A CASE STUDY: HIGH PERCENTAGES OF WOMEN IN ENGINEERING COLLEGE AT UPRM

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Abstract — *With 40% women, the College of Engineering at the University of Puerto Rico at Mayagüez (UPRM) has one of the highest percentages of women in Engineering in the United States. It is also one of the largest Engineering Colleges in the Nation by number of students enrolled (4,077) according to the latest report by the America Association for Science and Engineering Education (ASEE). UPRM graduated 665 engineering bachelor students last year. Of those, 267 engineering degrees were awarded to women. UPRM ranked as one of the highest in the percentage of women together with Gonzaga University, Mercer University and Morgan State University. This work intends to examine the factors that contribute to these high numbers. Focus groups were gathered and interviewed to determine these factors and preliminary results were compared to previous results from related works.*

Index Terms — Factors contributing to increasing number of women, High percentages of women in engineering.

INTRODUCTION

For many years, the engineering program at UPRM has been characterized by the high percentages of women in the undergraduate Engineering College. As a result, various research efforts have been focused in trying to identify factors leading to the high percentage, currently around 40% undergraduate women in the Engineering College (see Fig.1). This high percent contrasts with the Hispanic Macho-stereotype culture. In this study, we have explored preliminary socio-economic, and ethnic factors among others, that might help enlighten us on the reasons for these high numbers. Figure 2 shows the percentage of women in each of the engineering departments at UPRM. Chemical and Industrial engineering departments boast over 50% and 60% women, respectively.

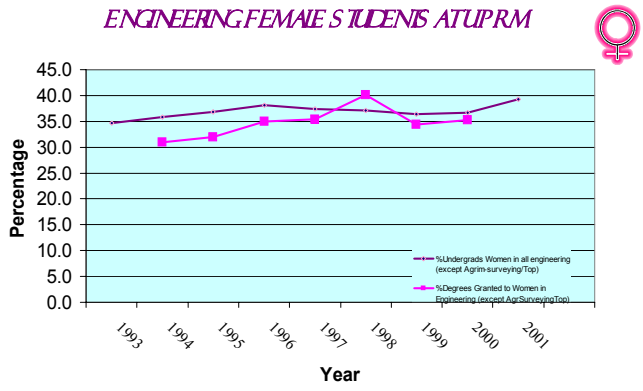

FIGURE 1.
PERCENTAGE OF WOMEN AT UPRM ENGINEERING COLLEGE DURING THE LAST TEN YEARS (FINE LINE). SQUARE-BULLETS LINE SHOWS THE NUMBER OF DEGREES GRANTED TO WOMEN. UPRM ALSO COUNTS WITH A VERY HIGH RETENTION RATE.

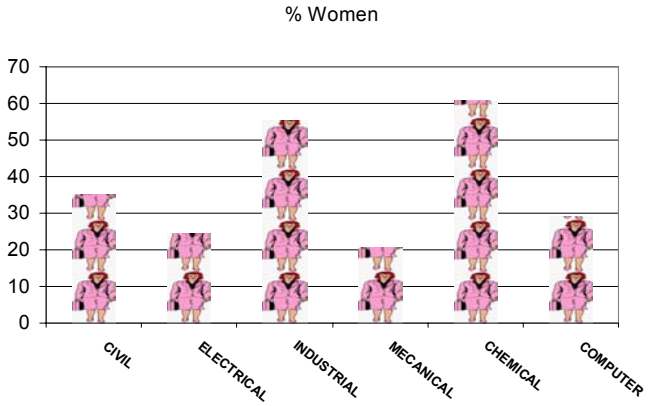

FIGURE 2.
PERCENTAGES OF WOMEN IN UPRM UNDERGRADUATE ENGINEERING DEPARTMENTS; CIVIL, ELECTRICAL INDUSTRIAL, MECHANICAL, CHEMICAL AND COMPUTER ENGINEERING.

