Best Practices Conference 2006
Discussion Papers

Recruiting and Retaining
Engineering and Computer Science Students
Technology Workforce Development

January 10-11, 2006

Southern Methodist University Campus

sponsored by the

Texas Engineering and Technical Consortium

Best Practices Conference 2006

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Geoffrey C. Orsak, Dean, School of Engineering, Southern Methodist University, Dallas

Best Practices Conference 2006

Southern Methodist University Campus
Umphrey Lee Center – Grand Ballroom

Tuesday, January 10, 2006

9:00 am **Registration, Meet & Greet** (Lobby) – Complimentary coffee, tea, juice, pastry

10:00 am **Welcome and Introductions**
Geoffrey C. Orsak, Dean, School of Engineering, Southern Methodist University
Ray Almgren, Vice President, National Instruments, Austin, and Chair Elect, TETC Executive Committee

10:10 am **Keynote Address:** "Supporting Best Practices in Undergraduate Education"
Bevlee A. Watford, Program Director, Division of Undergraduate Education, National Science Foundation

11:00 am **Presentation/Discussion Session I – Best Practices for Retention**
Moderator: Torrence Robinson, Director of Public Affairs, Texas Instruments, Dallas, TX

Intensive Intervention in the First Courses in Computer Science, Kleanthis Psarris and Kay Robbins, The University of Texas at San Antonio
Collaborative Learning as a Tool for Retention of Engineering Students, David P. Shattuck, Betty J. Barr, Jennifer L. Ruchhoeft, Julie Martin Trenor, Stuart A. Long, and Frank J. Claydon, University of Houston
Women in Research Development (WiReD) Program, Peggy Doerschuk, Lamar University

12:15 pm **Lunch Break – TETC Advisory Committee will meet** (Complimentary box lunch)

1:15 pm **Presentation/Discussion Session II – Best Practices for Retention (continued)**
Moderator: Brad Beavers, Austin Site Manager, Intel Corp., Austin, TX

Peer Teachers, Valerie Taylor, Joseph Hurley, Lawrence Petersen, Jennifer Welch, Frank Shipman, Texas A&M University
Students Mentoring Students, Raymond Shoults and William Dillon, The University of Texas at Arlington
Mentoring and Learning Communities for Entering Freshmen, Richard H. Fowler and Peter A. Ng, The University of Texas – Pan American
Engineering Retention Enhancement through On-Campus Jobs, Heinrich Foltz and Edwin LeMaster, The University of Texas – Pan American

3:00 pm **Break** (Lobby) Complimentary refreshments

3:20 pm **Presentation/Discussion Session III – Best Practices for Recruiting**
Moderator: Dan Marcek, Deputy Director, University Relations, Hewlett Packard, Brookline, NH

Girls Reaching and Demonstrating Excellence (GRADE) Camps: An Innovative Recruiting Strategy at the University of Houston to Increase Female Representation in Engineering, John R. Glover,Jennifer L. Ruchhoeft, Julie Martin Trenor, Stuart A. Long and Frank J. Claydon, University of Houston
Enhancing Computing Workforce by Providing Higher Education to Working Professionals, Moonis Ali, Texas State University – San Marcos
Counselor Update Events, Janet Lind, The University of Texas at Dallas

5:00 pm **Evening Break**

Wednesday, January 11, 2006

8:00 am **Presentation/Discussion Session IV – Best Practices for Curriculum Revision**
Moderator: Monte Cely, Vice President (ret.), SBC Laboratories, Round Rock, TX

Setting Student Expectations with a Majors-Only Programming Course, Krishna M. Kavi and David M. Keathly, University of North Texas
Use of Team Projects in First-Year EE Course, Anthony P. Ambler and Archie L. Holmes, Jr., The University of Texas at Austin
Curriculum and Instructional Enhancement of Gateway Courses, C. Singh, P. Enjeti, and N. Reddy, Texas A&M University
Introduction to Electrical and Computer Engineering Course to Improve Retention of Freshman Students, Mohammad A. Saed, Texas Tech University
Turing Scholars Program, Greg Lavender and Calvin Lin, The University of Texas at Austin

9:50 am **Break** (Lobby) Complimentary refreshments

10:10 am **Presentation/Discussion Session V – Experiences with Statewide Implementation of the Infinity Program**
Moderator: Tammy Richards, P.E., Assistant Dean, SMU School of Engineering, Dallas, TX

Paradigmatic Labs for Introduction to Electrical Engineering, Harley R. Myler, Lamar University
Increase Retention Through the Use of the Infinity Project, John O. Attia, Prairie View A&M University
Cross-Disciplinary Early Engineering Design Experiences for Undergraduates, Marc P. Christensen, David A. Willis, and Scott C. Douglas, Southern Methodist University
Modification of the Infinity Kits to Provide Improved Hands-On Experiences, Jonathan Bredow, University of Texas at Arlington

Noon **Lunch Break** (Complimentary box lunch)

12:30 pm **Summary Session** Moderator: Tegwin Pulley, Vice President, Texas Instruments, and Chair, TETC Executive Committee
Moderators of presentation/discussion sessions I through V summarize the conclusions of those discussions.

1:45 pm **Capstone Discussion** Moderator: Ray Almgren, Vice President, National Instruments, and Chair Elect, TETC Executive Committee
What does TETC need to do now to facilitate statewide implementation of best practices identified in this conference?

3:00 pm **Conference Adjourns**

3:15 pm Meeting of conference steering commit

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Papers Related to Curriculum Revision

Papers Related to Statewide Implementation of the INFINITY Project

Session I

Best Practices for Retention of Engineering and Computer Science Students

Moderator: Torrence Robinson, Director of Public Affairs, Texas Instruments, Dallas

Recorder: Paul Lin, Graduate Student, University of North Texas

Intensive Intervention in the First Courses in Computer Science

Kleanthis Psarris and Kay Robbins, The University of Texas – 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 45.3% Hispanic and 6.1% black. Many of UTSA's 27,000 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. In order to retain our students we have implemented a strategy of curriculum development, peer tutoring, advising and intensive mentoring.

Purpose

Our intervention strategy focuses on improving our student's mastery of programming and abstraction in the first courses, as well as helping to provide a context for them to develop professionally. More specifically, we aim to: (1) improve the curriculum and the teaching in the first courses, (2) provide peer tutoring to enhance learning and help students feel part of a community, (3) incorporate advising and career services support so that students understand where they are going and how to get there and (4) engage in intensive one-on-one mentoring.

Our intention is to improve student learning outcomes, retention and graduation rates. We believe our strategy is ideally suited, but not limited, to supporting our non-traditional minority and female students who desire, as several studies have shown, more interactive teaching methods and a collaborative environment of a learning community with peer support.

Implementation

We standardized and improved the curriculum for all sections of our introductory courses to meet recent advances in technology. The curriculum carefully integrates the laboratory material with the lectures. All of the lectures and laboratories are offered in computer classrooms and the course materials are on the web. All of the sections of the first two courses for majors are taught by tenure-track faculty.

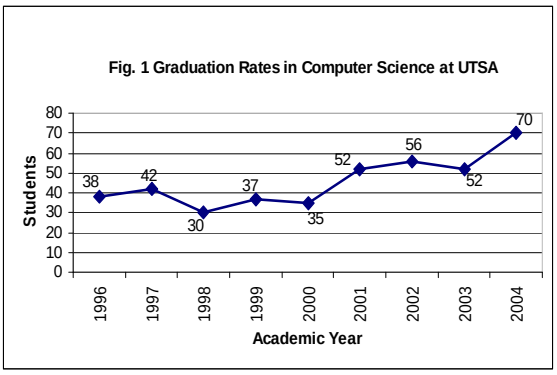
We hired our top undergraduate students as peer tutors for the freshman and sophomore level courses. Tutors provide lab assistance and handle routine technical problems so that instructors can focus on teaching concepts and improving their overall quality of instruction. Our tutors have become invaluable role models who helped to build a desired learning community.

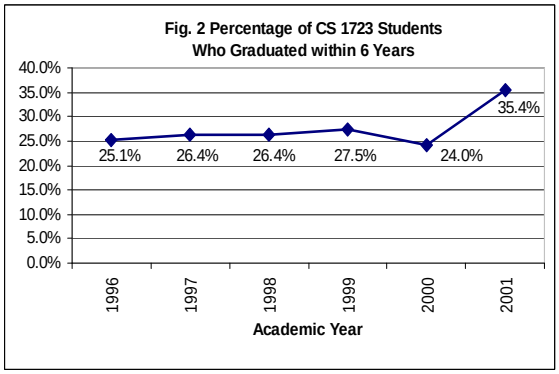
We incorporated into our curriculum advising and career services support. The academic advisors produce individualized programs of study for each student in the class. The career services representatives give presentations about career paths and internship opportunities and register each student with career services in the class.

We adopted an intensive one-on-one mentoring for pair-programming. We selected upper level students who are experienced programmers as mentors and we paired them with inexperienced beginning students. Students who participate spend two hours per week pair programming together with a mentor, which helps develop their programming skills more rapidly.

Evaluation

We are using four quantifiers to measure progress in our strategy: overall graduation rates, graduation rates of students who complete the second Computer Science course, CS 1723 Data Structures, percentage of A's and B's in the first courses, percentage of drops in the first courses. Fig. 1 shows overall graduation rates in computer science at UTSA. The number of graduates significantly increased last year at a much higher rate than the nationwide trend. Fig. 2 shows the 6-year graduation rate for students who successfully completed CS 1723 in a given year. 2001 is the last year for which sufficient years have elapsed to compute this value. Since we began peer tutoring and organized laboratories in the first courses in 2000, a promising trend appears to be developing. The A's, B's and drops in first courses after 2000, do not appear to reflect a statistically significant change and motivated our plan to adopt an intensive one-on-one mentoring with pair programming in the 2005-06 academic year.





Recommendations for Adopters

We believe that some of the basic strategies such as hands-on curriculum and peer tutoring support in the laboratories are essential to the operation of any current program in computer science because of the evolving complexity of the curriculum material. The costs of these strategies must be underwritten in some way as basic costs of operating a program. Advising and career services are low-cost items that can be easily incorporated into the beginning courses. The pair-mentoring program requires infrastructure to identify and track students. The overall cost of duplicating our strategy on another campus depends on the size of the program and the faculty and staff participation. In our program the costs of the tutors and mentors alone are about $50, 000 and $60,000 per year respectively. In order to duplicate our strategy we also recommend the use of computer equipped classrooms for all courses and laboratories and assigning experienced tenure track faculty to coordinate and teach the introductory courses.

