Before this course, students took a traditional computer programming course using C++. That course gave a false impression of electrical and computer engineering. A large portion of students considered it unappealing and boring. This resulted in poor passing rates. Now students take the C++ programming course in the second semester after passing the course described in this paper. Passing rates for both courses now are higher. In addition, student comments included in the course evaluation of instruction are far more positive.

Recommendations for Adopters

In the past few semesters, the lecture part of the course was taught in a standard lecture format while the discussion sessions were held in the department's computer lab. Now, we teach the course in a more interactive format by giving students laptop PCs loaded with necessary software at the beginning of the lecture. Discussion sessions are held in the same room. This method is more effective and more engaging than in the past. Since our department uses a "nontraditional" set of five project laboratory sequence in the curriculum, we do not have typical laboratories associated with lecture courses such as a circuits or an electronics lab. Students taking one of the project labs borrow equipment from a stock room as needed. Therefore, for us to incorporate hardware projects in our introductory course, using the NI ELVIS systems is necessary. The NI ELVIS system also has the advantage of replacing several standalone units in a very convenient unit that can be used in the same classroom with the laptop PCs. Departments in other universities can easily adapt the course content and delivery style to fit their own situations. For example, if a department has a classroom already equipped with computers, laptop PCs are not necessary. Or, if a department has a well equipped circuits laboratory, the department may choose to teach the hardware component of the course there instead of having NI ELVIS systems. This course should be taught by faculty who are effective teachers, who enjoy teaching freshman level courses, and who are committed to teaching excellence. We believe having the discussion sessions, while not absolutely necessary, is very helpful. In addition, using peer mentors who themselves went through the same experience in the previous semester has a very positive impact. As described in the "implementation section", the course covers several areas in electrical engineering. Individual departments have the flexibility to emphasize the various topics in the course differently as they see fit.

Sources of Additional Information

Course details, syllabus, and specific projects can be obtained from the author of this paper. The contact information is provided below.

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Online/Classroom Hybrid Computer Science Program: A Pilot Project

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Department of Computer Science, University of Houston

Emerging technologies to deliver coursework have tremendous potential to improve the education experience and make it more flexible. However, traditional distance learning has met with limited success in science and engineering. University of Houston has a large distance education program but a relatively small enrollment in science and engineering, despite a clear need. A large fraction of students in computer science at UH have jobs and can benefit from more convenient and flexible schedules. Further, there is a significant demand for selected computer science courses among IT professionals. In our view, there are two fundamental reasons for the limited success of distance learning in technical fields. First, traditional distance learning eliminates classroom interaction that is critical for learning. Second, traditional delivery mechanisms are not sufficient. In particular, camera based videotaping of lectures with detailed Powerpoint viewgraphs is cumbersome and the results can be of poor quality. We report our experience with an innovative “hybrid” model for technical courses. Tablet PC based technology is applied to develop recorded high quality lecture material for “anytime anywhere” access but sufficient human interaction is maintained.

Hybrid course structure: A hybrid course in our framework has complete lectures available online, but regular, although infrequent, classroom meetings are also an important component. Typically the instructor prepares a lecture as asset of (Powerpoint) viewgraphs but can freely annotate prepared content and mix in hand illustrations by writing on the Tablet PC screen with an electronic stencil while teaching. The lecture consisting of audio and screenshots is recorded on the PC itself and made available online. We employed the Classroom Presenter from the University of Washington for teaching with a Tablet PC and Camtasia or Camstudio software for recording. The videos are the main source of the lecture for hybrid sections but are available to all students. A semester long course is typically divided into 4 to 8 modules with one classroom meeting per module and additional meetings as needed. Class time is utilized for activities for which direct personal interaction is important, such as student queries, discussions that center around student participation, descriptions of projects and assignments, and show and tell demonstrations. All examinations, quizzes and project demonstrations are in the classroom or at designated locations.

