Teaching and Learning in an Era of Equality: An Engineering Program for Middle School Girls

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Abstract - The Women in Applied Science and Engineering (WISE) Program at Arizona State University was founded to improve the retention and recruitment of women in the College of Engineering and Applied Sciences (CEAS). In the summer of 1996, WISE obtained a grant from the City of Tempe to develop an engineering program targeted at middle school girls to expose them to and to interest them in engineering. This program, WISE TEAMS (Teaming Engineering Advocates with Middle School Students), was a two-day commuter program consisting of hands-on engineering activities, career information, and team building exercises. Among the thirty-eight participants for TEAMS, there were twelve underrepresented minorities. The content of the program is presented in this paper.

Introduction

Women constituted only 18% of those awarded bachelor degrees in engineering in 1996 [1]. In 1990, senior males in public high schools were more than three times as likely to choose a career in science, math or engineering than women [3]. Interest in engineering careers among college freshmen in 1996 remained at a 20-year low, with only 2% of the women planning to enter engineering majors [5]. Minority women are the least represented in engineering, making up only 4.8% of the 1995-96 freshman class [6] and receiving only 2.2% of the Bachelor’s degrees in engineering in 1994 [7]. The underrepresentation of women and minorities in engineering is particularly disturbing when one considers the shifting demographics in the workforce:

By the year 2000, economic expansion will create up to 18 million new jobs, but the number of young job seekers will decline due to a shift in birth rates. Reflecting changes in racial and ethnic populations, the entry rate of blacks, Hispanics, Asians and Pacific Islanders and American Indians and Alaska Natives into the workforce will be higher than for whites. Women of all racial and ethnic groups will be the major source of new entrants into the labor force, comprising 47 percent of the total workforce by 2000, compared to 45 percent in 1988. Half of women in the workforce will be between 25 and 44. Between 1988 and the year 2000, white men will comprise only 25 percent of the net growth of the labor force. Occupations most likely to grow include service, professional, technical, sales and executive and management positions [8].

In order to maintain the necessary supply of engineers, and to ensure the continuing technological edge of the U.S., women must be recruited into engineering careers in greater numbers. Furthermore, in order to ensure that engineering problems are approached from a variety of angles, women, and other "non-traditional" engineers must be sought. Research suggests that the crucial intervention point for encouraging girls to pursue math and science-related fields such as engineering is during middle school. As early as the seventh grade, boys plan to study more math than girls do [9]. Programs designed to educate middle school girls about the applications of math and science to real world problems are an important means of reversing this trend.

Tempe TEAMS

The Women in Applied Science and Engineering (WISE) Program at Arizona State University was founded to improve the retention and recruitment of women in the College of Engineering and Applied Sciences (CEAS). In the summer of 1996, WISE obtained a grant from the City of Tempe to develop an engineering program targeted at middle school girls to expose and to interest them in engineering. This program, WISE TEAMS (Teaming Engineering Advocates with Middle School Students), was a two-day commuter program.

Recruiting Participants

WISE received notice of funding from the City of Tempe in April of 1996, allowing only three weeks to recruit participants for the program. A simple tri-fold brochure was developed and mailed out to middle school math and science teachers in the Tempe area. Brochures contained a registration form, which asked for a recommending teachers’ signature, GPA, and the highest-level math class taken. Teachers were asked to distribute to brochures to female students who were not necessarily already excelling, but who showed interest and/or potential in the areas of math or science. Information about the TEAMS program was included in the City's program listings, which were also distributed to the schools. In addition, brochures were posted at the local...
YMCA and Boys and Girls Club, as well as at Tempe grocery store bulletin boards. Finally, brochures were mailed to a wait-list of a summer science camp for girls, conducted by a local school district.

Since the City of Tempe funded the program, residents from this area were accepted first. Preference was then given to underrepresented minorities. The program was then filled on a first-come, first-served basis. Fortunately, all applicants could be accommodated in the program. Participants were charged a $35 tuition, with scholarships available to low-income families. Among the thirty-eight participants for TEAMS first year were eight underrepresented minorities.

Once accepted, participants were required to submit parental permission forms and a photo release form. This form is required for underage individuals to have their picture published. Tempe TEAMS received media coverage on local news stations and in a number of local and community papers.

Program Content

The program was scheduled from 8:30 a.m. to 4:30 p.m., with optional programming from 7:30 - 8:30 a.m. and 4:30 - 5:30 p.m. to assist with parent’s transportation schedules. Optional programming in the mornings included videos about women in engineering, word games, and other activities that did not depend on everyone arriving at the same time. The afternoon optional programming gave the participants time to explore the Internet, play Engineering Pictionary, and do other similar activities. The optional programming was utilized by about one-third of the participants.