Sources of Additional Information

Introduction to Computer Science website http://www.cs.utsa.edu/~javalab/cs1713/index.html
Data Structures website http://www.cs.utsa.edu/~javalab/cs1723/index.html

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Collaborative Learning as a Tool for Retention of Engineering Students

David P. Shattuck, Betty J. Barr, Jennifer L. Ruchhoeft,Julie Martin Trenor, Stuart A. Long, and Frank J. Claydon - University of Houston

Abstract: *To better prepare students for the challenging sophomore 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 the Circuits course have varied between 40 and 61% for students who did not complete the program. In contrast, students who completed the program had pass rates between 62 and 75%. Success has been even greater in the Electromagnetics course: non-participant pass rates varied between 46 and 59%, while 78 to 91% of program participants successfully completed the course.*

Purpose: Far too often, students who enter college aspiring to careers in ECE manage to progress through their freshman courses but, do not survive their sophomore year of courses. Yet traditional remedial and counseling approaches have rarely achieved significant results in assisting these students through the crucial sophomore year of the ECE curriculum. To address this issue we created ECE Redshirt Camps in combination with 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 in ECE. The idea behind a workshop program is that, under the guidance of a skilled facilitator, ECE students can learn core electrical engineering principles more efficiently by working together with their peers. Instead of providing remediation, Redshirt Camp plus academic 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 assistance by an ECE Teaching Fellow, and six dedicated graduate teaching assistants. The one-week camps are held in August and January of each year. All ECE rising sophomores and incoming transfer students are invited to participate in a one week of camp at no cost to the student. In fact, students who successfully complete the camp are awarded a "book" scholarship for their next semester of study. Modules that are covered in camp include problem solving, intermediate MATLAB programming, vector calculus as applied in basic electromagnetics, linear algebra as applied in basic circuit theory, 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 hours once a week throughout the semester. The idea behind our workshop series is that, under the guidance of a trained facilitator, students can learn core principles more efficiently by working together with their peers. 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, so that continuity with the lecture material is ensured. 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 ECE Workshop program has seen an overall participation rate of 35% of enrolled students in our targeted circuits and electromagnetics courses. Over the past six semesters (Fall 2002-Spring 2005), 55% of the Circuits course students, who did not participate (no intervention) in the Redshirt Camps and ECE Workshops, passed the course. The pass rate for the Circuits course students who attended Redshirt Camp and the ECE Workshops (intervention) was 72%. For the electromagnetics course, the pass rate for students with no intervention was 61%, compared to an 84% pass rate for students who were enrolled in Redshirt Camp and the ECE Workshops. In total, we have seen an average 36% increase in pass rates for our "Intervention" 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 ECE Workshops can and do improve retention rates in these rigorous courses.

Recommendation for Adopters: *Make it Real:* One of the reasons why students lose interest in core ECE courses is that these introductory courses are often seen by students as abstract with limited examples that relate content to students' lives. Thus, each of the modules in Redshirt Camp and our Academic 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 require teamwork.

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 about how to facilitate collaborative learning – make sure that it doesn't turn into another lecture, and 4) Maintain 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

Contact Information: F. Claydon (fclaydon@uh.edu)

Women in Research Development (WiReD) Program

Peggy Doerschuk, Lamar University

Abstract

Lamar University's Women in Research Development Program is designed to develop and enhance the education and experience of female computer science students and to encourage them to embrace the field with enthusiasm and confidence. It gives female students an opportunity to perform research under the guidance of a female professor of computer science. The WiReD team members include female students of all levels: freshmen through graduate students. The women work as a team, and the more experienced students help to train and act as role models and mentors to those with less experience.

Purpose

The Women in Research Development (WiReD) program addresses the issue of underrepresentation of women in computer science. The percentage of bachelor's degrees in Computer Science awarded to women decreased from 37.1% in 1983-84 to 28.0% in 1999 – 2000. The Higher Education Research Institute reports that only 0.3 percent of incoming freshmen women in 2004 expressed an interest in computer science, a decline of 80 percent since 1998.

Many studies have been made to identify causes and strategies for overcoming this situation. These studies stress the importance of (1) providing positive role models for women, (2) providing women the opportunity to work in groups, (3) involving women in the "tinkering" aspects of computer science; and (4) exposing women to useful applications of computer science. The Lamar University WiReD Program uses all of these strategies.

Implementation

In the WiReD program, female students work in teams under the direction of a female faculty member. Students are paid a $1000 stipend for each semester and work ¼ time on the research project. They also participate in recruiting activities from time to time. Research teams are comprised of three to five students from all levels (freshman through graduate student). The more advanced students train and serve as peer mentors to the newer team members. This gives them experience in teamwork and leadership. As their experience grows, their confidence in themselves and, typically, their enthusiasm for Computer Science grows.

Autonomous robotics was specifically selected as the research area for the WiReD program for several reasons. It gives the students practical experience in many different areas of computer science, including computer architecture, digital logic, artificial intelligence, programming with Java and C, assembly language programming, and software design. It also makes them 'tinker' with hardware, which is typically outside of the experience of females. This research is attractive to women because autonomous robots have many useful applications that benefit society, including space exploration and search and rescue. It's also great fun!

Team members are involved in all levels of research, from problem definition through experimental design, implementation and publication. Each team must produce a formal research report and present its research at a seminar each year. This enhances their communication and presentation skills, which also boosts their confidence.

Evaluation

The WiReD research program has been highly successful in developing our female students. The WiReD team has won the award for Best Research Presentation in Lamar University's Annual Student Research Conference for two of the last three years. A total of twenty women have participated in WiReD thus far. Of these, six have graduated with degrees in CS/CIS, and eight are continuing towards a degree in CS/CIS. However, six changed majors (three each in years 1 and 2), so it is not a panacea. All of the students who participated in WiReD since fall, 2004 either have graduated or are continuing. All of our graduating WiReD students have embarked on successful careers in computer science.

We have been successful in obtaining funding for the WiReD student stipends from ExxonMobil for 2004, 2005 and 2006.

WiReD team members have been a positive force for recruiting at local high schools and on-campus recruiting functions. The WiReD team is an integral part of our plan to develop weekend and/or summer robotics camps for middle school and high school girls this year.

Recommendations for Adopters

This can be a relatively inexpensive program. Our robots are built with Lego Mindstorms Robotics kits and MIT's Handyboards. There are excellent texts on designing and programming these robots: (1) Bagnall, Brian, Core Lego Mindstorms Programming, Prentice Hall, 2002; and (2) Martin, Fred G., Robotic Explorations, Prentice Hall, 2001. A typical robot, including its sensors, costs about $800 altogether. There should be a robot and a computer for every two students. There should be a dedicated lab with enough space for a large work table, computers, locked storage areas for the robots and room enough for constructing the robot's world. There should be a technician with experience in creating and trouble-shooting electronic circuits and components. The program director should be not only a good researcher but also a good teacher. The director should have release time in order to provide proper guidance for the research. Including both graduate and undergraduate students on the team is beneficial.

We pay our WiReD students $1000 per semester. Several have other jobs on or off campus to supplement this income, which can put their grades at risk. The stipends should be increased to enable students to quit any other jobs they may have. Lack of funding prevents us from conducting WiReD in the summer months. A yearlong program would greatly increase the continuity of the research and enable more students to participate.

Sources of Additional Information: More details on the WiReD program can be found in: (1) "Research Experience in Computer Science for Undergraduate Women," Peggy Doerschuk, *Proceedings of the 2003 International Conference on Information Technology: Coding and Computing*, April, 2003; and (2) "A Research and Mentoring Program for Women in Computer Science," Peggy Doerschuk, *Proceedings of the 34th ASEE/IEEE Frontiers in Education Conference*, October, 2004.

Contact Information: For more information on the WiReD program, please contact Professor Peggy Doerschuk at (409)880-8782 or at israel@sal.lamar.edu

Session II

Best Practices for Retention of Engineering and Computer Science Students (continued)

Moderator: Brad Beavers, Austin Site Manager, Intel Corp., Austin

Recorder: Anastasia Kurdia, Graduate Student, The University of Texas at Dallas

Undergraduate Peer Teacher Program

Valerie Taylor, Joseph Hurley, Lawrence Petersen, Jennifer Welch, Frank Shipman
Texas A&M University

Abstract

The Peer Teachers program is an excellent program that has been implemented in the Department of Computer Science at Texas A&M University. In this program, qualified undergraduate students are hired to assist in undergraduate courses as peer teachers to help with lab instruction and course assignments. To qualify as a peer teacher for a course, a student must have recently taken the course and earned an A in it. 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.

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. The Peer Teachers program addresses two major goals. The primary goal is to reduce the frustrations and difficulties encountered by undergraduate students attempting to learn sophisticated programming languages and technical concepts, and to acquire the technical skills necessary for an undergraduate degree in Computer Science or Computer Engineering. Students typically attend lectures followed by practical work in labs. Students have reported that one of the principal reasons for leaving the computer science and computer engineering majors is the frustration of dealing with difficult lab assignments, with insufficient assistance. Experience has shown that one TA has difficulty getting around to 17 to 22 students in lab and effectively assisting them. It has further been noticed that many students are reluctant to ask questions of their TA because the TA is a graduate student and can have input into their grades. In contrast, peer teachers have no input into students' grades.

The secondary goal of the Peer Teachers program is to provide a positive reinforcement of concepts for the peer teachers themselves, 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 allows the peer teachers to gain more in-depth knowledge, which aids them in learning more advanced concepts taught in future courses.

Implementation

The primary task for implementation of a Peer Teachers program is the selection of the peer teachers. Currently, we require students to have earned an A in the course with which they are assigned as a peer teacher and to maintain at least a 3.0 grade point average overall. Peer teachers are assigned at the beginning of each semester. Generally, the students selected as peer teachers for a given course took the course in the previous year. 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 give some background about being an effective tutor. They also receive a small handbook on peer teaching. Once a student has agreed to be a peer teacher, the student is required to meet with the course

instructor to work out the details of his/her responsibilities for the assigned course. Further, peer teachers are usually required to meet with the course instructor on a weekly basis.

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 all of our undergraduate courses offered in computer science, subject to our ability to find qualified peer teachers. Hence, because of the demand, students can participate in the program as peer teachers multiple times.

Evaluation

The Peer Teachers program was made available to all students taking a course. As such, we did not have a control group consisting of students in the same course but without access to peer teachers. Survey data, however, 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 value of the program such that it should be continued in the future.

We attempted to collect 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. At this time we are focused on the data collection of assignment scores, since the peer teachers assist with assignments and lab. The preliminary data on assignments from one class (CPSC 206, three semesters without peer teachers and eight semesters with them) demonstrated a 6.2% increase in assignment scores. Further, we have found in another course (CPSC 410, one semester) that the peer teachers aided in transitioning to a new course project; the presence of peer teachers allowed the instructor to focus on a very aggressive project for the course.