Experience and feedback: The hybrid framework was employed to teach 3 different senior electives; Introduction to Computer Networks, Interactive Computer Graphics, and Software Engineering. The class sizes for these were relatively small and the total enrollment in all courses was approximately 50. The instructors did not notice any significant impact on grades and dropout rates although there is not enough data to make a conclusive judgment. When a hybrid class was taught as a separate section of a regular class, students in all sections were free to attend lectures in the class and/or watch lectures online. While no attendance records were kept and the pattern varied across classes, typically a quarter to over half of the enrolled students would attend lectures that were not mandatory. At the end of each semester, the students were asked to fill out a questionnaire to evaluate various aspects of the hybrid framework. We discuss the key points from student feedback as follows:

- Tablet PC based technology: Virtually all students rated the video quality of lectures between acceptable and excellent. Students had the choice of watching a class video by direct streaming or by downloading on their computer and playing locally. Direct streaming has the advantage that video watching can begin almost immediately. However, downloading first has the advantage that the video can be watched independent of the

quality or existence of an internet connection, which is particularly relevant for mobile users. Both streaming and downloading were roughly equally popular.

- Hybrid format: The students were queried to understand how studying habits were affected. The most relevant questions and responses are charted in Figure 1. From the left chart, we see that approximately 80% of students made less use of the textbooks to varying degrees since video lectures were available. The center chart shows that video lectures competed with textbooks as study material for exams. Rightmost chart shows that students were almost evenly divided in their preference for classroom access and video lectures if (hypothetically) only one was available.

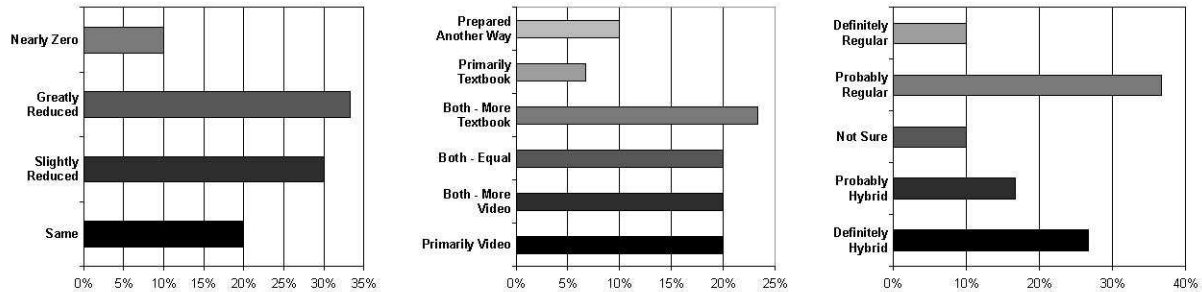


Figure 1: Student responses to the following questions. **Left:** *As compared to the time you would probably spend if video lectures were not available, the time you spent studying the textbook was?* **Center:** *How did you prepare for the mid-term and final exams?* **Right:** *Suppose you had to strictly pick one or the other format for this class: If you picked Hybrid, you would not be allowed to attend classes and if you picked Regular, you would not have access to video lectures. What format would you pick?*

- Future improvements: The students were queried on the potential value of a set of future improvements: 1) The videos included the instructor beside Tablet PC screenshots, 2) The videos came with index snapshots where a new topic or subtopic was started, and 3) Live webcast of lectures with ability to ask questions in real-time from remote sites. An overwhelming majority of students responded that adding indexing to videos will be a big improvement, while the level of enthusiasm for other features was limited. Indexing has the obvious appeal that students can quickly move to the topics they want to learn or with which they are having difficulty. Our ongoing research is addressing automatic indexing of lecture videos.

Conclusions: It is clear that Tablet PCs offer an excellent way to record and deliver classroom experience for technical courses. The students consider video lectures a critical resource, on par with live class and textbooks. This project is an attempt to provide “anywhere anytime” learning flexibility to students without losing the benefits of classroom interaction. The goals include reducing time to graduation and increasing enrollments by providing flexibility. The model is becoming popular and a number of other courses will be offered as hybrids in semesters to come. However, many questions remain about the applicability, scope, and future developments. One of our goals is to help form a community to address these challenges together.

