EVALUATING THE SUCCESS OF AN UNDERREPRESENTED MINORITY SUMMER RECRUITMENT PROGRAM FOR RISING JUNIORS AND SENIORS

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Abstract - The Office of Minority Engineering Programs in the College of Engineering and Applied Sciences at Arizona State University (ASU) has created a pathway for the recruitment of underrepresented minority students. The ASU Mathematics Engineering Science Achievement Program works with over 600 underrepresented and low-income students in twenty-two schools. Through this academic program, students are introduced to and encouraged to consider engineering and related careers as they transition from elementary to junior high to high school to college. As a part of this pathway, for the past four summers, the GTE Foundation has sponsored a one-week engineering residential summer program for rising junior and senior high school students. The objective of the GTE Engineering Summer Institute is to expose students to skills that would assist them in investigating and in pursuing engineering and/or technology as an academic major and career option and to instill the importance of mathematics and science as tools for future careers, especially in the high tech industries. Computer Science and Computer Systems Engineering are presented and used as an avenue to explore the other engineering disciplines. Due to student demand, the program has grown from five days to seven. The curriculum has evolved from doing several projects during the program to one major engineering team design project that includes web page documentation. A pre-program survey on computer skills is used to place the students in teams. A post-program survey is used to evaluate the effectiveness of the program. The results of this successful program will be discussed (including numbers of students who have transitioned into college and enrolled in engineering) as well as the lessons learned in the evolution of the program.

INTRODUCTION

Arizona State University (ASU) is the nation's fourth largest university with over 44,000 students on its main campus. ASU is striving to serve as a model for the metropolitan research university for the next century according to the vision of its President, Lattie Coor. This "metropolitanism" is very visible in the College of Engineering and Applied Sciences (CEAS). The CEAS, which includes Engineering, Computer Science, and the Del E. Web School of Construction, is diverse with underrepresented minority students comprising 16.2\% and women comprising 20.7\% of the undergraduate CEAS student body [1]. The college actively partners with global industries, many of them located in its own backyard. As a state university, ASU has a high acceptance rate (over 80\%) of undergraduate applicants. In addition, approximately 80\% of the students are commuters.

ASU is an active participant of the High Technology Industry - School to Work Partnership (HTI-STWP) sponsored by the Governor's Strategic Partnership for Economic Development (GSPED) and directed by the Arizona Department of Commerce. Members of the public and private Governor's Council for Workforce Development Policy are in active partnership to develop a comprehensive plan to address the state's current and future high tech workforce needs.

The Office of Minority Engineering Programs (OMEP) at ASU was established by the CEAS to assist in the recruitment and retention of underrepresented minority students. The OMEP is embedded in the infrastructure of the CEAS Office of Student Affairs [2]. The overall goals of the OMEP are to build a community of minority students that are academically prepared to pursue baccalaureate and graduate degrees within the CEAS and to create an environment that develops and promotes academic excellence, technical competence, and marketable skills. These goals are executed through a comprehensive programmatic support system for both the recruitment and the retention of underrepresented minority students. The recruitment program targets K-12 students through the efforts of the Mathematics, Engineering, and Science Achievement (MESA) Program. The retention goals are supported through the Minority Engineering Program (MEP), where students can find assistance and direction in adjusting to the challenges of university life and the rigor of an engineering and technical curriculum.

As part of the ASU's K-12 outreach effort to increase the number of qualified minority students entering CEAS, the MESA program collaborates with industry, engineering faculty, and community in an effort to expose secondary students to the stimulating environment of engineering and technology. The offering of engineering summer programs is an essential part of this collaboration.
THE MESA PROGRAM

The MESA program is a K-12 university academic intervention program supported by the CEAS, industry, local school districts, and governmental agencies for the purpose of expanding the local technical talent within Arizona. The goal of MESA is to increase the number of historically underrepresented minority students who are competitively eligible to enter and successfully complete university programs in the designated fields of mathematics, engineering, and science. The ASU MESA, part of Arizona MESA and a national partner of MESA USA, an eight state collaborative, was established to assist our state and nation in achieving the MESA goal [3]. ASU MESA is active in ten high schools, ten middle schools, and two elementary schools and serves over 600 students within the central region of the state and as far northeast as the Navajo Indian Reservation.