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 in the learning of concepts. To be effective, it is important to require that peer teachers 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 teacher not be involved with student grades to allow students enrolled in the course to have a level of comfort in asking any questions. 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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Valerie Taylor, taylor@cs.tamu.edu, phone: 979-845-5820

Students Mentoring Students

Raymond Shoults and William Dillon, The University of Texas at Arlington

Abstract

A highly successful Mentoring Office is described. The salient feature of this program is students-mentoring-students. Foresight and determination of the IEEE Student Branch Organization's leadership are the primary reasons for its success. Well qualified Mentors are screened and selected from among a pool of upper division undergraduate and graduate students. Funds from the TWD Grant are used to pay hourly wages for the Student Mentors. Surveys are conducted to determine the effectiveness of the mentoring program. The overall goal is to increase the retention rate of both freshman and transfer students entering the electrical engineering program.

Purpose

The goal of the TWD Grant Program is to increase the number of students completing baccalaureate degrees in electrical engineering and entering the high tech work force in Texas. This goal can be accomplished by (1) increasing the number of entering freshman and/or by (2) increasing the retention rate of entering students. The approach taken in this project focused on the retention rate issue.

The freshmen and sophomore students enrolled in UTA's undergraduate electrical engineering degree program are faced with rather difficult science, math, and engineering courses. In addition there are significant differences between a high school environment and a university environment. In general, many lower division undergraduate students need encouragement and mentoring to be successful and thereby remain in school. It is quite critical to mentor and motivate the lower division student in these first two years for it is in these years that the drop-out rate is the highest.

Implementation

The salient feature of this mentoring program is that it is students mentoring students. It was conceived by officers of the IEEE Student Branch and is operated and managed by the IEEE Mentoring Office within the IEEE Student Branch organization. The IEEE Mentoring Office stays open Monday through Friday for the fall, spring, and summer semesters. The student mentors are rigorously screened and come from the ranks of upper division undergraduate students and graduate students. The Student Mentors are paid hourly wages from the TWD Grant funds. The student supervisor for the IEEE Mentoring office is a Graduate Teaching Assistant paid by the department and is a member of the IEEE Student Branch organization.

The Dean of Engineering renovated space for the Mentoring Office and the University provided a small grant for purchase of eleven computers. The Department of Electrical Engineering and the University provided a set of software tools used for simulation and analysis. The Department equipped the Mentoring Office with two complete Undergraduate Teaching Lab stations identical to those used in the teaching laboratories. These facilities and computational tools provide an excellent environment for mentoring.

Evaluation

The Mentoring Office uses a survey approach at the end of each semester to assess the success of their mentoring services. Six survey questions are used: (1) How long have you been using the mentoring services? (2) Has the tutoring helped you improve your grades? (3) Has the tutoring helped you comprehend and appreciate concepts better? (4) Are the Mentors approachable and friendly? (5) Do you think the Mentoring Office should continue? (6) To what extent are you satisfied with the Mentoring Office services? Survey results thus far rate the Mentoring Program quite highly. Our goal is to develop a more direct measure of the correlation between the success of the Mentoring Office and improved retention rates.

Recommendation for Adopters

Below is a list of important considerations for implementing this strategy.

- Important to listen to students' needs, particularly the freshmen and sophomore level undergraduate students. This "listening" led to the conception and implementation of the Mentoring Office.
- Important to have creative and visionary faculty advising the IEEE Student Branch Organization.
- Extremely important to have creative and visionary student leadership within the IEEE Student Branch Organization.
- Extremely important to have enthusiastic support of the EE Department Chairman and College Dean.
- Important to have available adequate space to house the Mentoring Office.
- Important to have available adequate facilities such as computers, applicable software tools, desks, tables, chairs, etc.
- Extremely important to let the leadership of the IEEE Student Branch organization have "ownership" of the Mentoring Office. They need to operate and maintain the Mentoring Office under the guidance of the Faculty Advisor.
- Important to develop and maintain a small library of relevant books immediately available to the mentors, consisting of the basic texts required for the undergraduate courses.
- Important for the mentors to create and maintain open dialogue with the faculty teaching the courses.
- Important to develop means to fund the Mentoring Office after TWD funds are gone.

Sources of Additional Information

- Stephan Wright and Amit Thakkar, "IEEE Mentoring Office @ UTA: From Concept to Realization", Proceedings of the 2004 ASEE Gulf-Southwest Annual Conference held at Texas Tech University
- Raymond Shoults and William Dillon, "TWD Annual Report – Summer 2005"

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Mentoring and Learning Communities for Entering Freshmen

Richard H. Fowler and Peter A. Ng - The University of Texas – Pan American

Abstract

The mentoring and learning community program implemented at The University of Texas – Pan American has proven to be a successful, cost effective means to increase retention among entering computer science students. The program implements widely used techniques, together with techniques tuned to the unique needs of students at this university. Its social elements address a critical need in the often difficult transition to university life often not explicitly addressed by university wide programs, but dealt with well at the small group and department level.

Purpose

The transition from high school to university is often challenging for students, and a variety of strategies are available to address students' difficulties. For low income first generation college students entering STEM disciplines, these challenges are particularly acute and often include lack of skills. The University of Texas – Pan American enrolls 17,048 students of whom 69% are in the first generation of their family to attend college and 70% qualify for needs-based financial aid. 87% of all students are Hispanic and for the 264 computer science majors 71% are Hispanic.

The Mentoring and Learning Communities program implements a number of widely used techniques for addressing the challenges of building a student community and providing student support, together with techniques tuned to the unique needs of students at this university. The program's academically focused elements supplement, coordinate, and refine existing university structures and programs with an emphasis on needs of entering students in computer science. Its social elements provide a critical element in the often difficult transition to university life that is not supplied by existing programs. The program's techniques are applicable across a broad range of university populations.

Implementation

The Mentoring and Learning Communities program provides a series of activities that 1) introduce participants to the university's culture and processes, 2) provide ongoing tutorial support, 3) create opportunities for one-to-one interactions with faculty and successful upper class students, 4) supply less formal structures for social interaction, and 5) introduce students to university resources, such as financial aid and career placement. The program was able to attract highly qualified and dedicated student mentors. A key element is the personalized experience in which peer and mentor support is available. As detailed below, a significant component of the mentoring experience was introduction of participants to existing services and the computer science department community.

Evaluation

For 2004-2005 participants, 84% continued and successfully completed the CS 1 course versus 58% for nonparticipants. Student participants and computer science faculty were surveyed and both groups reported that the program "was an important factor in successfully completing" the

first programming course (92% and 100%, respectively) and “continuing study in computer science” (96% and 100%, respectively).

Recommendations for Adopters

This short section highlights some of the elements found particularly useful in the program. The first weeks included activities targeting pragmatic elements of the transition to university studies. Among the most important elements was the informal advising of participants. Though university and departmental advising is mandatory, a large number of entering students arrive at the first mentoring meeting with inappropriate schedules. For the student who must work a significant, often large, number of hours off campus, the course load the student registers for is simply more than can be accomplished. It has been our experience that this issue can in many cases be dealt with more effectively by peers than staff or faculty. The recognition of limitations is an ongoing element of development that can be facilitated by group discussions, past experiences of mentors, and other mechanisms available in the mentor-led small group setting. Participants were also introduced to the range of university sponsored support services available through visitations by staff members, tours of facilities, etc.

Peer tutorial support was provided throughout the year. This supplemented laboratory support provided by the department to all students. Groups were formed based on class membership in the required CS 1 class. Instructors in those classes cooperated closely with the program in student placement in the program, as well as ongoing support for the program and its tutorial efforts. Tutoring activities extended to other classes as well, as there was significant commonality in course enrollment in the university’s required courses. Last year saw the university’s implementation of a required “learning frameworks” course that was organized to group students in the same college. Evolution of this and other university efforts at learning community implementation is ongoing.

Each mentoring group was assigned a faculty advisor who met with the group throughout the semester. A primary charge to advisors was to provide students with information about the scope of career opportunities in computing and the life and career path of the computing professional. Outside speakers from the profession were also invited to give presentations. Toward the end of the semester, university career placement staff attended meetings. Participants attended and later discussed the university career fair. Most presentations were open to all students. This presentation series has become widely attended and serves to integrate the entering freshman participants with the larger computer science community.

In general, the small group setting of a mentoring meeting creates opportunities for one-to-one interactions with faculty and successful upper class students. In some respects this was an attempt to provide at a large commuter campus the opportunities for establishing relationships that are more readily encountered in other settings. Interaction extended spontaneously beyond the formal university setting, as the mentors and participants initiated social meetings off campus.

Sources of Additional Information

Student web site: www.cs.panam.edu/~mentoring
Reports and materials: www.cs.panam.edu/~rfowler/mentoring

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Engineering Retention Enhancement through On-Campus Jobs

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

Abstract

Electrical engineering students were offered part-time employment in the electrical engineering department in an effort to reduce conflicts with outside work, increase early contacts with faculty and staff, and encourage students to spend a larger fraction of their time on-campus. Despite the fact that no GPA screening or selection process was used, participating students had significantly higher rates of first-year retention than non-participants.

Purpose

The University of Texas - Pan American (UTPA) serves students that are mostly commuters, primarily first-generation college students, and essentially all in need of financial aid. We identified several issues that were of special importance to students in the Rio Grande Valley:

- Financial pressures force many students to take on part- or full-time employment that conflicts with their studies.
- Even with financial aid, commuter students are often under strong social pressure to hold a job to demonstrate maturity, responsibility, and family commitment.
- Many students enter with relatively little knowledge of the engineering profession, and with almost no prior contact with engineering faculty.
- Student "engagement," that is, students' willingness to view their education as their chief daily activity, is a major factor in retention.

The purpose of our project was to alleviate these problems by offering students an alternative to off-campus employment that would

- partially meet their financial needs,
- remove outside time conflicts,
- fulfill their need to work and engage their sense of responsibility,
- build contacts with faculty, staff, and more advanced students,
- keep the students on campus more hours per day, and
- give them initial experience with technical employment.

The project was tailored to match the needs of our students, and would be most applicable to institutions which also have a large population of commuting students and/or lower income students.

Implementation

The project offered students employment, typically 10 hours per week at $7.50 per hour, under the conditions that: (a) they remain full-time as electrical engineering majors, and (b) agree to give up any outside employment. Advertising was by website postings; announcements at convocations; and word-of-mouth at advising and recruitment events. Priority was given to freshmen, sophomore, and new transfers. Once hired, students could retain the job until graduation or the end of the project. Students were accepted without any GPA or other qualifications other than those listed above, on a first-come, first-serve, non-competitive basis.

Evaluation

At the project midpoint, 46 students had been enrolled. 100% were still retained (or graduated), and 96% had been retained (or graduated) as electrical engineering majors. 93% of the students had GPA > 2.0. These figures compare very favorably to overall University retention rates of 67% for freshmen and 85% for upper level students. As with any voluntary program there are self-selection effects; nevertheless, we emphasize that students were accepted on a non-competitive basis.

We saw a marked difference in results between this program and conventional scholarships. A conventional stipend program we ran in the first year of TETC support produced retention numbers *less* than the university average. We believe that the sense of responsibility and commitment associated with employment, as well as ongoing contact with faculty and staff, had a beneficial effect on student engagement, and loss of students to competing majors.