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Presentation/Discussion Session **6**

Best Practices in Consortium Building

Moderator

Brad Beavers, Austin Site Manager, Intel Corp., Austin, TX

Increasing the Applicant Pool and Retention in Computer Engineering

Anthony P. Ambler, Department of Electrical & Computer Engineering
The University of Texas at Austin

The Department of Electrical and Computer Engineering at the University of Texas at Austin has been fortunate to receive significant resources from the TETC program. This has enabled us to increase the numbers of TAs available to support the faculty with direct student interactions, and to increase the number of adjunct professors we can use to begin to reduce class sizes. In more recent funding rounds the use of undergraduate mentors is being encouraged in a significant way – it is hoped that this will lead to even better support for our undergraduate students and improve our retention figures.

More significantly we desperately need to address the applicant pool – computer science has seen a large drop in applications for undergraduate studies over the past years and the ECE Department at UT is seeing some evidence of a small drop, but nothing like as significant. However we cannot be complacent and we need to revisit what we are doing in our ‘marketing’ approaches.

Increasing the Applicant Pool

The Edison Lecture Series, supported in part by TETC, has completed its 3rd annual event of one hour presentations to middle and high school students on a facet of electrical and computer engineering – to date it has been exposed to ~11,000 students. Data from other sources has shown that presentations such as this can lead to a **20%** increase in the numbers of high school students applying to study engineering at college level. We have tried to address the need for an adequate math-readiness requirement to study engineering at admission. But one area that could lead to a potentially significant increase in applications is to address the needs and interests of women students.

Currently ECE at UT has a female undergraduate population of <10%. The undergraduate female population in the College of Engineering as a whole is ~22%. Chemical Engineering is ~25%, Biomedical Engineering is ~40%. Clearly we could do more!

Under the direction of Professor Mack Grady, power electronics has seen a resurgence in interest and, significantly, a female enrollment of ~35% out of our total female population of <10%! Two factors appear to be significant in this – the introduction of practical work involving the construction and testing of real circuits and components, but also the bias of the course towards renewable energy. If these factors are, indeed, the reason we have the basis for a radical improvement in the applicant pool...and then we need to address how we market these programs and changes to the high school student body.

Other Approaches for Retention

We must continue to improve the perceived student experience in Computer Engineering – students often come to college enthused with the idea of studying something they wish to make a career out of and we are unable to adequately maintain that enthusiasm. There are groups of faculty and students who have taken it upon themselves to give up their time to create extra-mural activities in technical areas, e.g. solar car, robot society, HoneyNet Project etc, ‘Hands On’ Electrical Engineering etc, but all too often they lack the resources necessary to do anything

meaningful and for larger numbers of students. A not small amount of funding is needed to maintain these activities and we are dependent upon the donations from industry and other donors to make these things happen – very little discretionary funding is available to the departments to support these activities.

Conclusion

The TETC program has enabled us to greatly improve how we present our materials to students and create an outreach program to the community. More importantly it has led us to look inward at how and what we are doing, and to continually make improvements along the way.

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Computer Science Scholars: Recruiting, Retention and Mentoring

Sadegh Davari and Elham Khabiri, University of Houston-Clear Lake

Mike Kent and Eva Brown, San Jacinto College Central Campus

Jim Meeks and Pamela Betts, San Jacinto College South Campus

Abstract

University of Houston-Clear Lake, San Jacinto College Central Campus and San Jacinto College South Campus have jointly undertaken highly successful recruiting and mentoring programs. The recruiting and the retention efforts of the three campuses combine to improve the quality and to increase the number of computing majors at all three campuses. Our strategies include joint recruiting and peer mentoring. We visited the computer science labs of surrounding high schools and we have established peer mentoring centers at all three campuses. We have periodic joint meetings to present progress reports and to brainstorm a variety of innovative ideas.

Purpose

The main goals of this grant are (1) to increase the number of in-coming students into the technology programs of the two San Jacinto College campuses, (2) to increase the retention rate of these students, (3) to prepare these students for transfer to the computing programs at UHCL, and (4) to increase the retention rate of these students at UHCL.

Students entering San Jacinto College campuses are predominantly new to the college environment and often need additional assistance in developing computer technology and critical thinking skills. The implementation of the student mentoring program helps to develop these skills.

