Attracting Underrepresented Students for Careers in Science and Engineering

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Abstract

Texas A&M - Corpus Christi recently implemented a new program geared toward local area high school students. Its efforts in encouraging juniors to participate in a two-week summer workshop and a follow-up science and technology exhibit promises to improve the recruitment of underrepresented students. Several faculty members, students, professional organizations, and manufacturing and processing industries are involved in the delivery of the program. The workshops are designed to introduce students to college life, involve them in hands-on activities, and encourage them to pursue math, science or engineering careers. Our goal is to make the activities of this project an integral part of the recruiting and training efforts and expand them to reach a larger geographical area and a higher number of underrepresented students. This paper will describe the program and present the results of the summer 2004 workshops.

Introduction

The current US workforce is comprised of 77% White, 4% Asian, and 19% Minority. According to the Bureau of Labor Statistics and the National Science Foundation, however, among engineering professionals, 88% are White, 6% are Asian, and only 6% are minority [1]. To improve minority representation in engineering and engineering technology programs, institutions of higher education have used a number of approaches, such as the increase of visibility of the engineering profession, mentoring students, and academic support [2]. Strategies to recruit and retain students include hands-on approaches [3, 4], field trips [5, 6], summer workshops [7], and software training programs [8].

This paper discusses a project that uses all these methods to attract underrepresented students to science and engineering as well as the 2004 summer program summary. The summer program includes presentations at high schools, invited speakers, field trips, hands-on laboratory activities, and science and technology exhibits[1] [9]. Specifically, the program involves attracting 11th grade students to attend a two-week Science and Technology workshop. At this level, students are ready to make decisions that affect them for the rest of their lives; selecting the college they wish to attend and choosing the

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field of study they wish to pursue. It is anticipated that this innovative approach, focusing on the 11th grade, can serve as a model for other Hispanic-Serving Institutions and for future national efforts.

The workshop is designed to introduce students to job opportunities in the food industry and agriculture, expose them to college life, involve them in hands-on activities, and encourage them to pursue science and engineering careers. One of our goals is to make the activities undertaken by this project an integral part of the recruiting and training efforts and expand them to reach a larger geographical area and a higher number of underrepresented students.

After the completion of the summer workshops, students are recruited to participate in a follow-up Science and Technology Exhibit, conducted during National Engineer's Week in February of each year. This exhibit consists of high school students of all levels creating unique LEGO® inventions using the LEGO® MINDSTORMS™ kits provided by the CSREES-USDA grant.

The entire project involves collaboration between A&M-CC, local high schools, local and regional professionals and industries, and local and regional institutions of higher education. Volunteers from the food, agricultural, and other industries are instrumental in identifying applications for training materials, organizing plant tours, mentoring students, serving as guest speakers, and implementing the Science and Technology Exhibit. Collaborators include major food processors, refineries, and manufacturing plants. The rest of this paper will show the importance of technology in advancing the food industry, describe the summer 2004 workshops, and present evaluation results.

Technology and the Food Industry

The food industry has made great strides in using technologically sophisticated equipment. Technology has resulted, among other things, in greater diversity of food products and a more competitive domestic food industry with more export opportunities. It is imperative, however, that the supply of technically competent professionals be increased so that U.S. manufacturing plants remain competitive in the current world environment. Technicians, technologists, and engineers play an important role in employing and using technology. They are responsible for the design, testing, maintenance, and operation of various machines and systems such as conveyers, compressors, generators, microcontrollers, programmable logic controllers, microcomputers, processing equipment, inspection stations, freezers, grain processors, automatic feeding systems, global positioning systems, irrigation control, and packaging equipment. They also support and contribute to the quality, utilization, and safety of food products, including the development of quality control techniques, advanced processes, and packaging methods.

Institutions of higher education have recognized the important role of technology. At Purdue University, for example, the Agricultural and Biological Engineering Department introduced an Instrumentation and Data Acquisition course in 1998 [10]. Another course

based on the 68HC11 microcontroller to teach industrial monitoring and control applications was developed in 1997 in the Agricultural and Biological Engineering Department at the University of Georgia [11].

