AC 2008-2337: RECRUITING AND MENTORING OF PRE-COLLEGE MINORITY STUDENTS FOR ELECTRICAL AND COMPUTER ENGINEERING PROGRAMS

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Recruiting and Mentoring of Pre-College Minority Students for Electrical and Computer Engineering Programs

Abstract

As the engineering market continues to grow, the need for diversity is becoming more apparent. The gap continues to widen for minority ethnic groups and women pursuing engineering as a career. This paper describes the efforts and results for actively recruiting minorities and women to an undergraduate electrical and computer engineering program at a Historically Black University. It also describes a series of activities aimed toward producing leaders for tomorrow in industry and academia. Such recruitment of women and minorities is critical to the country's efforts to increase the number of engineering professionals, and is a priority at many institutions.

Introduction

For decades, one of the top priorities for America's higher education leaders has been to raise the number of students enrolling in college [1,2,3]. The second priority has been to graduate students that are competent in their field of study. These priorities are of particular importance in the field of Engineering. The number of engineering degrees has declined during the past decade [4]. This decline, coupled with the continued globalization of our economic markets, bears serious implications for the economic development and prosperity of the nation. The national decline in engineering degrees has been greater for minorities. In a recent national study, only two of five minority students who enroll in engineering programs graduate with a baccalaureate degree in engineering, as compared to two of three non-minority students [5]. Another national study found that 54 percent of students entering four-year colleges in 1997 had a degree six years later, with an even lower percentage for Hispanics and Blacks [6]. To minimize the impact of this disturbing trend, a priority must be set to establish a strong academic foundation for students pursuing an education in the field of engineering.

One method that has proven successful at some schools in the recruitment of engineering students is the offering of engineering summer camps [7,8]. Within these camps, students are introduced to and work with Lego Robotics in addition to sharpening preparatory skills for science, technology, engineering, and math. The use of these programs create more opportunities to educate students about the fundamentals of engineering using innovative, fun and exciting projects.

Prairie View A&M University held the Electrical and Computer Engineering Leadership (ExCEL) Summer Program in June 2007 for sophomore, junior and senior high school students. The two-week program highlighted key areas of study necessary for academic success in the areas of Electrical and Computer Engineering, including math, physics, and English. The program also included opportunities for the development of pre-professional skills with the incorporation of LEGO laboratory exercises, company visits, engineering ethics and history sessions.

The ExCEL Program recruited most of the participating high school students from school districts within the state of Texas. Efforts were made to expand the recruitment to a national level; however, the results of the national recruitment efforts were minimal. One student attended from the state of Texas. A total of 20 students attended the program, with the majority of the students residing in the Houston, TX area.

Mission

The mission of the ExCEL Program is to increase student awareness and create an enthusiasm for math, science and technology in high school students by combining intense coursework with hands-on learning activities. The goals of the program include: *strengthening* academic abilities; *preparing* students for matriculation into the field of engineering; *providing* multicultural experiences and academic enrichment activities; *creating* awareness of contributions of scientists and inventors of under-represented groups; and *building* self-confidence and self-esteem within the program participants.

Program Schedule

The ExCEL Summer Program schedule was centered on life and test preparation skills, hands-on projects and engineering field trips, as shown in Figure 1. Also built into each week is a full, structured evening activity schedule designed to enhance the campus experience and allow students to meet new friends from all over the country who have similar academic and career interests.

	Time	Sun	Mon	Tues	Wed	Thurs	Fri	Sat
	8 - 8:50a		Breakfast	Breakfast	Breakfast	Breakfast	Breakfast	
Weeks 1 & 2	9 - 9:50a		Math and English Skills Test	Math	Invited Talk/Plant Visit Rm 117	Math	Math/ **Awards Ceremony Week2 10a – noon**	Field Trip to San Antonio (Meals sponsored by College of Engineering)
	10 - 10:50a			English		English	English	
	11 - 11:50a		History	History		History	History	
	12 - 12:50p		Lunch	Lunch	Lunch Sponsored by Industry	Lunch	Lunch	
	1 - 2:50p		Chem. Lab	Chem. Lab		Chem. Lab	Chem. Lab	
	3 - 3:50p	Check-In	Computer Appl. EE Bldg Rm 126	Computer Appl. EE Bldg Rm 126	Computer Appl. EE Bldg Rm 126	Computer Appl. EE Bldg Rm 126	Computer Appl. EE Bldg Rm 126	
	4 - 4:50	Dinner	Dinner	Dinner	Dinner	Dinner	Dinner	
	5 - 6:50p	Welcome & Engineering Profession Talk Rm 137	Design Project #1 using Lego Robotic kits EE Bldg Rm 119	Design Project #2 using Lego Robotic kits EE Bldg Rm 119	Design Project #3 using Lego Robotic kits EE Bldg rm 119	Design Project #4 using Lego Robotic kits EE Bldg Rm 119	Career Strategies & meeting with Engr. students EE Bldg Rm 117	

Figure 1. Schedule of student activities

Students were housed at University College with a full evening staff of current College of Engineering students to provide supervision and coordinate activities. Breakfast lunch, and dinner were provided in the Memorial Student Center.