Implementation

Our goal in recruiting is to reach out to area high school students and to show them (1) the positive job outlook in Computer Science areas, (2) the benefits of gaining a four-year CS degree from the combination of SJC and UHCL, which may not otherwise be available to them because of financial concerns and/or because of their inability to pursue higher education away from home. To reach high school students, we have divided area high schools into regions and each SJC campus is given the task of making the necessary arrangements to visit the science labs of high schools in its region. UHCL faculty accompany SJC faculty in each recruiting visit. We have prepared presentation slides to get our points across. A comprehensive list of area high schools and key contact persons at each school have been developed. This list is still an on-going work. We have visited 7 area high schools and the plans are underway to visit 7 more.

The development of the interesting and colorful recruiting poster at SJC Central is nearing an end. This poster features the pioneers of Computer Science as well as information about the SJC and UHCL CS/CIS programs. It will be given to high school teachers to place it on the walls of their classrooms.

A mini grant was won from the San Jacinto college foundation INNOVATIVE INITIATIVES & PROJECTS to provide memory sticks to high school programming and web development students and their teachers. Recruiting slides, scholarship information, and links to our websites will be pre-placed in the memory sticks before distribution.

The goal of our peer mentoring strategy is to increase the retention rate of Computer Science majors by creating CS mentoring centers at UHCL and at the two SJC campuses. These centers have been created and peer mentors are in place. The mentors are carefully screened for both their in-depth technical knowledge and their ability to work one-on-one with fellow students. There are five student mentors at UHCL and two student mentors at each of the SJC campuses. The mentoring centers are publicized by mentors visiting classes at the beginning of the semester and by distributing/posting flyers. We have also created a website for the mentoring centers. Courses that are mentored are mainly programming intensive courses that students take during their first year at each of the three institutions. The mentors at each center are supervised by a faculty of that campus. The student mentors receive a salary to supplement their scholarships. Even more rewarding is the reinforcement of the mentors' knowledge in the computer science courses through their mentoring activities. The student mentors also participate in the preparation of the recruiting materials and in on-campus and off-campus recruiting events.

Mentors at UHCL are gathering data for two white papers, one on CS job outlook and another on the effects of job outsourcing. They are also developing a software system to keep track of the questions raised and their answers for each covered class. The software will also be used to keep track of the progress of the students who have visited the centers. The goal is to track the progress of these students in the future courses as well.

Students at SJC South can obtain mentor assistance with both homework assignments and with their own personal computer problems. There has been a very surprising yet positive outcome of this program. In addition to the educational assistance provided by these mentors, they have become an outlet for discussion about all areas of computing – including gaming. These ongoing discussions have led to the formation of a gaming guild that provides support and encouragement for those students wishing to pursue a career in this field. As a result of the guild, several students have opted to continue their education in computing.

Evaluation

Mentoring activities have been very well received by students who visit the centers and by their professors. Student participation in this program is now strongly encouraged throughout the departments and instructors are using the mentoring centers as a tool to help those students who need more assistance than can be provided by the instructor. The departmental instructors are polled at the end of each semester to determine if there has been any marked change in a mentored student's ability to comprehend the subject materials. These instructors report both a higher rate of attendance and a larger student success rate for those students utilizing the tutor program.

Source of Additional Information

For additional information please refer to the project website: http://dcm.cl.uh.edu/twd_mentor. When completed, copies of white papers, helpful links, and recommendation for adopting these strategies will appear in the project website.

Innovative Strategies to Establish a Pipeline with Local School Districts

Jonathan Bredow, Electrical Engineering, The University of Texas at Arlington

Abstract

This paper addresses cooperative work between the University of Texas at Arlington (UTA) and Arlington Independent School District (AISD), the 9th largest school district in Texas with over 60,000 students. A major component involves interaction with high school students and instructors in pre-engineering courses offered at AISD as a part of the Project Lead the Way (PLTW) program. Six scholarships are awarded to selected senior-level UTA students who regularly participate, on the high school campuses, in these courses. Over 150 high school students are currently being impacted. Other aspects are also presented in the paper.

Purpose

Beginning this academic year (2006-07) AISD is offering PLTW courses at all levels (8th through 12th grades), courses such as Introduction to Engineering Design (IED), Principles of Engineering (POE), Digital Electronics (DE), Aerospace Engineering (AE), and Engineering Design and Development (EDD). AISD currently has about 1400 students in these courses over 6 high schools and 12 junior high schools. In addition, the Director and Curriculum Specialist in Career and Technology Education at AISD, who oversee this program, are very supportive of UTA involvement. This has provided an ideal environment for pilot efforts to draw more K-12 students into engineering and technology fields.

