
AC 2012-3244: SUMMER ENRICHMENT WORKSHOPS FOR PROMOTING ENGINEERING EDUCATION

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Summer Enrichment Workshops for Promoting Engineering Education

Abstract

The paper describes the two summer enrichment workshops that were conducted during in the last two years. The workshops provided high school and middle school students with a realistic and engaging introduction to engineering. The participants had the opportunity to 1) learn about engineering fields through hands-on problem-solving experiences; 2) experience the engineering design process using a software program and applying mathematics and science principles; 3) engage in teamwork activities that integrate software and hardware knowledge to build and program Lego robots; 4) Participate in a field trip and talk to engineers on the job; and 5) Engage in a question and answer panel session where professional engineers describe their experiences and expectations of new hires. The papers will present statistics and evaluation results of the two workshops.

Keywords: Engineering, Enrichment, Higher Education, Minorities

Introduction

The summer enrichment program offers high school and middle school students the opportunity to participate in hands-on science, technology, engineering, and mathematics activities delivered by university faculty and engineering professionals. This program was funded by the Texas Higher Education Coordinating Board (THECB) to increase recruitment and graduation of Hispanic and other underrepresented minorities in engineering. It is believed exposing young students to engineering concepts, opportunities, and career prospects, would enhance their interest in engineering education, and influence them to choose programs in engineering after graduation from high school. Other aspects for this profession were also addressed. Among them were familiarity with the laboratory instruments and equipment and the importance of writing and presentation skills. Engineering laboratory experience plays an important role in determining the future of engineers. This role is emphasized greatly in the discipline and activities embedded in the program [1].

Commitment of professionals to fostering sustainable program development is crucial for institutions of higher learning. The focus should be given to engineering, compared to other subjects such as mathematics and physics, because the activities that implement scientific advance are rooted in engineering. However, better foundation of these two subjects is a part of engineering education. Even if there is a technical option, it can be made safe for courageous students to take educational paths different from traditional tracks to become engineering professionals [2].

There is a need to provide value-added for the engineering curriculum beyond classroom instruction and laboratory activities. However, relevant and effective teaching is still critical for those who aspire to be engineers. Research and teaching functions are often balanced to provide a right recipe for optimum benefit to the clientele who target this population. It is believed that universities need to recognize that they are in a competition with the rest of the world and preparation and exposure of adequate innovation to young students are done accordingly [3]. Keeping these ideas in mind, activities for this program were designed and implemented.

Program Synopsis

This paper outlines a program that was held at Texas A&M International University (TAMIU) on July 18-22, 2011 and is similar to a program held in 2010 [4]. Creating a program website, program brochures, application materials, and conducting visits to middle and high schools in the area were used to recruit students. The application form requires basis contact and school information and a 200-300 word essay addressing future career and academic interest.

This program featured team competitions, project presentations, field trips, industry site visits, and panel discussions with professional engineers and scientists, information for the parent/guardian that covers Texas university application process, financial aid system, and scholarship opportunities. The program sessions and activities were scheduled on Monday thru Friday from 8:00 am to 5:00 pm. Award of certifications were presented on the last day, Friday, July 22, 2011. As for the subject matter in the profession, two sessions accomplished a very important portion of the program. One was on “Engineering design projects using AutoCAD” and the other was “Lego robot session” followed by “Lego robot competition for the participants”. Winners of the competition were recognized.

Program planning included first, seeking adequate collaboration from local schools, United Independent School District (UISD), Laredo Independent School District (LISD), and other area educational academies. A website was developed to provide details about the program, including application material. A brochure/filer was created and distributed to high schools and middles within UISD, LISD, and the Early College High School (ECHS). Every middle and high school in the area was mailed a package containing 25 applications. Two high schools that have engineering magnet programs were visited (United High School and Cigarroa High School) to recruit students. Selection of program participants was based on the information provided in the Uniform Student Application.