The students who enroll in MESA are encouraged daily by MESA Advisors, who are selected mathematics and science teachers, to pursue curriculum in high school that will academically prepare them to become competitively eligible for entrance into a university and to study the designated disciplines. The academic components of the MESA program are designed to heighten the students’ academic preparedness, to bring scholastic and “life” skills to students to build confidence, and to enhance the basic footing necessary to excel academically. To assist MESA students with their academics and career preparation throughout the year, students are required to have an individual academic plan on file with the MESA Center and MESA Advisor to ensure that, when they reach graduation from high school, they are competitively eligible for university admission. The ASU MESA Center coordinates recruitment activities such as Saturday Science Academies and campus visits, which provide students and their families an opportunity to interact with university students and CEAS faculty, while exploring educational opportunities. MESA students participate in PSAT/SAT workshops and learning skill workshops, where they learn specific academic techniques, such as note taking, exam preparation, and time management. Students also attend leadership retreats, participate in industry tours, and compete in local, state, and national mathematics and science competitions. ASU engineering students, referred to as MESA Liaisons, are assigned to each MESA school to work with the advisors and students on projects, tutoring, and mentoring. Industry members partner with MESA schools by sponsoring tours, after school internships, and mentoring within the classroom, as well as providing direct financial support. Industry also provides funding for summer programs.

The ASU MESA program serves students from the elementary to the high school level. High schools in Arizona are striving to provide courses with a career focus.

ASU and CEAS through the MESA program are working to meet this objective by providing information on engineering careers through engineering-related activities and hands-on experience. The program reviewed in this paper focuses on high school students involved in the exploration of engineering and computer science.

GTE ENGINEERING SUMMER INSTITUTE

In 1996, the GTE Foundation awarded a $30,000 grant to the ASU OMEP to fund a one-week engineering residential summer program over a two-year period. In 1998, OMEP was awarded a second $30,000 two-year grant. The funding thus allowed OMEP to offer the summer program over a four-year period from 1997 through 2000. This grant provided support for the first CEAS high school program targeting underrepresented minority students.

The objective of the Engineering Summer Institute (ESI) was to expose high school students to skills that would assist them in investigating and pursuing engineering or computer science as a career. The program was open to high school students within the historically underrepresented student groups. The pilot ESI was offered in the summer of 1997 to rising high school sophomores, juniors, and seniors. Additional offerings of other CEAS summer programs geared for rising freshman and sophomores were added in the summer of 1998. In 1998, 1999, and 2000, the ESI was limited to rising high school juniors and seniors.

The publicity of the ESI is an integral element to the recruitment of interested and qualified applicants. A summer brochure advertising the programs offered by the CEAS was mailed to all Arizona high school counselors and science and mathematics department chairs. A separate ASU MESA Center Summer Academic Enrichment Program brochure was also mailed, not only to all Arizona schools, but also to each MESA Advisor and to the home of each ASU MESA student. The ESI was advertised in the CEAS quarterly newsletter, Full Circle, which is disseminated throughout the ASU campus and mailed to CEAS alumni, industry, and community supporters. The CEAS Office of Recruitment, along with the Coalition of Engineering Minority Societies, and the Society of Women Engineers (CEMSWE) student organizations, which includes the American Indian Science of Engineering Society (AISES), the National Society of Black Engineers (NSBE), the Society of Hispanic Professional Engineers (SHPE), and the Society of Women Engineers (SWE), disseminated information and brochures during their recruitment visits to local high schools [3]. Students were instructed to submit their application for admission with an official copy of their transcript (minimum 2.5 GPA required), letters of recommendation, and a short essay on a designated topic related to engineering [3].
Program Structure

The program curriculum was designed to allow students classroom time for project design, exploring various engineering disciplines, interaction with university faculty and students, and campus awareness. The 1997 pilot program consisted of five days beginning on a Monday and ending on a Friday. The agenda included four days of instruction and on the fifth day the students presented their final projects to parents and CEAS faculty and staff. The evaluation of the pilot program suggested a strong desire by the students for extended time, not only for the hours in the day allotted to project time, but an increase in the number of days of the program offering. Therefore, the 1998 program structure incorporated two more days to include instruction for six days and presentations on the seventh day [3]. The enhanced program structure continued throughout the 1999 and 2000 ESI.