Originally the project was conceived as both recruitment and retention; however, the number of entering freshmen choosing electrical engineering has decreased, indicating lack of effectiveness in recruitment. This occurred in the context of weak EE and CS enrollment nationwide. Despite the decrease, our credit-hour production increased and graduating class sizes remained level, giving further evidence of improved retention and student progress.

Recommendations for Adopters

[1] Proper Use As stated in the previous section, we now feel that the strategy is primarily a retention tool, not a recruitment tool. It is thus probably most effective at institutions with relatively open admission standards.
[2] Rate of Pay Most students prefer technical employment related to their major to unrelated outside jobs, even if the rate of pay and hours are lower. Therefore, wages need not be competitive with local businesses. We normally limited the jobs to 10 hours per week; however, participants indicated a desire for more hours, and 15 hours may be closer to optimum.
[3] Supervisors The immediate supervisors of the students should understand the purpose of the program. In particular, they should know that employees need flexibility to change schedules, especially during “crunch” periods such as final exams. Supervisors also need a realistic idea of the productivity level that can be expected from incoming freshmen.
[4] Task Assignment In a small or medium size department, some ingenuity may be required to find meaningful assignments for all participants, especially incoming freshmen. In addition to faculty, lab technicians and office staff can serve as supervisors..
[5] Not a Stipend A critical aspect of the program is that it is not a scholarship or stipend. The distinction is particularly important when dealing with first generation college students at a commuter campus.

Source of Additional Information

Further information can be found at our website: http://www.engr.panam.edu/ee. Statistical information about the institution as a whole, including retention rates, can be found at the UTPA Office of Institutional Research and Effectiveness: http://oire.factbook.utpa.edu/index.cfm.

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Session III

Best Practices for Recruiting Engineering and Computer Science Students

Moderator: Dan Marcek, Deputy Director, University Relations, Hewlett Packard, Brookline, NH

Recorder: Vishal Bahn, Graduate Student, The University of Texas at Arlington

Girls Reaching and Demonstrating Excellence (GRADE) Camps: An Innovative Recruiting Strategy at the University of Houston to Increase Female Representation in Engineering

John R. Glover, Jennifer L. Ruchhoeft, Julie Martin Trenor,
Stuart A. Long and Frank J. Claydon – University of Houston

Abstract: *GRADE Camp is an innovative weeklong camp is designed to introduce high school females to the marvels of engineering. Program content is comprised of engineering topics necessary for the girls to design a Lego™ robot to autonomously maneuver through a maze. Engineering faculty and SWE undergraduate/graduate mentors guide the girls through the curriculum and help them develop problem solving and teamwork skills. The girls interact also interact with female engineers in industry to discuss issues specific to females pursuing careers in engineering. GRADE Camp concludes with the girls demonstrating what they learned to their parents, teachers, and peer participants.*

Purpose: The continuation of the technology explosion into the 21st century necessitates the availability of a diverse and highly capable, technical workforce. The formation of a diverse workforce depends on active recruitment of women. Recent statistics show that while women represent more than half of all U.S. undergraduates, only about 20% of bachelor degrees awarded in engineering in 2003 were to women. Many young women have the skills and qualifications to study engineering, but choose careers in business, social science, and the humanities without ever considering more 'technical' careers. We believe this is due in large part to lack of appropriate role models for women and the lack of early exposure to engineering related fields and career opportunities. For these reasons, we created GRADE Camps. The program goals of GRADE camps are 1) to help female students make an informed choice about pursuing an engineering career field and 2) to help increase the number of female students in engineering careers.

Implementation: Through emphasis on career exposure rather than career choice, GRADE provides girls with a better understanding of the nature of engineering, including the need for a solid foundation in math and science courses. GRADE utilizes active, co-operative learning and hands-on experiences rather than traditional lecture or demonstration-based formats. Participants learn theory during the mornings and then apply the theory during the afternoons in sequential, hands-on laboratories completed in teams of two or three girls. Each activity and discussion session is carefully designed to lead into a portion of a final design project, thereby linking theory to practice. Modules that are covered in camp include problem solving, robotics, programming a micro-controller, motors and generators, magnetism, history of electrical and computer engineering, team building, networking, and oral presentations. SWE student mentors work with small groups of GRADE camp participants to integrate camp modules into a design project. By working on engineering design projects, students 1) apply their science and math knowledge to solve real problems, and 2) gain an insider's view of engineering design and scientific inquiry processes. Each camp culminates with GRADE participants presenting their design project to their camp peers, invited family members, and teachers of their choosing. The one-week camps are held each summer (4 camps). GRADE camps are targeted towards entering 9th-12th grade girls (25 to 30 per camp) with appropriate math and science background for their grade. Students who successfully complete the camp are awarded a $1,000 scholarship if they subsequently major in Electrical or Computer Engineering at UH. ECE at UH maintains a website where GRADE participants can seek advice or help in homework from GRADE mentors, engineer guests, and ECE faculty, who are an integral part of GRADE Camp.

Evaluation: To date, we have implemented three successful summers (2003-2005) of week-long engineering camps reaching a total of 225 female high school participants. We consistently receive unanimous positive program feedback from GRADE participants, parents, teachers, guest engineers, featured speakers, and engineering faculty. A vast majority of the camp participants reported changing their perspectives positively towards engineering as a result of attending GRADE Camp. Student's paired T-tests were performed at the 99% confidence interval to determine the statistical significance in differences in girls' responses to pre- and post-camp assessment statements. Results show that the girls' confidence in pursuing degrees in engineering improved significantly ($p<0.01$) as a result of participation in GRADE Camp. In fact, in the post-camp assessment, 83% of participants reported agreement or strong agreement with the statement "I will be more confident to pursue a degree in engineering as result of having attended GRADE Camp," compared to 57% responses in the pre-camp assessment. Tracking efforts are ongoing to determine long-term effectiveness of GRADE Camp on future career choices. The results thus far appear promising.

Recommendation for Adopters: Young women often do not recognize the possibility, opportunities, and rewards of an engineering career. Dr. Karan Watson suggests in her working paper for the National Academy of Engineering, "*What's Next in Diversifying the UD Engineering Workforce*" that *isolation* is a major factor when looking at reasons woman do not pursue careers in engineering and science. Our strategy addresses this issue by offering high school girls an academic support system and a supportive learning community. GRADE Camp incorporates student mentoring and also allows campers to speak candidly with female engineering faculty and female engineers during Camp and throughout the campers' high school and college years through the GRADE Communities of Practice website. Offering a non-threatening environment for girls to learn about math and science free of stereotypical pressures that they may place upon themselves is a fundamental reason why GRADE Camps have been well received and successful. We believe that ECE GRADE Camps at UH are instrumental in fostering increased interest in ECE resulting in a larger number of females pursuing and obtaining electrical and computer engineering degrees. Of the 225 girls have attended GRADE Camp, 62 have attended through need based scholarship funds.

Cost Estimates: six SWE undergraduate students @ one month each, $12,000; two graduate students @ one month each, $3,000; four faculty @ 0.5 month each, $20,000; one teaching fellow @ one month, $5,000; 20 need based camp scholarships @ $100 each, $2,000; participant camp fee @ $200 each, $20,000; Total Costs, $62,000.

Sources of Additional Information

Title	Venue	When	Authors
Making the GRADE (Girls Reaching and Demonstrating Excellence) at the University of Houston	SWE annual conf Career Fair.	Oct 04	John R. Glover, Jennifer L. Ruchhoeft, Julie Martin Trenor, Stuart A. Long, Frank J. Claydon
Girls Reaching and Demonstrating Excellence (GRADE) Camps: An Innovative Recruiting Strategy at the University of Houston to Increase Female Representation in Engineering	ASEE Annual Conf. Presentation and Paper	June 05	John R. Glover, Jennifer L. Ruchhoeft, Julie Martin Trenor, Stuart A. Long, and Frank J. Claydon

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Enhancing Computing Workforce by Providing Higher Education to Working Professionals

Moonis Ali, Texas State University-San Marcos

Abstract

We are successfully accomplishing our goal of increasing computer science graduates by providing opportunities to working professionals to pursue higher education in Computer Science. The ABET Accredited Program is offered in collaboration with area's community colleges at times convenient for working professionals. We already graduated 166 students. Our model can easily be adopted for producing high quality outcomes most economically.

Purpose

Our purpose is to increase the number of graduates in computer science. The Best Practice we developed focuses on the following three components:
a) PROBLEM SOLVING: There are a large number of working professionals in Austin and the vicinity who would like to join the Texas information technology workforce, but no public institution in this area has been offering an undergraduate degree program in computer science at times convenient for working professionals. Our Best Practice resulted in offering an undergraduate degree in Computer Science at the Round Rock Higher Education Center (RRHEC) in North Austin to solve the problem.
b) QUALITY OUTCOMES: The Bachelor of Science degree program offered under the Best Practice is accredited by the Accreditation Board for Engineering and Technology (ABET). Only 196 degree programs in the country currently have ABET accreditation. The quality of our program is obviously confirmed through this accreditation which has high standards.
c) ACHIEVEMENT OUTCOMES ECONOMICALLY: We are offering a computer science degree program at RRHEC in collaboration with Austin Community College (ACC) which already has an established associate degree in computer science and has graduated many working professionals with this associate degree. These working professionals now are taking advantage of our program by completing the full baccalaureate degree in computer science. In addition, more working professionals are now attracted to join our collaborative program to receive a full baccalaureate degree in computer science. The cost of the program is minimal because it includes only the cost of our offering junior and senior level computer science courses since other courses are taken by students at ACC or through other programs already offered by sister departments at RRHEC. Therefore, the outcomes are achieved very economically by our Best Practice.

Implementation

The focus of the implementation for our model has been on quality and economy as described in above paragraphs. The other part of implementation involved developing infrastructure like creating classrooms and laboratories at our North Austin/Round Rock campus called "Round Rock Higher Education Center (RRHEC). Lab assistants were hired to run the labs and new faculty members were hired to cover the course offerings with junior and senior level courses. Our preference has been to involve highly experienced professionals from industry as adjunct faculty and that experience has been very rewarding. The more challenging part of our implementation has been dissemination of information about the program to working professionals. We have tried many modes of communications like direct mailing, notices in libraries, advertisements in Austin Business Journal, contacting human resource departments of industry, participation in job fairs and industrial education days. We have also used services of

our admission counselors who travel throughout the states giving presentations to a diverse population. Currently, we have rented bill boards on IH35 and Interstate 183 in Austin to promote the program. We have also created web pages to attract new students to the program. We are also considering advertising the program through radio and television advertisements.

Evaluation

The table below illustrates our success. We have already produced 166 graduates since the fall of 2001 and the number of graduates has been increasing consistently from year to year. Over 23% of the graduates were females and the number of female students has more than doubled since fall of 2001. The growth in Hispanic graduates is also high.