<table>
<thead>
<tr>
<th>a.m.</th>
<th>Day 1</th>
<th>Day 2</th>
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<tbody>
<tr>
<td>7:30</td>
<td>Optional Programming</td>
<td>Optional Programming</td>
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<tr>
<td>8:30</td>
<td>Welcome/Orientation</td>
<td>Rocket Launch/Civil Engineering Lab</td>
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<tr>
<td>9:30</td>
<td>Lab I or Lab II</td>
<td>Lab IV</td>
</tr>
<tr>
<td>11:30</td>
<td>Team Building</td>
<td>Team Building</td>
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<td></td>
<td>Activities</td>
<td>Activities</td>
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<table>
<thead>
<tr>
<th>p.m.</th>
<th>Day 1</th>
<th>Day 2</th>
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<tbody>
<tr>
<td>12:30</td>
<td>Lunch</td>
<td>Lunch</td>
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<tr>
<td>1:00</td>
<td>Lab I or Lab II</td>
<td>Lab V</td>
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<tr>
<td>3:00</td>
<td>Lab III</td>
<td>Ice Cream Lab</td>
</tr>
<tr>
<td>4:30</td>
<td>Optional Programming</td>
<td>Optional Programming</td>
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The morning of Day 1 included a Welcome/Orientation with a continental breakfast. The participants filled out an interest survey as well. An icebreaker called “The Name Game” was used to help the girls meet each other and the staff, as well as to help them feel more comfortable in their surroundings. “The Name Game” requires that the participants, who are sitting in a circle, introduce themselves and say one thing about themselves. The person to her left then must give the same introduction and then repeat the information about the person that spoke before them. This continues around the circle until the first person is reached again, at which time she repeats the information about each person in the circle. This really helped the participants learn each other’s names and feel more comfortable with each other.

Next, the girls were split into two teams. Each team had two female engineering undergraduate students who served as Team Leaders. The Team Leaders assisted with the labs and served as role models and mentors to the girls. Team A went to Lab I and Team B to Lab II. Lab I was an Aerospace Engineering Lab, developed and facilitated by a female engineering graduate student. In this lab, the girls had the opportunity to build and paint their own toy rockets. They learned about some of the basic physics principles that are involved in the designing and building of rockets and gained an understanding of what Aerospace Engineers do. Lab II was a BioEngineering Lab in which the participants listened to blood flowing through the arteries and veins, monitored the heart rate and blood pressure, and learned about some of the medical devices, such as artificial hips and pacemakers, that Bio Engineers create. An engineering faculty member and female graduate students presented the bioengineering lab.

After the morning lab sessions, the girls participated in team-building activities with staff from the Athletics Department. The importance of working in a team was incorporated into physical activities, such as the “body-pass”, where a participant was literally passed, by hand, over a line of her teammates.

After lunch, the groups spent the afternoon in another lab block. This time Team A went to Lab II and Team B went to Lab I. After these labs were complete, all of the girls went to Lab III. This was an Internet Lab designed to teach the girls how to use the Internet and become more familiar with computers. Students that were more advanced in these areas were given instructions on how to create their own homepages. Many of the girls enjoyed this lab so much that they wanted to stay later and play on the Internet.

Day Two began with another continental breakfast. By this time, the girls were much more familiar with each other and spent most of the breakfast socializing. After breakfast, the girls split into the their teams and went to either the Civil Engineering Lab or the Rocket Launch, where they launched the rockets they had constructed the day before. The Civil Engineering Lab incorporated more team-building skills with an understanding of some of the fundamentals of Civil Engineering. The teams then switched so that everyone had the chance to launch their rocket and attend the Civil Engineering Lab.

All of the girls then participated in Lab IV, the Electrical Engineering Lab. In this lab the girls used wax, cloth, and dye to simulate the doping of silicon wafers. To do this they drew designs on a piece of cloth with hot wax and then dyed the cloth. After the cloth dried and the wax was removed, the
design showed through. The girls then engaged in more team building activities with the Athletic staff.

After lunch, the girls attended Lab V. This was an Industrial Engineering lab in which the girls learned about probability and statistics using the numbers of different colored M&Ms in a bag of M&Ms. They also learned that most Industrial Engineers work with companies to increase the companies’ efficiency. After this lab, the girls built their own “comets-in-a-bag”, which taught them about some of the basic chemistry and physics principles that all engineering students are required to know.

The participants all had their pictures taken in their Tempe TEAMS T-shirts, which had been handed out the day before. The program concluded with the “Ice Cream Lab”. In teams, the girls wrote out instructions for making an ice cream sundae. The instructions were followed by TEAMS staff, who followed the instructions literally, making for great laughs and a big mess. While participants enjoyed ice cream sundaes, they completed a summary evaluation of the program and said good-bye. Many of the girls vowed to return to TEAMS the following year.

**Continuation**

WISE has received funding from the INTEL Corporation to present TEAMS again in the summer of 1997. This year’s TEAMS program will be extended to three days with new labs so that any returning participants will have the opportunity to learn new aspects of engineering.