Summer 2004 Workshops

High school students were made aware of the program via brochures, advertisement on the program web site [9], and presentations offered at local and regional high schools. Evaluation criteria included factors such as underrepresented status, income level, and parents' education level. Students were chosen based on the applications they submitted, with priority given to students from low-income and first-generation college-students. Two workshops were conducted in summer 2004. Table 1 shows Workshop I schedule.

Table 1 (a) Workshop I - Week One Schedule

	9 to 12	12 to 1	1 to 4	4 to 5
Mon 5/31	*Memorial Day*			
Tue 6/1	Registration, welcome, and tours of library and UC	Lunch	TI 83PLUS Activities	
Wed 6/2	Communication Skills Activities	Lunch	Field Trip: Flint Hills Resources	
Thu 6/3	Mechanical Design Activities	Lunch	Field Trip: Texas Agricultural Extension Service-Shrimp Farm	
Fri 6/4	Mission Gulf of Mexico	Lunch	Mission Gulf of Mexico (cont.)	

Table 1 (b) Workshop I - Week Two Schedule

	9 to 12	12 to 1	1 to 4	4 to 5
Mon 6/7	The Canvas	Lunch	Tour of University Labs/Facilities	
Tue 6/8	LabVIEW Programming Activities	Lunch	Field Trip: San Patricio Municipal Water District: Water Treatment Plant	
Wed 6/9	Precision Agriculture using GPS/GIS	Lunch	Chemistry Activities	Work on presentations
Thu 6/10	Field Trip: Southwest Research Institute			
Fri 6/11	Finalize presentations Presentations by students	Lunch	Presentations, Guest speaker, Presentation of certificates	

A graduate student assistant helped the directors with many tasks, including conducting some of the sessions. Two undergraduate students helped with a variety of tasks such as monitoring students, collecting evaluation forms, and assisting participants as needed. Workshop participants received a free TI-83 Plus graphing calculator, teaching supplies, a per diem for lunch at the University Center Food Court, and a stipend of $300.00. At the end of the workshop, each participant received a certificate of completion. A few select students were also recognized for their exemplary achievements and/or contributions towards the workshops activities.

Workshop I Evaluation

Workshop participants evaluated all activities, including field trips. Workshop I started with 20 students. Four students cancelled at the last minute, 16 students attended both weeks and 16 successfully completed the workshop. Two different evaluation forms were used. The form shown in Fig. 1 was used to evaluate the field trips. Results of question 4 are shown in Figure 2.

FUSE - Summer 2004
FIELD TRIP EVALUATION FORM

Field Trip to:_____
Date: _____

1. The most important thing I learned from participating in this field trip was:_____
   _____
2. This field trip can be improved if_____
3. Did this field trip increase your understanding of the operations, equipment, and facilities of industrial facilities?
   ___YES ___NO
4. Overall, this tour was ___Excellent ___Good ___Fair ___Poor
5. Other comments. _____