Posted TETC Student Roster	Entering	Progressing	Advanced	Graduated	Sum
Fall 2001	0	3	16	3	22
Spring 2002	0	4	14	5	23
Fall 2002	8	5	30	6	49
Spring 2003	10	14	47	13	84
Fall 2003	15	6	40	28	89
Spring 2004	9	6	48	26	89
Fall 2004	4	2	36	25	67
Spring 2005	2	8	41	31	82
Fall 2005	11	5	29	29	74

Another anecdotal success of the Best Practices resulted in receiving a CSTEP Computer Science Training Academy (COSTA) grant from the National Science Foundation. This grant is focused on enhancing computer science education at junior high schools and to increase interest in computer science among junior high school students. The funded amount of $846,830 is for a three year project that uses information technology experiences to develop an educational and career pathway for Hispanic students in grades 8-10 at five school districts in South and Central Texas. In addition, we have submitted another proposal to the National Science Foundation for a grant of over one million dollars to enhance computer science education at high schools and to increase interest in computer science among high school students.

Recommendations for Adopters

One very important characteristic of our model is that it can be adopted in every metropolitan area of the state as well as the nation. These populated areas have many working professionals who may not have opportunities of higher education to prepare them for skilled professional computing jobs. These cities usually have two year colleges which are an important component of our model. Thus many areas in the state of Texas and the nation have all the components employed in our model to successfully implement this model for increasing computer science graduates.

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Counselor Update Events

Janet Lind, The University of Texas at Dallas

Abstract

The UTD School of Engineering and Computer Science targets highly qualified students with a serious interest in High Technology fields. As a relatively new university, we must continue to grow our reputation in the field, with industry, and with the citizenry. By informing Texas and Neighboring State counselors of a high quality, Texas public university, we give them the opportunity to provide students with a very cost effective option for getting an excellent education while "getting away from home" in a full campus environment.

Purpose

The UTD School of Engineering and Computer Science (ECS) is mandated to grow in three interconnected areas: student population, faculty, and research funding. UTD's High School and Junior College recruiting efforts have successfully attracted high quality students from within the state of Texas, yielding a Fall 2005 ECS undergraduate enrollment of 1,677. Nevertheless, due to the recent recession's perceived impacts to the high technology industry, state-wide undergraduate enrollment rate has seen some decline in recent years.

Addressing the need to increase engineering and computer science enrollment requires an effort in educating the population on the reality of US high technology opportunities throughout various facets of our economy, and on the educational opportunities provided by the UTD School of Engineering and Computer Science. It is especially important to inform High School counselors responsible for advising college-bound students. With this objective, UTD staff conducts a series of Counselor Updates throughout the state of Texas, focusing on the Fall as the period of greatest influence. This practice was extended to neighboring states in 2005.

Implementation

High School counselors are extremely influential on college-bound students, advising on areas of study as well as specific university opportunities. The counselor update session informs the counselors of general facts about UTD, including overall opportunities, scholarships, housing, and admissions criteria. Specific ECS programs and high technology employment opportunities in Dallas and nationwide are also presented.

Prior to the start of our recruiting efforts, we create a current list of High School counselors including phone numbers, and physical and electronic mailing addresses. We schedule events based upon population location and previous student enrollment statistics. Breakfast or luncheon meetings are typically used to allow the counselors to gain new information in a relaxed environment at a time when they would not typically be expected to be in attendance at their respective schools. Quantities of University collateral and specific ECS information are distributed, as well as individual gifts for each counselor.

The counselors are asked to encourage students to attend UTD Fiesta Nights in the local city, as well as ECS Summits held on the UTD campus. The Fiesta Nights are attended by candidates for all UTD schools, their parents, and other influencers. The attendance at these events has grown over the past three years, as has the attendance in the ECS Summits.

Evaluation

The UTD Texas cities Counselor Updates have been being conducted for approximately three years. The attendance has grown significantly in that time period, with a very strong turnout in the Fall 2005 period. TETC funding was used to introduce out-of-state counselor updates in 2005. The specific details are:

Fall 2004		Spring 2005		Fall 2005	
City	Attended	City	Attended	City	Attended
Austin	30	Tulsa	5	Little Rock	7
San Antonio	28	Oklahoma City	26	San Antonio	35
Houston	116	Little Rock	5	Austin	35
El Paso	25	New Orleans	16	Oklahoma City	14
				Tulsa	10
				Houston	130
				North Dallas	39
				Arlington/FW	16
				New Orleans	cancelled
				El Paso	12
				Albuquerque	5
				McAllen	10

The S05 Oklahoma City numbers reflect the value of conducting this event in near proximity to a state organized counselor session. The parochial school counselors were not included but were aware of the public school counselor event, and enthusiastically joined the UTD event both to receive our information and simultaneously network with public school peers.

Recommendations for Adopters

The Counselor Updates are most effective when conducted in advance of the specific student recruiting activity. This allows the counselors to be informed of ECS opportunities with appropriate time for them to possibly target and certainly influence students, parents, and High School faculty. Furthermore, it is most effective to target the events to occur either in proximity to some other ISD or State directed counselor meetings, or at least at a time when the counselors are not overtaxed with events such as registration or graduation. For out-of-state events, it is valuable to understand the mix of public versus private school attendance in the area. Therefore, one should consider the public school calendars and events as well as the events influencing the availability and work load for private school counselors.

Spring 2005 was the first time ECS conducted out-of-state recruiting events, with the first focus targeting Oklahoma, Arkansas, New Mexico and Louisiana. Given that this was a “first time” event, the objectives were to meet and update as many counselors as possible while learning more about effective locations and venue. As first time events, the Student / parent Fiesta Night updates were not expected to generate any significant attendance.

Sources of Additional Information

The practice of working with High School Counselors is a well known recruiting tool, as has been demonstrated by top tier Engineering Schools such as Georgia Tech, Purdue, and University of Illinois at Urbana. Many organizations host counselors on campus, and in several cases they will also travel regionally to visit counselors. UTD has hosted counselors on campus for several years, and continues this practice when appropriate. The fairly young practice of traveling to Texas cities and beyond for Counselor Updates has proven to attract a wide audience of influencers. UTD program details can be found by contacting Dr. Janet Lind, janet.lind@utdallas.edu.

Session IV

Best Practices for Curriculum Revision

Moderator: Monte Cely, Vice President (ret.), SBC Laboratories, Round Rock, TX

Recorder: Archana Krishna, Graduate Student, Southern Methodist University

Setting Student Expectations with a Majors-Only Programming Course

Krishna M. Kavi and David M. Keathly, University of North Texas

Abstract

Separating Computer Science majors and non-majors in the Introductory Computer Science course, and expanding the beginning sequence to permit coverage of fields of study and careers in Computer Science, has improved the retention and satisfaction among both groups of students at UNT. Providing assistance in the form of a dedicated Help Lab staffed with graduate students and teaching assistants has further added to the improved retention rates in the Computer Science programs.

Purpose

The initial course in Computer Science offered at the University of North Texas serves a number of constituencies, including the Computer Science and Engineering majors, as well as Electrical Engineering, Engineering Technology, several programs in the College of Business as well as programs in Visual Arts and other interested students. Those students pursuing a major, or a minor, in Computer Science or Computer Engineering are typically the only students that will move forward into additional courses in programming and related topics. This has created a clear division between the needs of major students in this first course and the needs of those who are not majors and who will likely not pursue further courses in computer science.

Implementation

The implementation of this program has progressed through several phases and revisions since first undertaken in the Fall semester of 2002. The initial implementation was to merely offer separate sections of the introductory course, where each section was designated for either majors or non-majors. The majors section of the course provided a comprehensive introduction to Program Structure and Design, as well as developed skills in core programming using the C++ Programming Language, including a relatively large component of the course devoted to writing and testing applications.

As this concept developed, the courses were restructured as part of a major curriculum change in the fall semester of 2005 to provide completely separate courses for majors and non-majors. A third course was also added to the introductory sequence of courses required for both the Computer Science major and minor, and the focus in the first majors course was modified to provide more of a breadth-first approach to the field of Computer Science, rather than a depth-first trek directly into detailed program design and construction. The Computer Literacy course offered for non-majors was also modified to provide a broad introduction to applications of computers and technology in a variety of disciplines with the aim of generating interest in computer science among this student population.

To support the efforts in this classes, as well as others in the Computer Science program, he department also established a Help Lab that is staffed by graduate students who will assist and instruct students in the use of the various departmental and university computer systems and related resources.

Evaluation

Preliminary analyses of surveys and grade distributions indicate that student performance improved as a result of these strategies. Retention of Computer Science majors between the Freshman and Sophomore years, traditionally a period of high drop rates, has risen steadily throughout the adoption of these effort to a level of 66% for Freshmen and 75% for Sophomores during the 2003-2004 academic year. We expect the 2004-2005 year to see further improvements as we evaluate the latest changes in the program.

The additional resources provided to students in the introductory courses have proven to be a very worthwhile endeavor. In the Fall semester of 2002, 25% of the students enrolled in the department's first computer science course used the Help Lab. This number increased to 60% in the Spring semester of 2003. Course surveys conducted during this same period indicate that none of the students who used the Help Lab anticipated failing their classes, while students who never used the Lab had much lower expectations. In addition to students enrolled in the introductory courses, transfer students who unfamiliar with Java, C++ and/or UNIX systems used the Help Lab with greater frequency. Student surveys also include many positive comments regarding the help lab and the curriculum changes.

Recommendations for Adopters

The motivation to expand the introductory course sequence to three courses came primarily from a desire to expose students to multiple languages as well as providing a glimpse into the overall world of computer science much earlier in the program. Accomplishing this task requires identifying faulty members that can relate well to entering students and who can positively represent many different aspects and opportunities that will later be open to students in their upper division courses and careers. One of the biggest challenges has been the selection of appropriate textbooks, which we are addressing through exploration of custom publishing opportunities.

Establishment of the Help Lab, or other structured tutoring and mentoring programs and facilities, has been critical to the success of the program. Without these resources, the retention rate for early Computer Science majors would not reflect such a high rate of success. Non-major sections and courses continue to have high enrollment rates. Our Help Lab has a dedicated facility with a variety of computer equipment that is connected to the departmental and university networks. It is staffed during 8 hours per day 5 days per week. This is a critical feature in its success and popularity over tutoring and mentoring programs without a fixed facility dedicated to their use.

Sources of Additional Information

Course descriptions and other information regarding the introductory courses and the Help Lab are available on the department's website at www.cse.unt.edu as well as on individual faculty member websites accessible from the main departmental pages.

Contact Information

Dr. Krishna Kavi can be contacted by email at kavi@cse.unt.edu and David 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

The Use of Team Projects in the First-Year EE Course

Anthony P. Ambler and Archie L. Holmes, Jr., The University of Texas at Austin

This paper was not available at time this document was printed. Copies will be distributed at the conference.