The collaborative effort between UTA and AISD now consists of two strategies. The first strategy, aimed at drawing in additional high performing high school students from the local area by more frequent pre-college instruction and interaction, consists of 3 primary activities. In one of these, each of 6 senior-level students is awarded a \$1,500 scholarship to participate in PLTW courses on a particular high school campus for a minimum of 2 hours per week. The second activity centers around technology days at UTA, and the third activity involves visits of the author to selected PLTW classrooms on the high school campuses. The second strategy is aimed at increasing the enthusiasm and engineering knowledge of PLTW instructors and, as a result, their effectiveness in attracting the interest of their students toward scientific and engineering disciplines. Two primary activities are currently being conducted toward this aim: the author has participated in delivering a continuing education course targeting junior high school and high school PLTW instructors; and the author along with others supported by the project have one-on-one visits with PLTW instructors to provide an opportunity to address questions about various technical issues related to lectures and lab experiments in the courses.

Implementation

At the beginning of each new academic year, a scholarship announcement is posted at appropriate locations on the UTA campus for the purpose of finding suitable senior-level engineering students to assist in PLTW classrooms. Meanwhile, student officers of the major electrical engineering organizations are asked to help identify the best senior-level students for this activity. Once students are selected, they receive coaching concerning the objectives of their participation. Then the Curriculum Specialist at AISD arranges meetings with the appropriate PLTW instructors on each of the high school campuses, with meetings including the selected student, the targeted PLTW instructor(s), the author, and the Curriculum Specialist. In these meetings the nature of participation is determined and the student schedule for attending the selected course(s) is defined. The participating UTA students then report back to the

author, about the tasks being carried out and how they feel they are contributing to drawing student interest and developing student capabilities in technical areas. A group meeting of student assistants is held at least once per semester to share ideas and discuss progress.

Selection of the specific dates and activities for technology days at UTA involves the Director of the College of Engineering Counseling and Advising Center (who arranges many other similar types of events at UTA), the AISD Curriculum Specialist, and the author. The latter two make the decision about which PLTW classrooms to invite, while the two from UTA determine the number of PLTW students that can be accommodated and the types of activities to be done. The AISD Curriculum Specialist contacts the selected PLTW instructors and performs administrative tasks required for students to be off campus as well as arranges transportation.

The author periodically visits selected PLTW courses, typically 2 times per year to each high school campus, and interacts with PLTW instructors, via email, encouraging them to raise questions about technical subjects that may be of concern in the courses, and to solicit assistance as needed, e.g., as a presentation reviewer in the EDD course.

Evaluation

The courses targeted have been IED (Freshman level) and POE (Sophomore level) during the first year, and DE (junior level) during the second (current) year. Since this project is only in the second year, few students from the affected PLTW courses have graduated. However, the indirect evidence for impact is considerable. Pertaining to drawing interest toward engineering, the UTA student assistants, who serve classrooms of about 25 students, have described how many PLTW students are benefiting from one-on-one interaction and how many are asking questions about college life, engineering and UTA. While participating in PLTW classrooms the author has also had opportunities to entertain questions about engineering, as well as to study the mix of student performance and interest levels. Finally, there seems to be considerable benefit to the UTA student assistants, in nurturing their skills in mentoring and instructing young people. Several of these students have developed such interest that they have applied for recruiter-assistant positions within the College of Engineering, where they go out even more into the high schools.

Recommendations for Adopters

A solid working relationship with curriculum coordinators at the targeted school district is the first step. Courses offered within a technical or pre-engineering curriculum appear to be the best suited for involvement since they typically are not connected to the standardized tests required of all students. Finally, begin on a small scale and build on the successes.

Sources of Additional Information

For additional details on implementation, lessons learned, and results during the first year refer to the conference article listed here, or contact the author.

Bredow, Jonathan; Wright, Craig; and Manley, Bill, "Work in Progress – A model for cooperation between university and K-12 components in science and technology education," Proceedings of the 36th ASEE/IEEE Frontiers in Education Conference, pp. M1C-9 and 10, 2006.