Program Activities

Classroom. The ExCEL student participants attended intensive daily class sessions in math, English, science and social ethics, Monday through Friday of each program week. The courses were designed to prepare high school students for college in the areas of math, science, engineering and technology. The social ethics course was included to give the participants a sense of self-awareness, motivation, and achievement as well as expand their perspective on the world around them.

Professional Fieldtrips. The ExCEL Program provided students the opportunity to see the importance of the scientific principles and theories learned in the classroom with weekly professional fieldtrips. ExCEL students took tours, spoke with professional engineers, and view completed designs at the following facilities: METRO, Texas Department of Transportation, and TranSTAR.

Amusement Park Fieldtrip. The ExCEL program used a day-long trip to San Antonio Sea World as a means to incorporate fun into math and science and expand the students' perception of the world around them. Most of the participants had not had the opportunity to travel beyond Houston, TX. Additionally, many of the students did not have a true understanding of how engineering, science and technology impact the world around them.

San Antonio SeaWorld gave students the ability to explore the concepts of physics and how physics applies to real world situations. It also provided a clear picture of the practical use of computer and engineering principles throughout the park. Students were placed into teams and required to complete a scavenger hunt.

The SeaWorld Scavenger Hunt was designed to enable students to do the following:

1. Define velocity, acceleration, free fall and buoyancy.
2. Predict speeds of various animals in miles/hour.
3. Compare measurements of various activities, animals and park rides.
4. Observe and analyze data collected during animal shows.
5. Share their learning experiences with other team members.
6. Demonstrate the basic principles of research and teamwork.

The following are samples of the activities included in the scavenger hunt:

1. **Free Fall**
    a. *The Great White Roller Coaster*
    Ride the Great White and pay special attention to the zero-g roll that follows the first and tallest vertical loop.
        1. Note your sensations going over the large hilltop. Do you feel heavy or light?
        2. How long do you feel this way?
        3. Draw the shape of the hill as seen from the side.
    b. *The Shamu/The White Whales and Dolphins shows*
        1. Which marine animal has the greatest speed?
        2. What aspect of the show would tell you this?
        3. At what angle does a marine animal have to jump at in order to be out of the water for a long period of time?
        4. Compare your experience of the Great White Roller Coaster to that of the jump of the dolphin. What are the similarities?
2. **Buoyancy**
    a. *Shamu Show*
    Sketch a killer whale in its "rest" position. Determine if they are floaters, sinkers, or neutral. If they are floaters, indicate by sketch how much of the animal is above the surface. If you are uncertain, make your best guess based upon your other observations.
    b. *Rio Loco and/or Texas Splashdown*
    Sketch the "boats: for either or both of the rides, and show on your sketch how much is above the surface, then estimate what percent is above the surface. How much does the boat sink down when people step in?
3. **Velocity/Acceleration**
    a. *Steel Eel*
        1. At what point on the ride is there the most acceleration? Why is this?
        2. At what point on the ride is there the least acceleration? Why is this?
        3. On what point of the ride do you feel you are going the fastest?
        4. On what point of the ride do you feel you are going the slowest?
        5. What do you notice about the relationship between velocity and acceleration?
        6. Sketch the ride and indicate these different points on the ride.
    b. *The Shamu/The White Whales and Dolphins shows*
        1. Which animal has the greatest acceleration?
        2. Which animal that maintains a constant velocity (zero acceleration) for the longest time?
        3. Which animal changes its velocity the most?

Design Project. The technology for video game consoles and LEGO robotics were combined to create an interesting and positive environment for student learning. Fueled by students' attraction to the video game industry and the popularity of the Nintendo Wii, the ExCEL program challenged students to design and implement the WiigoBot.

The LEGO Robotics project involved the design and implementation of the WiigoBot. The WiigoBot is an NXT Lego Mindstorms Robot designed to play Wii Bowling. The Wii remote was mounted on a robotically controlled swing. A second motor was used to trigger the bowling, by first pressing the A button and left arrow, and then holding down the B button, swinging, and finally releasing the B button. The design challenge served as a demonstration tool for student engagement in computer engineering. The application was tied to electrical and computer engineering tasks and functions. See Figures 2 and 3 for illustration of the WiigoBot.