Curriculum and Instructional Enhancement of Gateway Courses

C. Singh, P. Enjeti, and N. Reddy - Texas A&M University

Abstract

The core strategy employed for retention is based on curriculum and instructional enhancement of gateway courses. The rationale is that if the students can get interested and challenged in their course material and can appreciate the road map of their program, they are likely to stay. The strategy has resulted in enhancement of the quality of education and an increased number of graduates. Design and implementation of such a strategy does require release time for faculty and Graduate Assistant support to help implement the strategy.

Introduction and Purpose

Analysis of electrical engineering data in 2001 indicated that we were losing over 50% of freshmen in the first two years, with high retention over subsequent years. Faculty resources were constrained as the teaching load was already high. The space and equipment available for undergraduate laboratories was also constrained. Thus the core strategy was not to increase the total number of students but to make the yield higher, i.e., enhance retention than enrollment. The premise was that if retention could be increased during the first two years, an increased number of graduates would result. Several strategies were suggested in the TWD proposal but at the core of all these was the enhancement of curriculum and 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. The strategy was safe as at the minimum this would lead to the enhancement of the quality of education received by the students.

Implementation

First the faculty was identified who would put their heart into this activity if they had enough time available. There was a clear understanding that faculty workload needs to be properly balanced between teaching demands and scholarly accomplishments. So these faculty champions were initially given release time and appropriate Graduate Assistant support to accomplish this task. This proved to be quite effective as the dedication and energy that the faculty have put into this task is quite remarkable.

In the first phase the following courses were targeted:
ENGR 111: *the first course in engineering – Restructuring under the leadership of Dr. Narasimha Reddy.*
In the past, the general introduction to engineering at the freshman level was achieved through two classes, ENGR 111 and ENGR 112. A survey of the students concluded that these classes did not serve to motivate and excite students about Electrical or Computer Engineering. As a result it was decided to restructure and offer a special ENGR 111 for those interested in electrical or computer engineering. This class is 2-hour lecture and two-hour lab. The students are introduced to what electrical and computer engineers do, taught basic technologies and presented a four year road map of their education. The class also emphasizes the role of design in engineering and calculations are tied to measurements. The whole teaching philosophy is centered on “understand and apply” rather than “memorize and reproduce”. Theory is connected to practice through labs that are currently using OGS Tekbots as a vehicle.

ELEN 214: *Electric Circuit Theory - Curriculum and instructional Enhancement of the lecture and labs under the leadership of Dr. Prasad Enjeti*
Historically this course has been taught primarily from the (bottom up) perspective of engineering science whereby the mathematical and analytical tools required to solve for electrical circuit responses are presented and exercised through extensive problem solving. This approach was felt somewhat sterile and not effective in demonstrating the excitement and creative opportunities afforded by careers in Electrical and Computer Engineering. The instructional philosophy of the course was significantly altered by introducing more engineering design in the curriculum and adopting WebCT based interactive homework submission system. Several changes have been made to introduce more challenging and industry related experiments in the laboratory portion of this course. A design studio concept 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.

In the second phase of implementation, faculty champions are working on enhancement of next level courses including *ELEN 314:Linear Circuit Analysis(Dr. Kundur), ELEN 325:Electronics (Dr. Silva-Martinez)and ELEN 405: Capstone Design(Dr. McDougal).*

Evaluation
The success of this strategy can be judged from the actual graduation rate – our main objective. The number of graduates(Table 1) has increased steadily since the start of the project in 2002.

Table 1: Number of Graduates

Year	Graduated
Fall 2001	126
Fall 2002	147
Fall 2003	196
Fall 2004	204

In addition qualitative feed back from the faculty teaching higher level courses on the quality of education is positive. More detailed analysis is now contemplated.

Recommendations for Adopters

There need to be faculty champions to lead the curriculum and instruction enhancement at the freshman and sophomore levels. In a research-intensive institution, this requires adequate resources to provide release time for the faculty, at least in the beginning phase of this strategy and adequate support for student assistants to help faculty in designing and programming problems in WebCT, for revising laboratory manuals and testing new experiments, design studios and help desk. There also need to be resources to buy new equipment needed for adding experiments to the laboratories. Each institution has to estimate such resources depending upon where they start. Senior faculty teaching early gateway courses is an effective strategy to excite and interest students in the program.

Sources of Additional Information

At present additional information can be obtained by contacting the individual faculty champions but it is intended to make the information available on the internet in the future.

Introduction to Electrical and Computer Engineering Course to Improve Retention of Freshman Students

Mohammad A. Saed, Texas Tech University

Abstract

This paper describes the development and implementation of a new and innovative introductory course for Electrical and Computer Engineering students to help improve retention rates. The course also provides fundamental concepts and tools that are very useful for students throughout their program of study and future careers. Project-based discussion (lab) sessions are integrated with the course to stimulate student learning and to help students succeed. The course is geared toward freshman students in their first semester at the university. Several areas of Electrical and Computer Engineering such as signal processing, communications, electric circuits, and digital systems are introduced with minimum mathematical background. The popular software packages MATLAB and PSpice are used to implement projects during the discussion sessions.

Purpose

This introductory course improves retention of freshman students by achieving several important goals. The course provides an honest and exciting introduction to Electrical and Computer Engineering with its many fascinating areas. It is by no means a trivial course; students have to work hard to succeed. Being a first semester freshman course, it provides students with immediate contact and interaction with ECE faculty. In most other universities, there is an almost total lack of contact between freshman students and ECE faculty. We believe this is detrimental to retention; students need to know what electrical engineering has to offer before deciding to quit or switch to another major based only on math and science courses. The course also provides a good transition to other courses such as computer programming, digital design, and electric circuits. Students also gain introductory skills of using MATLAB and PSpice.

Implementation

At Texas Tech, the course consists of 3 hours of lecture per week in addition to weekly discussion sessions held in a computer lab. The lectures are taught by full-time faculty while the discussion sessions are done by graduate teaching assistants (TAs). Typically at Texas Tech, there are about 40-50 students per lecture section and 20-25 students per discussion session. Each discussion session is held once a week. Weekly projects relevant to the material taught are assigned by the faculty. Projects are due during the discussion sessions. Students are strongly encouraged to start working on their projects prior to the discussion sessions so that they can complete and demonstrate them to their TAs. The course starts by introducing programming using MATLAB since it will be used for most of the projects. Another goal of this component is to teach programming skills since, typically, almost half of the class has never been 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. Instead, 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. Simple image processing concepts then follow. MATLAB is an excellent environment to demonstrate all these concepts. The course then switches gears to introduce

electric circuits, analog or digital or both (if time allows). In this portion of the course, PSpice is introduced to carry out simulations. For digital circuits, since expensive laboratory equipment such as oscilloscopes and function generators are not necessary, some instructors prefer to assign hardware projects that students build on breadboards.

Evaluation

We introduced this course 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, boring, and that it is not what they thought electrical engineering is. This resulted in poor passing rates. Now students take the C++ programming course in the second semester after passing our new course described in this paper. Passing rates for both courses now are much higher. In addition, initial roster data indicate better retention rates of entering students than before. Since roster data for Fall 2005 are now being prepared, quantitative measures will be presented at the conference.

Recommendations for Adopters

Implementing this course does not require major financial commitments. The most important requirement is finding the faculty who are effective teachers, who enjoy and are interested in teaching freshman level courses, and who are committed to teaching excellence. It is certainly much easier and more interesting for most faculty members to teach traditional upper level or graduate courses in their areas of expertise. We believe having the discussion sessions, while not absolutely necessary, is very important to help students complete difficult projects and to provide a friendlier environment for interaction. Discussion sessions require the availability of a computer lab, which every department has, and funds to support graduate teaching assistants. As described in the “implementation section”, the course covers several areas in electrical engineering. It is very difficult, if not impossible, to introduce all these topics equally. Certain areas must receive more emphasis than others. This provides flexibility for individual departments 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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Turing Scholars Program

Greg Lavender and Calvin Lin, The University of Texas at Austin

Abstract

With CS enrollments declining across the country, and with top math and science high school students being recruited heavily by top universities such as MIT, Stanford, and CMU, the Turing Scholars Program was created to recruit the best high school CS students from the state of Texas. The program does this by providing a challenging curriculum, by offering opportunities to do undergraduate research with our nationally ranked faculty, and by creating a smaller community within the context of a larger university. The program matriculates approximately 40 freshmen into the program each fall.

Purpose

Our strategy leverages both the quality and size of our CS department, which is ranked 7th nationally and in the academic year 2004-2005 had 1175 undergraduates in our Pre-CS and CS majors and 42 tenure-track faculty. The quality of our department reflects our national reputation across a broad set of research areas, which allows us to integrate undergraduate research into a large number of existing research projects. Our national ranking has also helped us recruit students from outside of Texas, as our applicant pool over the past 4 years has included students from 19 states and several foreign countries. The size of our department has helped us in two ways. First, it has kept steady-state operational costs low by allowing us to offer honors versions of courses that are approximately the same size as standard sections. In other words, instead of offering, say 5 standard sections of Operating Systems, we now offer 4 standard sections and one honors section. Second, as mentioned above, our size provides a large thriving research infrastructure into which we can integrate our very best undergraduates.

Our department's size is sometimes viewed as a detriment, as students often want a personalized college experience with the opportunity to socialize with like-minded students and to get to know their professors. The relatively small size of our honors program allows just this, as our students typically move through the curriculum as a cohort, socialize with one another, and then pass their collective wisdom down to the younger students. Certain department-sponsored activities help this bonding process.

Our strategy works well for large CS departments with high-quality faculty who are engaged in cutting edge research. Our strategy targets highly motivated science and math students.

Implementation

A key to our success is the effort of a small number of dedicated faculty. In particular, our honors Director, who receives partial support from a TETC grant and partial support from the Dean of the College of Natural Sciences, advises honors students, oversees curriculum development, recruits students, and heads the admissions process. The unwavering support and personal involvement of our Department Chairman is also crucial. Both the chairman and the Director attend many social and program-related events such as recruiting dinners and brown bag lunches. A n energetic undergraduate advisor has also been critical; she helps with recruiting, student advising, and often participates in program-related activities, as well. Both our advisor and Director know all students on a first name basis. A committee of 4-5 faculty supports the Director in the running of the program, and a separate committee evaluates honors

theses. Excellent teaching and research faculty have also been crucial to our success, as the honors courses and research have helped inspire and motivate our students.