Fig. 1 Field Trip Evaluation Form

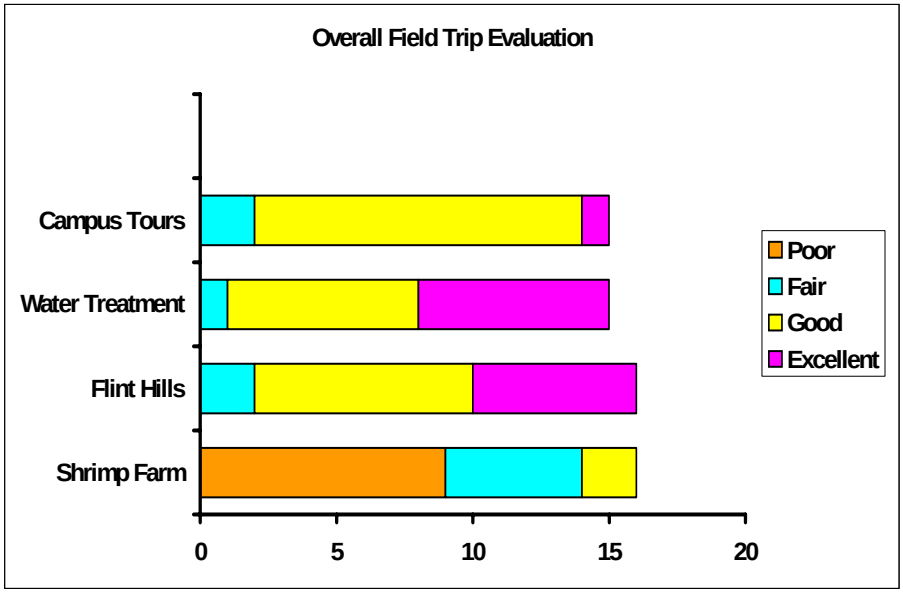

Fig. 2 Rating Field trips

The Southwest Research Institute (SWRI) trip, located in San Antonio, about 2 hours and 20 minutes from A&M-CC, received the highest score last summer. Unfortunately, the data for this trip was misplaced. Activities during this trip included having lunch in the center cafeteria and touring the Robotics Laboratory, Machine Vision & Inspection Division, Engine-Dynamometer Lubricant Testing Facility, and Mileage Accumulation Dynamometer Facility. Results of questions 3 and 4 are shown together in Fig. 3. Activities other than field trips were evaluated using the form shown in Fig. 4.

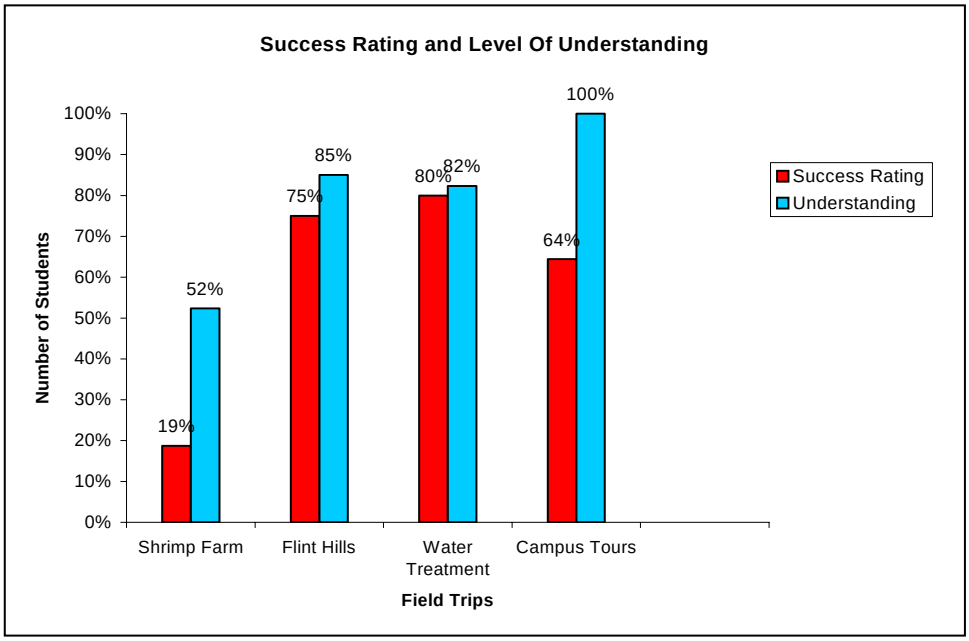

Fig. 3 Evaluation of Field Trips (Questions 3 and 4)

FUSE - Summer 2004
ACTIVITY EVALUATION FORM

Activity Title _____
Presenter _____
Date/Time _____

Please rate this activity according to the scale
(5 = Strongly Agree 4 = Agree 3 = Neutral 2 = Disagree 1 = Strongly Disagree)

____ This presentation added to my understanding of science and/or technology
____ The presentation was new to me, I have never seen anything like it before
____ This presentation was exciting
____ The presenter was encouraging and made me feel comfortable about learning
____ Overall I enjoyed this activity

Other comments:

Fig. 4 Activity Evaluation Form

Table 2 summarizes the evaluation results. A score of 100% represents a rating of 5 (strongly agree) by all students and a score of 0% represents a rating of 1 (strongly disagree) by all students. Both the Mechanical and LabVIEW activities were rated an impressive 94% and 95% respectively. The score the chemistry session received was surprising since this session only involved demonstrations and no hands-on activities by students.