The program began with a formal orientation held for students and parents on the first day of the institute. Students and parents were given the opportunity to meet one another, as well as the CEAS staff, instruction team, and student counselors who would be interacting with them throughout the entire program [3]. After orientation, the students immediately began receiving instruction. Throughout the week, the students were exposed to engineering departments and centers through labs or tours such as Chemical and Materials Engineering (CME), Civil & Environmental (CEE), Mechanical/Aerospace (MAE). Industry tours to the Arizona Science Center and Arizona Department of Transportation (ADOT) Traffic Signal Operation Center gave students a visual confirmation of how essential engineering and computer science have become and how they influence our everyday existence. Workshops and presentations on CEAS recruitment, principals of team building, and time management were facilitated by both CEAS faculty and university staff. Students attended review sessions for mathematics concepts and skills to assist in preparing for SAT and ACT testing. Classroom instruction concentrated on HTML/Web Page Development (included Java and Java Script), PhotoShop, Microsoft Word, Excel, and PowerPoint. A design project was implemented to allow the students to apply the skills learned [3].

The design projects each year required the students to design and to develop a team web page, individual web page, and team notebook on a specific assignment. Over the four years, the ESI has incorporated several projects into the student curriculum. The project for the pilot program in 1997 required the students to perform a timed study on a production line within an imaginary company. The objective was to allow students to complete an engineering design project from concept to final design. Students were divided into teams. They simulated a paper hat factory and each team member had their own responsibility in the production process. For example, one student would do the initial folding, while another colored and placed a security sticker on the hat. Each team completed a timed study of their production process. They then utilized their computer skills to document the design project, to input data on a spreadsheet, to calculate results, and to place their findings on the team web page [3].

The 1998 and 1999 ESI project, teams were instructed to gather information for the web page through interviews of company representatives in person and/or e-mail, usage of Internet research, or library visits. Upon completion of the research, the page was to include original text, composed by the team members on the company's mission, goals, product output, history, and personnel. Company logos were to be created by the team or modified from the actual company logo. The schedule incorporated an industry interview day where students had the opportunity to practice their interviewing skills with their chosen industry representative [3].

A mathematics component was included into the curriculum of the 1999 ESI. Students were instructed in a Math and Physics K'nex Project that helped them to apply their mathematical background to an actual roller coaster. The project began by giving the students a math placement exam. The students were divided into seven teams according to the exam results so that each team would be balanced by math ability. The teams began their project by building a portion of their roller coaster and applying some basic math concepts. Topics included length and angle measurements, application of a Cartesian coordinate system to the apparatus, employing the concept of two and three dimensions, and the use of the distance formula.

Once these basic concepts were understood, the project continued with the addition of a ramp and launching a car off of the roller coaster onto the floor. The purpose of this section was to expand the understanding of trigonometry and physics. The students made measurements via measuring angles, averaging the distance the car landed, and measuring the height from which the car was launched. This allowed the students to graph the behavior of the structure and to draw conclusions. A formula was generated with the help of the students' recognition of the parabolic path that their car would take. This formula was developed in such a fashion (with the use of physics) that the students could approximate the velocity at which their car was launched. Although there were students who had not taken trigonometry, the trigonometry concepts were explained to allow full class participation. After the calculations were completed, the students made displays of the concepts they had learned.

The 2000 ESI design project exposed the students to the stages of a product development process. The project assignment began with the construction of a Styrofoam glider by each student. Teams were formed and then instructed to try to improve the product and to build a model of the improved glider. Through a serious of modules, teams were to describe and to suggest improvements, to draw and to submit a sketch of the improvements, and to include all the dimensions and materials needed to complete...
the project. After approval of their proposed model, each team then built a prototype and tested their design for success.

Team notebooks included a table of contents and notes on labs, workshops, and the design project, as well as copies of both the team's and team members' individual web pages. Notebooks were turned in at the end of the week for grading. Each section of the notebook was allotted a specified number of points. The 1997 - 1999 ESI curriculum allowed each team to turn in an actual notebook. In the 2000 ESI, students were required to develop the entire team notebook on their team web page (excluding sketches/drawings of models), utilizing all their computer skills. Student individual web pages were to be a journal of their week throughout the ESI. The journal was to include, but not be limited to, background information, special interest of the student, highlights of the week, and their ASU experience. This was their time to have fun and to be creative. The individual page was then linked to the Team page.