A selection committee comprised of both PI (engineering) and Co-PI (mathematics), a faculty from biology and another from psychology who developed the selection criteria reviewed and evaluated all applications received by the deadline. Goals of the program were to encourage students to enter into engineering fields by exposing them into engineering programs and careers, thereafter, develop middle and high school students' analytical skills, and help them prepare for college admission with availability of scholarships and financial aids information.

Program Activities

The content and activities of the two summer workshops had many features as shown in Table 1. In order to emphasize teamwork efforts a Lego Robots activity was planned and covered in two sessions. Students were given the opportunity to design and build their own robots and participate in a competition. All participants were assigned a project and prepared to deliver final presentation of their project in order to develop presentation skill necessary in the discipline. Competitions and oral presentation skills were elaborated in these forums. An industry site visit was planned. Participants visited a local 45 MDG water treatment plant operated by the City of Laredo Water Utilities Department. To emphasize the importance of this item unique to this profession, a panel discussion, What Engineers Do, was organized by a group of six professional

engineers. A session was devoted to cover the Texas university application process, financial aid systems, and scholarship opportunities for the participants and parent/guardian. Other items covered by the sessions were: mathematics, physics, and engineering sessions to provide the basic foundations for engineering education. Throughout this week-long program, participants prepared for the final project presented on Friday, July 22, 2011 in the afternoon. The program concluded by the participants receiving a certificate of completion for 36 hours of enrichment, completing a feedback survey, and posing for a group picture.

Table 1: Program schedule

Monday, July 18, 2011		
8:00 am - 8:30 am: Registration and welcome		
8:30 am - 9:00 am: Pre-test		
	9:00 am – 12:30 pm	1:30 pm – 5:00 pm
Monday 7/18/11	Role of physics in engineering education	Role of mathematics in engineering education
Tuesday 7/19/11	Foundations of engineering	<u>1:30 am – 3:30 pm:</u> Texas university application process, financial aid system, and scholarship opportunities. Parent/guardian are invited to attend. (Representatives from the Office of Admissions and the Office of Financial Aid) <u>3:30 pm – 5:00 pm:</u> Panel discussion: What engineers do
Wednesday 7/20/11	Engineering design projects using AutoCAD	Industry site visit
Thursday 7/21/11	Lego robot session	Lego robot competition
Friday 7/22/11	Work on engineering design project	Conclusion: <ul style="list-style-type: none"> • Post-test • Award of certificates • Completing feedback form • Project presentation

Data and Analysis

More than 500 high and middle school students were made aware of the program. Eighty seven (87) applications were received by the deadline and another 12 late applications received. Twenty-three local middle school and high school students participated in the TAMU Engineering Summer Program (ESP) in 2011. All of the students who attended ESP are Hispanics. All participants showed a substantial improvement at the conclusion of the week-long program as was evident from the posttest scores. Participants successfully attended and

completed all program sessions and activities related to engineering. Breakdowns based on gender, ethnicity, and high and middle schools are in Table 2.

Table 2: Participant breakdown in terms of high/middle schools and gender

High School (Male)	Middle School (Male)	High School (Female)	Middle School (Female)
5	7	3	8
Total male: 12		Total female: 11	

Pretest/posttest comparison has been done for 21 participants as depicted in Figure 1. Two participants were unable to take the posttest due their involvements in other campus summer activities.