Table 2 Workshop I Summary of Activity Evaluation

Activity	Understanding (%)	New (%)	Exciting (%)	Encouraging (%)	Enjoying (%)	Avg (%)
GIS Activities	72	73	62	62	68	67
Library Tour	52	48	70	78	90	68
Communication Skills	74	56	66	78	82	71
Mission Gulf of Mexico	75	67	75	72	78	73
Calculator Activities	73	62	63	92	80	74
Chemistry	92	79	88	87	88	87
Mechanical	88	94	94	94	98	94
LabVIEW	95	92	95	100	93	95

Three activities received a score of 80% or above on the first question, "This presentation added to my understanding of science and/or technology." Also, three activities received an average of 80% or above. These activities are graphed for comparison in Fig. 5. Activities that received an average score of less than 80% are illustrated in Fig. 6.

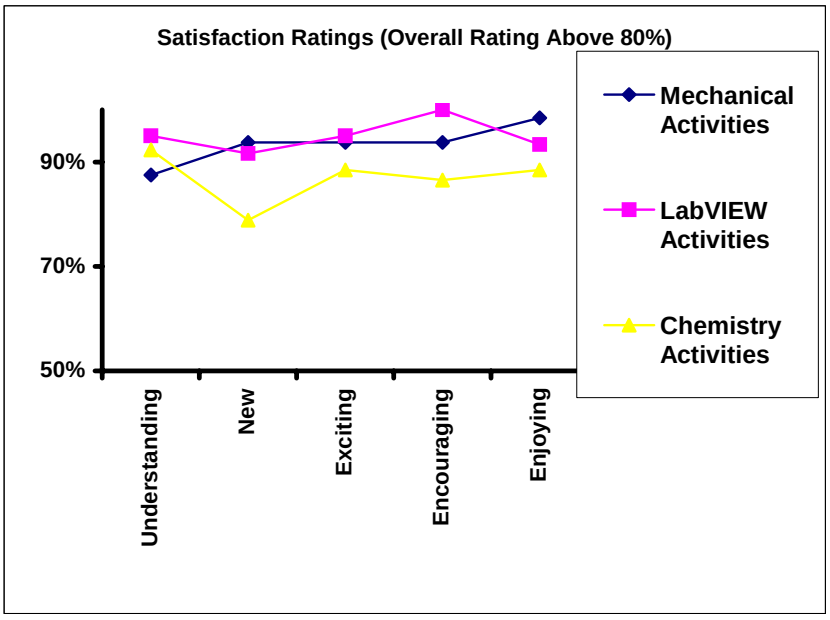

Fig. 5 Activities with an average score of 80% or above

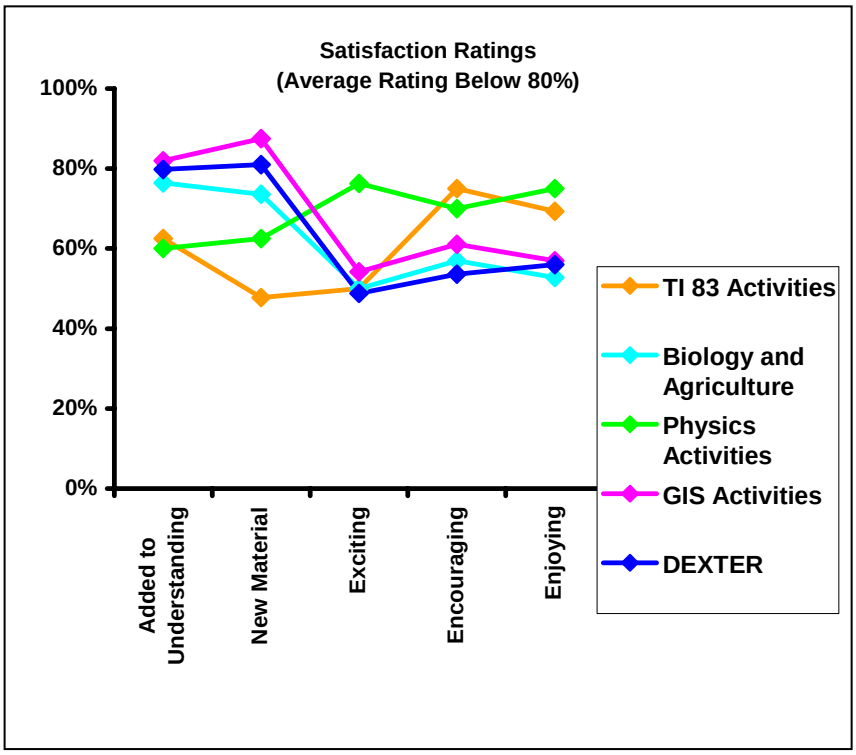

Fig. 6 Satisfaction Rating Below 80% above

Workshop II

This workshop started with 18 students on the first day but two cancelled at the last minute. One student joined in on the second day, and two began during the second week. 19 students successfully completed this workshop.