Evaluation

Our honors program has exceeded our expectations as we are now educating and graduating some of the best students that we have seen. We will graduate our initial freshman class in Spring 2006 (2 students from that class have already graduated in 3 years). Relevant statistics:

- Total students in the Turing Scholars Program (Fall 2005): 129
- Total students in the standard Pre-CS and CS majors (Fall 2005): 1015
- Average SAT of incoming Turing Scholars: 1440
- Average SAT of incoming non-Turing Scholars CS students: 1260
- Average GPA of Turing Scholars: 3.65
- Average GPA of standard CS students: 3.00
- Average GPA of top 50% of Turing Scholars: 3.91

The data indicate that we are attracting some of the best students in Texas. For example, 48% of Turing Scholars ranked 1st -10th in the high school class. Anecdotal evidence of recruiting success:

- Jason G. (entered Fall '03) chose UT over Michigan
- S.W. (Fall '03) chose UT over Berkeley, MIT, and Carnegie-Mellon (all top 4 CS depts.)
- Laura M. (Fall '03) chose UT over MIT
- T.N. (Fall '04) chose UT over Carnegie-Mellon, Illinois (ranked 6th), and Georgia Tech
- Matt K. (Fall '04) chose UT over Carnegie-Mellon and Cornell
- Sarah C. (Fall '04) chose UT over Carnegie-Mellon, Harvey Mudd, and Grinnell
- Matt S. (Fall '04) chose UT over Carnegie-Mellon, Illinois, and Rice
- Drake H. (Fall '04) chose UT over Carnegie-Mellon and Rose Hullman

The quality of our students and their success at UT is reflected through various external measures. A poll conducted in the spring of 2004 revealed that of the 60 respondents, over half (33) had found summer employment or internships in the high-tech industry, which is particularly impressive since these students had only completed their freshman and sophomore years. The employing companies included Deutsche Bank, IBM, Lockheed-Martin, Microsoft, National Instruments, and Sun Microsystems. The internships included positions at the University of Minnesota, the Arecibo Observatory in Puerto Rico, and NASA's Goddard Space Flight Center. The same poll showed that 36 of these students received an average of two scholarships (many nationally competitive) during the 2003-2004 academic year.

Recommendations for Adopters

As mentioned above, a small number of dedicated and energetic faculty and staff are crucial to the success of our program, as talented students often require special attention, for example, to pursue double-majors, special internships, or interdisciplinary research. We also recommend the creation of a course, Introduction to CS Research, that has helped students make the transition from the classroom to the laboratory. Another recommendation is to get the students involved in the running of the program (recruitment, mentoring, social events). Finally, our course structure has been important to minimize steady-state program costs.

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Session V

Experiences with Statewide Implementation of the INFINITY Project

Moderator: Larry W. Stephens, Director, Systems Engineering, Lockheed Martin, Dallas

Recorder: Dhia Mahjoub, Graduate Student, Southern Methodist University

Paradigmatic Labs for Introduction to Electrical Engineering

Harley R. Myler, Lamar University

Abstract

Lamar University Electrical Engineering has made an aggressive attempt to recruit and retain students into our undergraduate program under the philosophy that they should enjoy and be interested in the practice of EE. As part of this effort, we incorporated the Infinity Project into our curricula as an introductory freshman-level course. We found that the course lacked attention in defining areas of EE, and thus we developed what we call Paradigmatic Labs that address five fundamental paradigms: circuit theory, electronics, logic gates, electromagnetics and controls, which we added to the syllabus.

Purpose

Our original offering of the Infinity Project left many students feeling that Electrical Engineering was confined to Digital Signal Processing (DSP). We added the paradigmatic labs to show that the foundation of EE is based on five fundamental areas: circuits, electronics, electromagnetics, logic systems and controls[†]. A secondary advantage that we experienced with the paradigmatic labs is that in addition to student exposure to the DSP systems, they also get early on exposure to hardware and data acquisition through the Electronic Laboratory Virtual Instrumentation System (ELVIS) from National Instruments (NI) that uses the LabView software package. In one semester we expose the students to the following critical elements of EE study:

- DSP and CAD tools (Infinity Project Labs)
- EE Paradigm Labs (circuits, electronics, electromagnetics, logic systems and controls)
- LabView Virtual Instrumentation (DMM, O'Scope, Signal Generator)
- Laboratory Teamwork
- EE Laboratory Skills (components, breadboarding, etc.)

One significant improvement was our recent development of our own prototyping board that works with the ELVIS station. Our part, the "LUEE-ELVIS" board, is less expensive than the NI board and has a more compact form factor so that students can easily carry it around. The prototyping area is more than adequate for the paradigmatic labs of the intro course and also the labs in our circuits, electronics and logic design courses. The student purchases the board as a freshman and then uses it through four years of study.

A side outcome of the paradigmatic labs and the use of the ELVIS is that in our non-laboratory courses (upper division) the instructor has the option of assigning laboratory work as homework assignments. We call this Value Added Engineering Education (VAEE). This not only reinforces laboratory activities, but it also recoups "lost labs" from sub-disciplines in EE that traditionally had laboratory instruction associated with them (control theory, electromagnetics, etc.) but lost those labs as curricula became more crowded with required courses. The student becomes eligible after they complete electronics lab, which means that they have spent four semesters with the ELVIS/LabView system and are capable, with minimum supervision, to run experiments that reinforce theoretical concepts in the classroom.

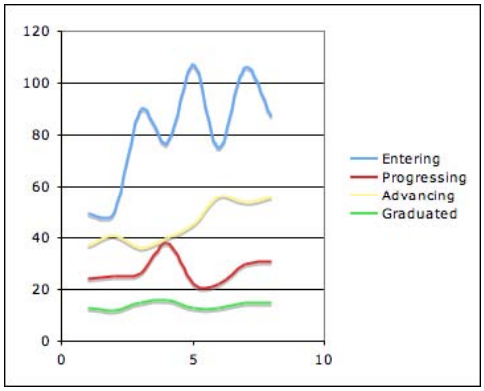
[†] As of this writing the controls experiment has not yet been added to the syllabus.

Implementation

We implemented our strategy by designing four lab experiments drawn from each of the four fundamental paradigms that we identified. These experiments were developed with simplicity and ease of execution in mind. We also developed them to utilize the National Instruments ELVIS system, which makes it easy for students to have access to an array of test equipment and computer controlled data acquisition. A secondary benefit is that we use the ELVIS throughout our curricula and this yields a layered-learning effect in that our students have repeated opportunities to develop expertise with the system.

Evaluation

The chart shows the progress in the program since Fall of 2001 where the vertical axis is number of students and the horizontal is spring/fall alternating semesters. The data is from the THECB online roster system. The troughs, particularly in the Entering category, illustrate the "Spring Dip" phenomena since most students start in the Fall. The general trend of entering students has been increasing and although the Graduated category appears flat, there is also a slow progression upward there as well. In fact, in May the program graduated twenty-six, which will not be reflected until the next roster update.



The data supports our conclusion that our introductory course has dramatically improved recruitment, a major goal of the program. The chart also reveals that we continue to have problems with retention (although not any more so than other programs).

Recommendations for Adopters

Potential adopters are welcome to add the paradigmatic labs that we developed to their programs. Although the labs make use of the ELVIS system, it is not a requirement and they can be easily adapted to discrete laboratory instruments. The labs are available at the following link and are downloadable in PDF format:

http://ee.lamar.edu/eelabs/ELEN1200/index.html

Please keep in mind that these labs were developed for beginning EE students with only pre-calculus and HS physics backgrounds, hence they are greatly simplified and intended for a *hands-on* experience rather than as support for theoretical constructs.

Sources of Additional Information

Myler, H. R., " Early Electrical Engineering Concepts Engagement in a Freshman Level Introductory Course," *Gulf Southwest Section ASEE Annual Conference*, Texas Tech University, Lubbock Texas, March 2004.

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Increase Retention Through the Use of the INFINITY Project

John O. Attia, Prairie View A&M University

Abstract

Prairie View A&M University introduced an Infinity Project course for the electrical and computer engineering students with the goal of increasing the retention rate of our freshmen. We have developed a laboratory to support the Infinity Project course. More than two hundred students have completed the course during the past three academic years. The retention rate for students who have taken the Infinity Project course is over 80%.

Purpose

Nationally the retention rate for freshman engineering students is close to 48%. The retention rate for all Prairie View A&M University freshmen during the 2000-2001 academic year was 69%. The main purpose of this project is to increase the retention rate of freshman electrical and computer engineering students.

Implementation

The Infinity Project is an innovative national program aimed at increasing the quantity, quality and diversity of students pursuing engineering and technical degrees [1]. The Infinity Project has increased the retention rate of incoming freshman students at Southern Methodist University and other institutions [2, 3]. The Electrical Engineering program at Prairie View A&M University (PVAMU) had enrollment of over 500 students in 1991. In 2002, at the inception of this project, the enrollment has decreased to 255 students. We wanted to increase the electrical engineering enrollment through increased retention by using the Infinity Project.

We started using the Infinity Project during the 2002-2003 academic year. The course, ELEG 1022, Fundamentals of Electrical and Computer Engineering, was formally introduced in Fall 2003 semester. The Infinity Project kits were purchased to build the necessary laboratory facilities at PVAMU campus to support the freshman class. The laboratory experiments use the Infinity Technology kits. The experiments allow students to have experience in envisioning, designing, and testing of modern electronic systems. Table 1 shows the number of students who have completed the course since the introduction of the Infinity Project in the Electrical and Computer Engineering programs.

Table 1 Students who Completed the Infinity Project Course

Academic Year	Students who Completed the Infinity Project Course
2002 – 2003	34
2003 – 2004	91
2004 – 2005	119

Evaluation

Table 2 shows the retention rate of students who have taken the course. The measurement is based on the students being registered as students at Prairie View A&M University one academic year after completing the Infinity Project course.

Table 2 Retention Rate of Students who have taken the Infinity Project Course

Academic Year	Retention Rate
2002 – 2003	86.5 %
2003 – 2004	81.3 %

The Infinity Project at PVAMU is a success since the retention rate of our freshmen students, who take the Infinity Project course, has increased beyond 80 percent. The retention rate for all Prairie View A&M University freshmen during the 2000-2001 academic year was 69 percent. Our statistics, based on limited data, confirm the efficacy of the Infinity Project increasing the retention rate of freshman engineering students.

Recommendations for Adopter

The following conditions are needed for the transfer of the best practice:
(i) Faculty members should be trained and committed to make the program a success.
(ii) Funds should be available to purchase the Infinity Project kits.
(iii) University administration should support of the Project.

Two faculty members from Prairie View A&M University, Dr. John Attia and Dr. Cajetan Akujuobi, attended a workshop on the Infinity Project in May 2002. They were trained during the workshop to teach with the resources provided by the Infinity Project. Since September 2002, three additional faculty members at PVAMU have been trained to teach the Infinity Project course. Funds provided by TETC were used to purchase the Infinity Project kits. PVAMU administration has been supportive in our efforts to use the Infinity Project to increase our retention rates.

Sources of Additional Information

[1] Geoffrey Orsak, *"K-12; Engineering's New Frontier*" IEEE Trans. On Education, Vol. 46, No.2, p.209-210, May 2003.

[2] Geoffrey Orsak, *Personal Communication*, Retention rate of freshman EE freshmen students increased to about 90% in 2000-2001 academic year, Dallas, Texas, June 2002.