Figure 2

Figure 3

Award Presentation. ExCEL students were given the opportunity to showcase their achievements during the two-week program to family and friends during the Awards Presentation. Awards were given to outstanding males and females in the following categories: math, English, science, social ethics, and Lego Robotics Design.

Program Participants

Nine Females and Eleven Males comprised the ExCEL Program participants.

- 7 students were 14-15 years old; 6 of the students were 16 years old;7 were 17 years old
- 17 students identified themselves as African-American,3 as Hispanic
- 7 students were seniors
- 7 of 7 students that are seniors are planning to attend Prairie View A&M University
- 10 students are going to be studying Algebra this year;2 students are in Algebra II; 2 of the students is taking Trigonometry;3 of the students are taking Pre-Calculus;2 of the students are in Calculus;1 student is in Geometry

- 11 of the students are in Chemistry this year;2 of the students are in Biology; 4 of the students are in Physics; 1 of the students is in College Chemistry;1of the students is in IPC; 1 of the students is complete with all of their Sciences
- 9 of 20 students have participated in a previous Summer Program before
- 20 of 20 students attend a public school.

Program Survey Outcomes

ExCEL student participants were asked to complete the ExCEL Program Survey at the completion of the two-week program. The surveys where designed to gather the following information from the students:

1. Why do I want to major in Engineering?
2. How confident am I in the following subjects (Science, Mathematics, Writing, Speaking, and Computer Skills)?
3. Do I enjoy the subjects of science and mathematics the most?
4. Are engineers innovative?
5. Do the advantages of studying engineering outweigh the disadvantages?

The following is a compilation of the survey results.

Outcome 1: Why do I want to major in Engineering?
17 of the 20 students plan on majoring in Engineering in college. The remaining 3 are still undecided on their major but has Engineering in their top 3 choices of studies. The students offered a number of reasons for their decision of Engineering.

- My parent(s) are making me study engineering
- They are studying Engineering because of the chance of making a lot of money
- They enjoy the subjects science and mathematics
- Engineering offers a host of well paid careers
- Engineering allows you to put your creativity to the test every day
- Because engineering is an international activity, professional engineers often have the opportunity to travel abroad
- There is ample opportunity for rapid advancement to the top jobs for those with the ability, ambition and drive to succeed

Outcome 2: What are the students' perceptions of ExCEL?
In general, the students were extremely positive when talking about the summer program. There were several words used to describe their experience of participating in the ExCEL program. Some of the comments are listed below.

> "Thanks for the opportunity……."; "I plan on coming to Prairie View after my 12th grade year because of ExCEL. I want to come back next year" " I enjoyed almost every moment in this program!"; "The counselors are very inspirational and very positive role models."

Outcome 3: How Confident are the student in the following subjects or skills?
This question was broken down into 4 different sections (Mathematics, Writing, Speaking and Computer Skills), and each student filled in the circle that corresponded to how confident they feel in the subjects (Not Strongly Confident, Not Confident, Neutral, Confident, and Strongly Confident). A majority of the students felt confident in the math and speaking skills, however computing and writing was mainly neutral.

Outcome 4: Positive Features of the Program
The one overwhelmingly positive attribute mentioned by participants was the practice of engineering ethics.

Other positives include:

- **Program Counselors**
  Spending nearly every minute of every day with the students certainly enhances skills in working with others. While these working relationships are established, other traits are also being fostered in the camp setting, such as patience, tenacity, the ability to stick with a job, and being a dedicated employee.

- **Housing**
  Fully furnished apartment homes, own personal space, social lounge on each floor, student recreational center and a place away from home were rated high for housing and location.

Outcome 5: Room for Improvement:
Reach out to more schools in the greater Houston area, across Texas and the surrounding states. By doing this it will make the program more interesting because the students will be force to adjust and get to know each other than remaining in a comfortable and familiar environment.

Conclusion

This paper described the efforts and results of a summer camp for actively recruiting minorities and women students to the Prairie View A&M University undergraduate electrical and computer engineering program. We also described a series of activities aimed toward producing leaders for tomorrow in industry and academia. Within these camps, students were introduced to and worked with Lego Robotics in addition to preparatory skills for science, technology, engineering, and math. Such recruitment of women and minorities is critical to the country's efforts to increase the number of engineering professionals, and is a priority at many institutions. The use of these programs introduces more opportunities to educate students about the fundamentals of engineering using innovative, fun and exciting projects.

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