Table 3 (a) Workshop II - Week One Schedule

	9 to 12	12 to 1	1 to 4	4 to 5
Mon, 6/14	Registration, welcome, and tours of library and UC	Lunch	TI 83PLUS Activities	
Tue, 6/15	Communication Skills Activities	Lunch	Field Trip: Horton Automatics	
Wed, 6/16	LabVIEW Programming Activities	Lunch	The Canvas	
Thu, 6/17	Mechanical Design Activities	Lunch	Field Trip: Texas Agricultural Extension Service-Shrimp Farm	
Fri, 6/18	Mission Gulf of Mexico	Lunch	Mission Gulf of Mexico (cont.)	

Table 3 (b) Workshop II - Week Two Schedule

	9 to 12	12 to 1	1 to 4	4 to 5
Mon, 6/21	Tour of University Facilities	Lunch	Precision Agriculture using GPS/GIS	DEXTER software
Tue, 6/22	Hands on Physics	Lunch	Field Trip: San Pat Municipal Water District-Water Treatment Plant	
Wed, 6/23	Lego Robots Activities	Lunch	Chemistry Activities	Work on Presentation
Thu, 6/24	Field Trip: Southwest Research Institute			
Fri, 6/25	Finalize presentations Presentations by students	Lunch	Presentations, Guest speaker, Presentation of certificates	

Workshop II Evaluation

Workshop II was evaluated using the same forms as Workshop I. Results of question 4 are shown in Figure 7.