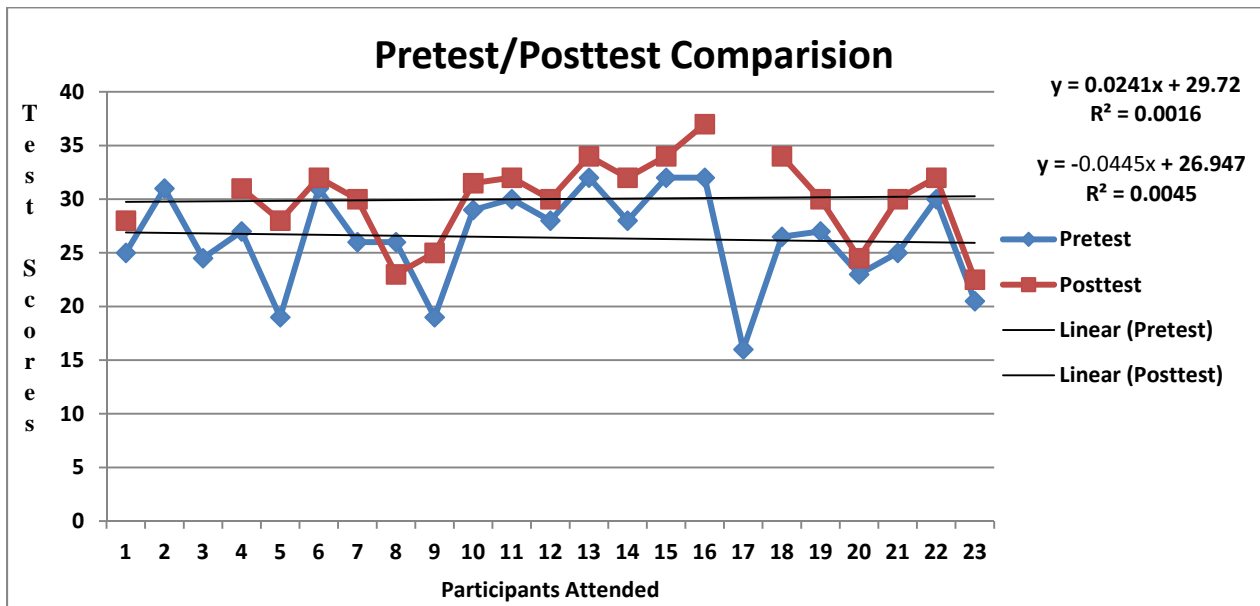


Figure 1: Pretest/posttest comparison for the participants

Analyses from the end-of-program survey [5] consisted of aggregates of responses received to parts 1 and II of the questionnaires supplied by THECB as provided in Figures 2 and 3.

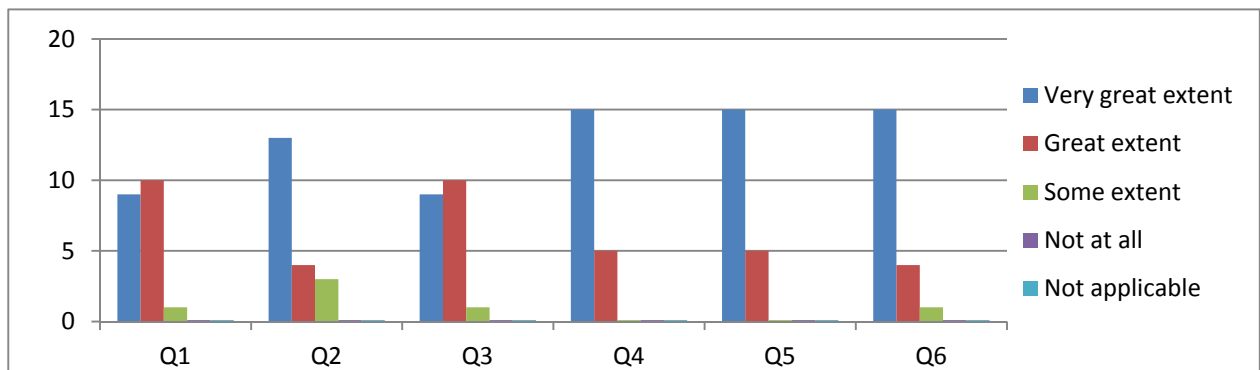


Figure 2: Analysis from the end-of-program survey (part I)