[3] Texas Higher Education Coordinating Board, Technology Workforce Development Grants Program*, 3rd Annual Report*, October 2004.

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Cross-Disciplinary Early Engineering Design Experiences for Undergraduates

Marc P. Christensen, David A. Willis, and Scott C. Douglas;
Southern Methodist University

Abstract

This strategy addresses the recruitment and retention of first-year engineering students in an academic institution where such students are not required to initially declare a specific engineering major and where multiple first-year engineering courses are offered. Students who enroll in a chosen first-year engineering course are teamed with students from first-year courses in other engineering disciplines, and these students work in groups to design systems that require expertise from the associated disciplines to complete. The design experiences provide opportunities for collaborative learning and active learning, and they give students the context to better understand their chosen engineering field.

Purpose

This strategy addresses the recruitment and retention of first-year engineering students in an academic institution where such students are not admitted directly into Departments within a College or School of Engineering and where multiple first-year engineering courses are offered. The goal of this strategy is threefold: (1) to retain students in an engineering major, (2) to increase students' awareness of engineering concepts that bridge multiple engineering disciplines, and (3) to increase students' enjoyment and commitment to the study of engineering design and analysis regardless of their background.

Implementation

The strategy has been implemented with slight variations in the Spring 2004, Fall 2004, Spring 2005, and Fall 2005 first-year courses within the Departments of Electrical Engineering and Mechanical Engineering at SMU. Students are divided into teams with an equal number of mechanical engineering and electrical engineering students to complete two design projects. The first task is to build a working loudspeaker from ordinary household items. Students are given only two constraints in the forms of a standardized piece of wire and a magnet. The students build two sets of designs—several individual designs and one joint design that fuses the best parts of the individual designs. This joint loudspeaker design is then evaluated against other teams' designs according to its efficiency, frequency response, and "musicality." This initial project focuses on learning the design process, techniques of communication, and teamwork.

The second joint design task is a five-week activity to construct a robot capable of playing "putt-putt" golf in a golf challenge. The design project encompasses two subsystems: 1) an overhead vision system to determine the distance from the golf ball to the hole, and 2) a hitting mechanism to "take the shot". In Spring 2004, students were allowed to load the ball by hand into their robot if such loading was required. In later semesters, students built systems to load the ball without a human hand. Each team is provided DSP hardware/software from the Infinity Project, a web camera, three motors, and batteries. All other materials are left up to the students.

The vision systems constructed by the student teams for judging ball-to-hole distance have been similar across semesters. The students develop a logical strategy for taking an overhead web camera image of the golf course, determining ball and hole positions within this image, and calculating distances. Issues of calibration, geometry, and reliability play important roles. The

physical designs of the golf-playing robots have been varied and have involved pendulums, plungers, ramps with motorized ball lifters, and wheel-based systems. Methods for controlling shot distance have varied and have included position and height variations of ramps or clubs. All robots were programmed using identical digital hardware and software from the Infinity Project. The groups developed different control strategies despite the similarity of the computing platform.

Evaluation

For the assessment of this activity, a short survey has been administered to the students since the Fall 2004 semester. Both means and standard deviations (in parentheses) are listed for both semesters in the table below. Participation in this survey and the competition was voluntary; grading of each team's design was based on oral presentations and written reports.

QUESTION	FALL 2004 (Ntotal = 80, Nsurvey=30)	SPRING 2005 (Ntotal=22, Nsurvey=10)	FALL 2005 (Ntotal = 96, Nsurvey=21)
1. How would you rate the Design Experience? (1=poor, 5=excellent)	4.10 (0.80)	3.90 (0.32)	3.81 (0.75)
2. How interested would you be in having design experiences in future engineering classes? (1=not at all, 5=very interested)	4.57 (0.82)	3.60 (1.35)	4.29 (0.85)
3. The combination of students from multiple departments enhanced the design experience. (1=completely disagree, 5=completely agree)	3.69 (1.14)	4.00 (0.87)	3.86 (1.31)
4. This design experience made me more or less likely to pursue an engineering degree: (1=very unlikely, 5=very likely)	3.93 (1.00)	4.00 (0.81)	4.14 (0.79)
5. How much "engineering" did you learn from this design experience? (1=absolutely nothing, 5=a lot)	3.53 (0.86)	3.75 (0.98)	3.76 (0.77)
6. How much "team / project management" did you learn from this design experience? (1=absolutely nothing, 5=a lot)	3.90 (0.99)	4.20 (0.79)	3.81 (1.08)
7. If the same class was offered with and without a design experience how likely would you be to choose the class offering with a design experience? (1=very unlikely, 5=very likely)	3.73 (1.39)	3.30 (1.16)	3.76 (1.37)

Question 2 received the most one-sided responses in the large-enrollment Fall semesters. Incoming students clearly want more design experiences as part of their courses. In Spring Semester 2005, students responded strongest to the team/project management component of the design experience. All of the responses are generally positive as well. In all three semesters, students appreciated the design experience. Moreover, they were self-motivated to achieve substantial outcomes *as first-year students* with these activities in place.

Recommendations for Adopters

Administering a cross-disciplinary design experience between first-year courses from multiple engineering disciplines requires coordination between the faculty and teaching assistants of both courses. Scheduling of common laboratory times is the most important logistical issue to allow easy collaboration across disciplines. As the intervention utilized existing hardware and software capabilities, the cost of materials was not prohibitive. Additional support time is required to administer the design experiences, particularly in terms of support staff (to help them fabricate parts for their robots in the ME shop, for example). The design challenges fit both courses, and both faculty instructors had ample time to teach their discipline-specific concepts.

Sources of Additional Information and Contact Information

For more information, please contact the authors at (mpc / dwillis / douglas) @engr.smu.edu or the Institute for Engineering Education at (214) 768-4262.

Modification of the Infinity Kits to Provide Improved Hands-On Experiences

Jonathan Bredow, University of Texas at Arlington

Abstract

This paper addresses perceived shortcomings with the original Infinity kits and associated curriculum, and provides tested plans for hardware modifications and software improvements to overcome them. In particular the emphasis is on including in the curriculum experiments with basic circuit components, electronic circuits, and comparing and combining digital and analog implementations of common functions. The paper also presents work to package the modified Infinity kit, with purpose of extending its utility in demonstrations, mentoring, and recruitment.

Purpose

The original Infinity kit was developed primarily for the purpose of generating excitement about engineering as a career choice: the curriculum has been adopted successfully in some high schools and freshman-level college courses. But for others, particularly in electrical engineering, a major drawback is the infinity kit provides no avenue for experimenting with hardware. Modification of the Infinity kit is considered to be a very worthwhile endeavor due to the attractive, pizzazz, learning features it offers. The infinity kit consists of a hardware processor with microphone and camera inputs, and speaker and CRT outputs; a set of high level software blocks for manipulating sound and video/images; a simple set of rules for connecting the blocks; and attractive graphical user interface to facilitate design and experimentation. Hence, users of the system need have only a high level understanding of how the kit works in order to develop innovative designs in processing and manipulation of video/images and sound.

Many electrical engineering (EE) activities are hardware intensive and/or involve a fair mix of hardware and software. Important topics for EE freshman include exposure to commonly used electric circuit components such as resistors, capacitors, inductors, diodes and transistors; and exposure to commonly used laboratory test instruments, such as function generators, multimeters and oscilloscopes. These concepts and experiences can be conveyed with a "modified" Infinity kit that includes signaling interface between the DSP Starter Kit (DSK) of the Infinity kit and a wiring breadboard, software modifications to exploit the interface, and appropriate curriculum. The resulting "modified" Infinity kit is expected to have rather broad appeal for introductory training, recruiting, and mentoring in electrical engineering. Current standard approaches to "hands-on" training include a set of experiments in which: 1) circuit components are wired together on a suitable breadboard and behavior is evaluated using standard benchtop test instruments; 2) pre-built circuits are used and behavior is tested using standard benchtop test instruments; and 3) circuit components are wired together on a "training" platform that contains both rudimentary test instruments and a breadboard for building circuits. Of the three, the latter is most attractive since it frees the student from the laboratory, but it requires a dedicated unit, i.e., the "training" platform, similar to the approach used with the Infinity kit. But the "modified" Infinity kit has advantages over all three, because it also includes the attractive, pizzazz, learning features described earlier.

Implementation

Suitable modifications have been done at University of Texas at Arlington (UTA), with regard to two versions of the Infinity kit, one using the earlier 6711-based DSK, and the other using the somewhat newer 6713-based DSK. Wiring modifications of the 6711-based kit include addition

of analog-to-digital (ADC) and digital-to-analog (DAC) daughter-cards, to provide a versatile input/output interface to breadboarded circuits. This allows the DSK to be programmed to provide user-defined signals as output and to perform either additional digital processing or test instrument-like functions on signals input to the DSK. The 6713-based kits do not require hardware modifications, since they can provide the needed input/output functions with only a change in programming.

New curriculum has been developed for the "modified" Infinity kits, using recently available modules for targeting the 6711 and 6713 DSKs within Matlab and LabView, two popular technical software packages. These modules allow a user to develop high-level programs for the DSK in Matlab and/or LabView, and to work through Texas Instrument's Code Composer Studio (C compiler and DSP assembler) to deliver the program code to the target processor. The new curriculum focuses on adding hardware experiments to the original Infinity curriculum.

UTA has developed an easily transportable package for the "modified" Infinity kit, with goal of reducing setup effort and facilitating hardware experiment activities. The original Infinity kit comes in pieces and needs to be assembled each time it is used: this is inconvenient for demos, and in off-site training activities. The package includes the original kit components, i.e., DSK circuit board, speakers, microphone and camera, wired and ready to go; wiring breadboard; power supplies; and circuit components case.

Evaluation

Currently, the case that our strategy will be effective is based on feedback received from a number of faculty and students. It is also based on observations about "hands-on" training approaches are used elsewhere. Updates on effectiveness in practice are expected during the semester, Spring 2006, as the "modified" Infinity kits are used for selected experiments in the freshman-level "Introduction to Electrical Engineering" at UTA, and in outreach activities to Arlington Independent School District.

Recommendations for Adopters

Major components used in the modifications include DSK daughter cards (for the 6711-DSK version) that are available from Texas Instruments ($100), wiring breadboard ($40 or less depending on the style), and power supplies ($50). (The latter 2 items are easily obtained from distributors such as Allied Electronics, Mouser, Digi-Key or Newark.) The modified Infinity kit "package" can be assembled in a hard-sided case such as a series 1500 Pelican case ($100). The new curriculum requires educational and/or research licenses to LabView and Matlab.

Sources of Additional Information

Supporting documents, providing detailed instructions for modification, and curriculum software are available from UTA. Use the contact information to inquire about those: by the time of presentation the URL to a dedicated website should be available.

Contact Information:
For further information, send email containing "modified Infinity kits" in the subject line, to Dr. Jonathan Bredow, at jbredow@uta.edu.

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