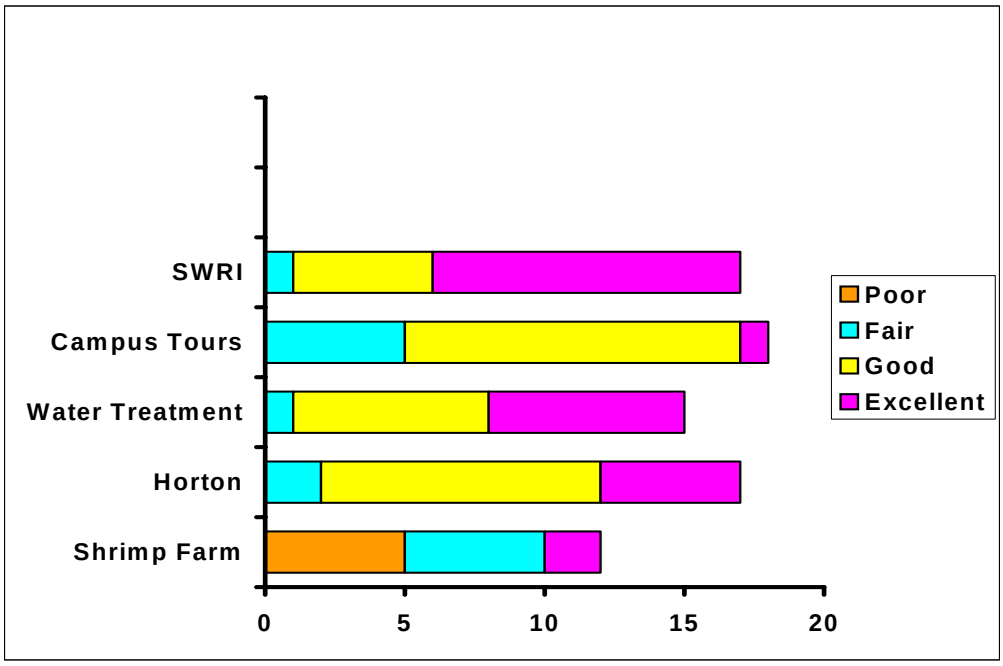

Fig. 7 Rating Field trips

Results of questions 3 and 4 are shown together in Fig. 8. This time, all five field trips received a high score on "increase your understanding of the operation, equipment, and facilities of industrial facilities" with two trips, Horton and SWRI receiving a perfect score of 100%. Horton is a manufacturing plant that designs and manufactures automatic doors and windows where students had a chance to walk through the plant and observe workers in a variety of areas.

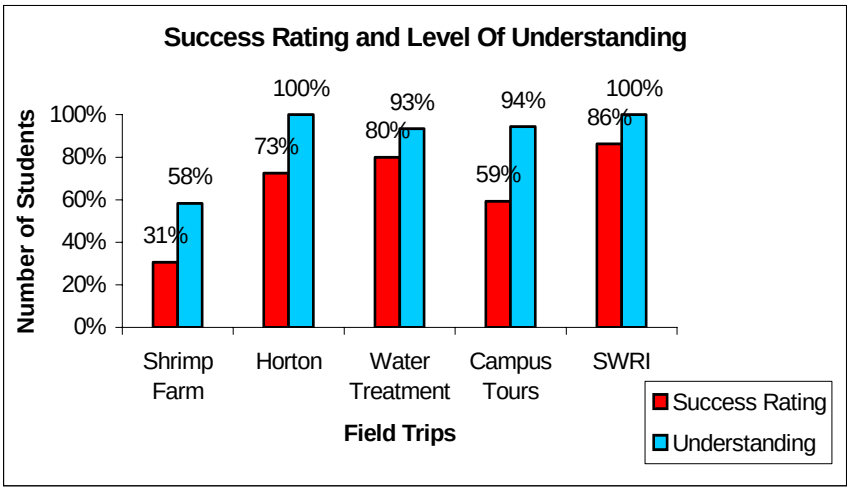

Fig. 8 Field Trip Evaluation (Questions 3 and 4)

Table 4 summarizes the results. The table shows some unexpected results. While the Mechanical Activities maintains high average score (95%), the LabVIEW session rated at 89%. Another interesting result is the TI 83 Calculator session received 64% in Workshop II compared to an average score of 74% in Workshop I. The communications session also dropped from a 71% in Workshop 1 to a 65% for the second workshop.

Table 4 Workshop II Summary of Activity Evaluation

Activity	Understanding (%)	New (%)	Exciting (%)	Encouraging (%)	Enjoying (%)	Avg (%)
Dexter	60	71	46	54	49	56
Physics	68	56	56	67	65	62
Viscosity	65	65	54	71	58	63
Calculator Activities	66	44	55	83	72	64
Communication Skills	65	57	62	71	68	65
GIS	74	74	69	72	78	73
Canvas	81	79	72	79	75	77
Mission Gulf of Mexico	82	78	70	80	78	77
LabVIEW	91	86	83	97	88	89
Lego	95	92	95	87	93	92
Mechanical	95	92	98	97	98	95

Five of the 11 activities received a score of 80% or above on the first question, "This presentation added to my understanding of science and/or technology." Three activities ranked above 80% overall. These activities are graphed for comparison in Fig. 9. The rest of the activities received an average of less than 80%. These activities are illustrated in Fig. 10.