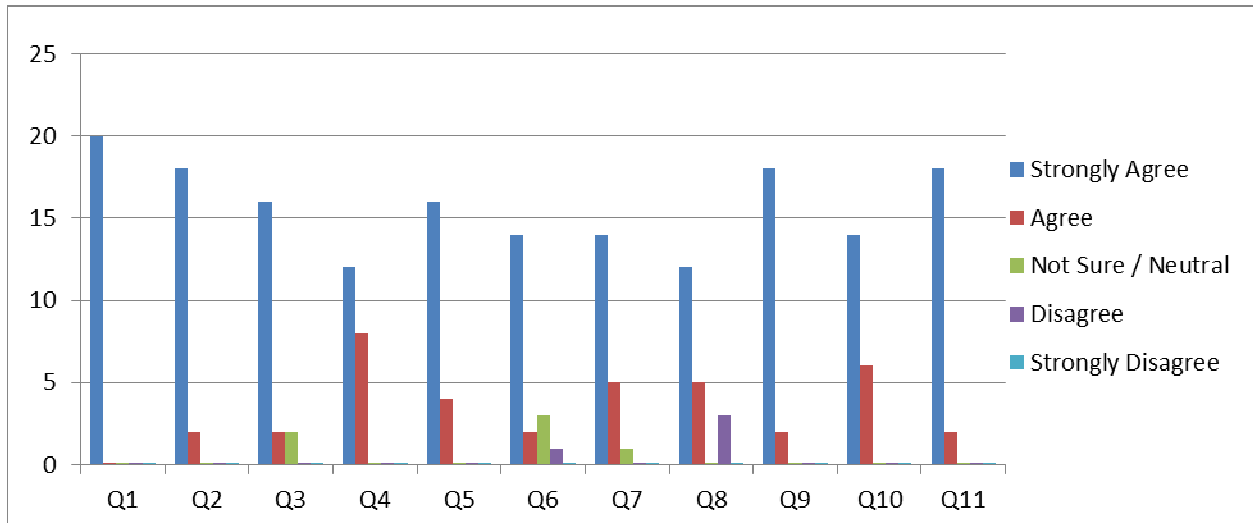


Figure 3: Analysis from the end-of-program survey (part II)

Conclusions

During these week-long programs, participants and their parents expressed their satisfaction of the planned activities. All indications are that the program objectives were achieved beyond expectation. Some participants stated either they will seek engineering degrees at TAMIU or elsewhere. In doing so, some students planned to enroll in the courses in Fall 2012 or Fall 2013. Among the remaining participants, the majority expressed that they would seek admission at TAMU's engineering programs at a later time. Data from the posttest and pretest analysis shows that students' knowledge of skills in the areas of engineering, mathematics, and physics improved. All participants engaged in and learned from planned sessions and activities. Throughout the program, participants expressed their excitement and appreciation for the organizers.

This summer engineering program alone does not solve all problems; it only provides a place where other educators, college administrators, and state legislatures can think about restructuring, planning, and creating a practical approach to remedy the situation. It also provides a glimpse of the reality we all are experiencing when promoting engineering education to meet the increasing demands of the today's society.

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References

- [1] Lyle D. Feisel and Albert J. Rosa, (2005) “The Role of the Laboratory in Undergraduate Engineering Education”, Journal of Engineering Education, pp. 121-130.
- [2] Nicholas A. Ashford, (2004) "Major challenges to engineering education for sustainable development: What has to change to make it creative, effective, and acceptable to the established disciplines?" International Journal of Sustainability in Higher Education, Vol. 5 Issue: 3, pp.239 – 250.
- [3] Kent M. Black, (1993) “An Industry View of Engineering Education”, Rockwell International Corporation Presented as a plenary address, ASEE Centennial Conference
- [4] Rohitha Goonatilake and Rafic A. Bachnak, (2011) “Promoting Engineering Education among High School and Middle School Students”, Journal of STEM Education: Innovations and Research.
- [5] The 2010 and 2011 ESP Website: <http://www.tamtu.edu/~rbachnak/THECB-ESP/ESP.html>