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What We Have Learned in the Infinity Project

Scott C. Douglas, Betsy Willis, and Geoffrey C. Orsak

The Institute for Engineering Education at Southern Methodist University

Abstract

The Infinity Project began in 1999 as a joint effort between university educators, high school teachers, administrators, and industrial leaders to establish an engineering curriculum that is taught within the regular high school day. In addition to its success in its core application, the Infinity Project has since spawned several additional curricular strategies designed to increase student interest in STEM knowledge acquisition in different ways and at different curricular levels. We briefly highlight two such strategies and the important elements within the Infinity Project that promoted these extensions.

Purpose

Elements of a curricular strategy have the most impact when they are widely used. We have found that the elements of the Infinity Project¹⁻⁸, which include (1) a course text, (2) integrated laboratory exercises with real-time signal processing hardware, (3) summer teacher training institutes, and (4) a web community portal for information sharing (www.infinity-project.org), are successful in its core application as a high school engineering class and in several additional curricular strategies that serve both younger (middle school) and older (college) students to promote STEM learning. Two of these strategies – Cross-Disciplinary Engineering Design Experiences for First Year Undergraduates and the SMU Engineering Camps for Girls – are briefly outlined, as are the features of the Infinity Project that led to their use in these and other strategies.

Implementation

Cross-Disciplinary Engineering Design Experiences for First Year Undergraduates have been implemented since the Spring 2004 semester and now include students from the Electrical, Mechanical, and Computer Science and Engineering departments at SMU. In this strategy, students from introductory courses in these departments attend their lectures and laboratories but jointly design two systems during the semester: a simple, extremely low-cost loudspeaker, and a robot capable of playing “putt-putt” golf. Additional details regarding this strategy can be found in published papers⁵⁻⁶. Implemented since Spring 2004, the students impacted by this activity now includes every graduating student in the SMU School of Engineering in the Computer Science, Electrical, and Mechanical Engineering department’s undergraduate programs.

SMU Engineering Camps for Girls supports the Gender Parity Initiative at SMU and its goal of reaching 50% female enrollment in undergraduate engineering. In this strategy, female high school students are given a five-day, 15-hour exposure to engineering involving Infinity Project designs, lab tours, and technical presentations in the summer months at SMU. Details regarding this curricular strategy are described in yearly reports that are available upon request. In 2005 and 2006, a total of eight sessions involving 159 young women have been conducted.

Evaluation

Both curricular strategies have been evaluated using surveys given to the participants at the end of the curricular experience. In four of the SMU Engineering Camps for Girls, pre-camp surveys were also administered. Our survey data obtained from first-year college students regarding their design experiences indicates that

- 1) They are more likely to take first-year engineering courses that involve significant design experiences than those that offer less-exploratory hands-on activities;

- 2) The design experiences teach important concepts in technical engineering topics as well as important ancillary skills such as time and project management; and
- 3) They desire such design experiences in follow-on courses.

Our survey data from the female high school participants indicates that

- 1) The participants' awareness of the societal benefit of engineering and technology was greatly increased;
- 2) The participants' enjoyment of teaming activities was significant; and
- 3) The participants' knowledge of career opportunities in engineering fields was increased.

Details regarding program evaluation are in the associated references and reports.

Recommendations for Curriculum Designers

From our experiences, several important features of the design of the Infinity Project made its successful reuse in multiple curricular strategies straightforward. (1) *Laboratory technology was chosen and developed based on a number of factors, including ease of teacher training, relevance to the chosen classroom subject material, and design flexibility.* (2) *Curriculum design was performed iteratively.* (3) *Methodologies for growing and scaling professional development and training processes for educators was identified and pursued.* (4) *Technology partnerships were leveraged both for financial assistance and laboratory technology development.* (5) *Ease of implementation and use drove the packaging and delivery of the curriculum.* (6) *Constant improvement of curricular offerings was performed.* Additional details regarding these implementation choices can be found in an ASEE publication⁷.

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SMU Engineering Camps for Girls: Dr. Betsy Willis, Institute for Engineering Education at SMU, Dallas, TX. Email: bwillis@theinstitute.smu.edu. Telephone: (214) 768-1732.

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