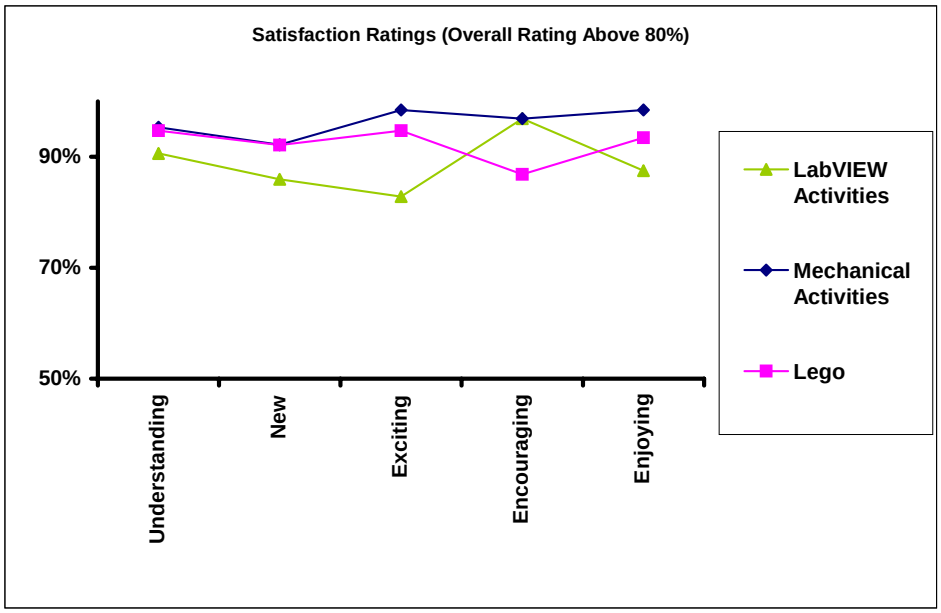

Fig. 9 Activities with an average score of 80% or above

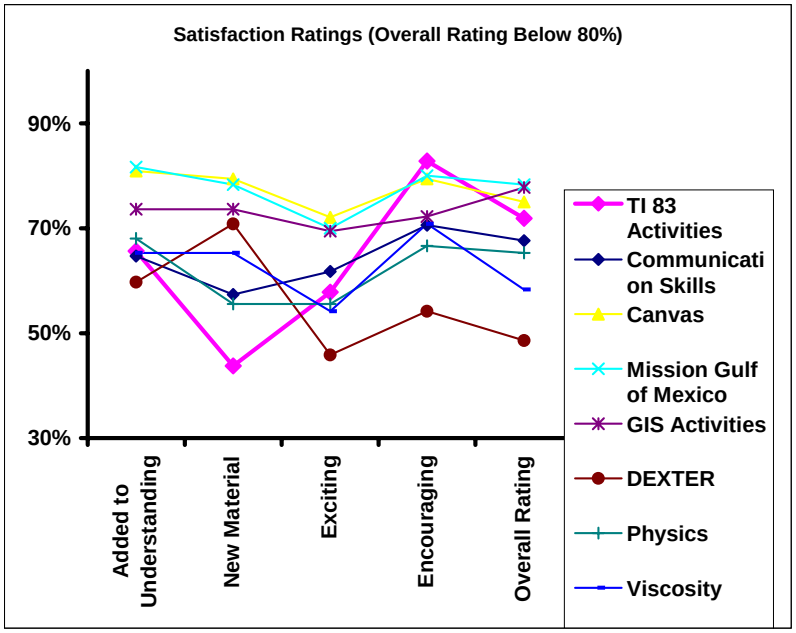

Fig. 10 Activities with an average score of 80% or above

Conclusion

This paper described a program for attracting and recruiting underrepresented students. The program consists of summer workshops and a follow-up science and technology exhibit. Activities include field trips, hands-on experimentation, written and oral communications, and invited speakers. A total of 35 students participated in summer 2004 workshops. Each workshop included five field trips to local and regional industries and eight or more different sessions. Four activities out of 13 received a score of 80% or above as "This presentation added to my understanding of science and/or technology." The science and technology exhibit will give students the opportunity to demonstrate the skills and knowledge that they have acquired both through the workshops and their education.

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