THE SURVEY

In this work, we distributed a survey to a small sample of students (36 undergraduate female students). The survey questions were based on and modified from previous work by UPRM and UTEP[1]. All the women were Hispanic, and all but one were single. Most (25) were between 21-24 age group, the rest being between 18-20 years' old. The family income was mostly (~50% of those surveyed) in the range of $20k-30k, with ~25% each in the $30k-$40k and >$50k brackets. Parents' education was found to be as shown in Figure 3. It is interesting to note from this graph that there were a higher number of mothers with college degrees, MS degrees and PHD degrees, which could be seen as a role model present in women students' lives. This results agrees with finding reported in [2] of Latinas and African-American women earning more bachelor degrees that their

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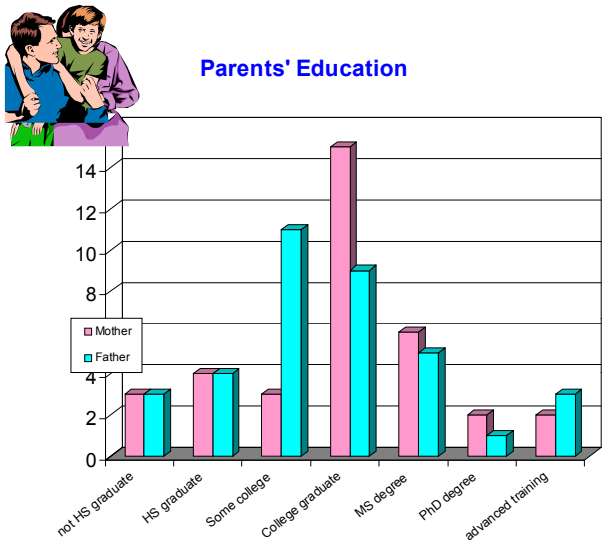

FIGURE 3.
PARENTS' EDUCATION FROM THE STUDENTS SURVEY SHOWING HIGHER NUMBERS OF MOTHERS WITH A COLLEGE DEGREE WHICH CAN SERVE AS A ROLE MODEL FOR THE STUDENTS.

male peers, yet it extends here to MS and doctoral degrees.

Most students responded in the survey that they started to think about engineering when they were in High School, not elementary school. Among the factors, the students indicated as contributing to their selection of engineering as a field of study, the number one reason was that they were good in Science and Math when in High School. These results would indicate that outreach efforts directed toward HS students are still in time to have a positive effect. However, the students have to be encouraged to keep a good work in S&M from elementary school until HS, since their self-esteem highly depends on their grades at that stage according to [3].

The main factors cited as contributing to their decision to study engineering were, in this order,

- Were good in Science and Math in High School
- Engineering viewed as empowering career
- Parents/relative motivation
- Did well in College board examination (SAT)
- Prestigious career

Other factors cited with less frequency were

- Participated in pre-engineering program
- Wanted to be economically independent
- Participated in S&E fairs
- Suggestions by HS counselor
- Had role models
- Financial reasons
- Motivation by teachers

The high retention rates at the UPRM have been related to the study-environment in which there is almost no hostility between students of the same or opposite sex, or faculty members. This is shown in the questions tabulated in Figures 4 and 5.