To reward the students for their participation and team efforts, the closing program was used as an opportunity for the students to showcase the team web page. Each team presented their web page to parents, CEAS faculty and staff, and the ESI program staff as well as students of the ESI. Points were allotted for creativity in web page development, incorporating skills learned, and presentation. Points earned from both the team presentation and notebook were combined for an overall team score. The team with the highest score won first place. Each member of the first place team received a Visor Palm Pilot. The second place team members each received a Hewlett Packard 48G Graphic calculator. The third place team members each received a gift certificate to the ASU bookstore as well as an ASU sweatshirt.

Evening enhancement activities consisted of visits to the ASU Physics and Astronomy Planetarium, Student Recreation Center to play basketball or swim, or a game night with the evening counselors. The students also attended a movie at the local theater and/or a Diamondback baseball game at the Bank One Ball Park

**STAFF PARTICIPANTS**

The program was staffed daily with the project coordinator, an academic aide, three student instructors, and six student residential assistants. The instruction team, under the direction of the project coordinator, the academic aid, and engineering faculty advisor Dr. Barry McNeill, developed and implemented curriculum for the classroom project. The student staff was composed of ASU engineering students. The instruction team consisted of upper division undergraduate computer science students. The residential assistants represented various disciplines and were members of CEMSWE. These students were responsible for implementing all evening activities and supervision of participants.

**DISCUSSION**

The ESI program has been well received over the four years. Between 1997 and 2000, 120 students attended the ESI summer programs (one student attended three times and four attended twice, making an actually total of 114 individual students served). As of June 2000, 73 (out of the 114) ESI students have now graduated from high school. The remaining 41 students will be graduating in 2001 and 2002 (19 in 2001 and 22 in 2002). Twenty-three of the 73 ESI graduates are presently attending ASU. Out of the 23 attending ASU, 19 are enrolled in the CEAS. The 19 students are majoring in a variety of engineering fields: four are majoring in Computer Systems, four in Bioengineering, three in Computer Science, two in Mechanical Engineering, two in Civil and Environmental Engineering, one in Chemical, and one in Electrical Engineering. Two of the ESI students are enrolled in the Del E. Webb School of Construction. Of the four ESI graduates not enrolled in the CEAS, three are presently enrolled in the College of Liberal Arts and Sciences, two majoring in General Studies and one in Political Science, and one student is enrolled in the College of Business majoring in Computer Information Systems.

To further enhance the ESI students' educational goals and to give them continued focus, students enrolling in CEAS have the opportunity to attend and to participate in the Minority Engineering Summer Bridge Program (MSB). The MSB is a two-week residential program for entering minority CEAS freshman. Within this program the ESI students are exposed even more to aspects of engineering and computer science. Many of the graduating ESI students have participated in this MSB as they have transitioned into college life.

**CONCLUSION**

The ESI program has been an excellent vehicle for creating awareness and recruiting students to pursue engineering and computer science. The overall positive responses from the participants through their evaluations have validated the program and their suggestions continually influence the curriculum development of future programs. The ESI will continue to be a program that focuses on engineering and computer science, specifically web page design and development. The future ESI curriculum will expand to include additional software programs and to include some exposure to hardware. Hands-on project design and documentation will continue to be a staple part of the program curriculum.

The large demand for individuals with technical competencies will continue to grow as we progress into the new millennium. The demand for diverse individuals with engineering and/or computer science backgrounds exceeds the present supply. ASU and the CEAS have a continuing
commitment to offer and to provide quality education for all students and to continually seek new avenues to expand their efforts in educational endeavors. The continuous emphasis on and exposure to mathematics, science, and engineering to pre-college students is an essential step in meeting the ever-growing need for a technically educated workforce. Summer programs such as the Engineering Summer Institute offer a gateway of opportunity for student achievement as well as preparation for fulfilling the demand of the future workforce.

REFERENCES


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Cathryne Jordan is a Student Services Coordinator, Associate. Her primary responsibility is the ASU Central Arizona MESA Program. She has a BA in Speech Communication and a Masters in Public Administration. Her focus is directing and working with K-16 students within the university, public and or private sector outreach programs to prepare students academically to enter four-year accredited institutions, and pursue undergraduate and graduate level degrees in the mathematics, science, and technology disciplines.

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