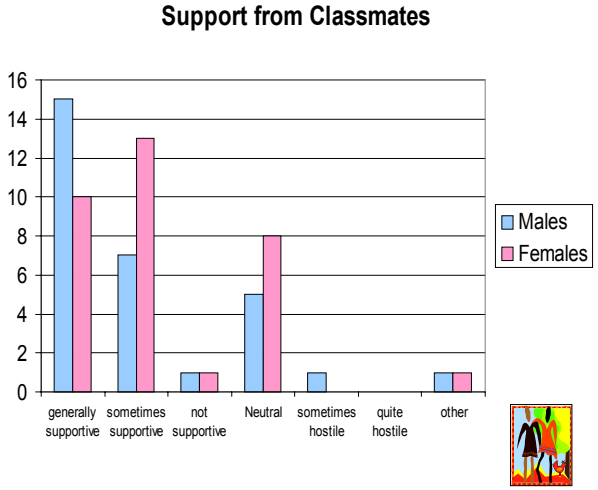

FIGURE 4.
THIS GRAPH SHOWS THE STUDENTS SURVEY RESPONSES RELATED TO CLASSMATES SUPPORT FROM OTHER FEMALE AND MALES STUDENTS. AS DEPICTED IN THE GRAPH, THEY GENERALLY ENCOUNTERED SUPPORT OR NEUTRALITY FROM BOTH FEMALE AND MALE CLASSMATES

Another revealing question asked to the students group was to give, in their opinion the factors contributing to the high percentages of women at UPRM. The five highest reasons given were:

- Cultural reasons
- Role models
- Encouragement by parents
- Motivation in High School
- Encouragement by High school teachers

The cultural reasons were not further detailed or explainedm, so that would have to be left for future work to determine exactly what cultural issues are key in promoting women to study this male-dominated field. Other factors mentioned with less frequency were

- Studying environment (not hostile)
- Pre-Engineering Programs
- Encouragement from HS teachers
- Encouragement from HS counselors
- Economic Reasons

These are just the students' perceptions but can help us understand their view on this matter.

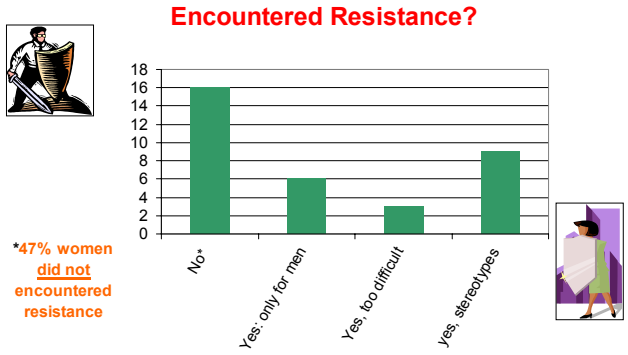

FIGURE 5.
ACCORDING TO THE STUDENTS SURVEYED, 47% OF THEM DID NOT ENCOUNTERED RESISTANCE AT ALL. SOME SDID FOUND STEREOTYPING, AND COMMENTS SUCH AS " ENGINEERING IS NOLY FOR MEN".

Even though students do not consider the economical factor as of high relevance, it is important to mention that the education costs at UPRM are extremely low compared to US Institutions and students seldom have to work to be able to study. In addition, more than 80% of the students receive federal assistant to complete their BS degree. It is worth to mention that students entering UPRM are the top students of the whole island. Every year, hundreds are left out because the demand is higher than the institution capability, even though is one of the largest engineering colleges in U.S. Therefore, students do not have financial obstacles to pursue an education in engineering, and entering UPRM has a certain prestige with it.

UPRM UNDERGRADUATE RESEARCH PROGRAM WITH INDUSTRY (IAP)

Within the UPRM, the Electrical and Computer Engineering (ECE) department has an Industrial Affiliates Program (IAP) to promote undergraduate research activities amongst its students. The students benefit greatly from this 14 years' old program. Mostly men students were participating in IAP, maybe because they are more aggressive and unafraid to ask professors for research projects availability. Figure 6 shows the percentage of women students participants in the programs as compared to the percentage of women students in the ECE department.

After the first few years of the program, the percentage of women started to decline. In the year 2000, we first noticed this trend, and decided to approach the professors to create awareness of this issue. We told the professors to approach the female students who they considered good candidates for research, to participate in this program, and explained how women are not as aggressive as men and waited to be called instead of offering to participate. This is not due to a lack of interest but in fact to the way most women behave [2, 4]. With this simple measure, next years, 2001 and 2002, have seen a great improvement in the percentage of women participation in this undergraduate research programs (Figure 6).

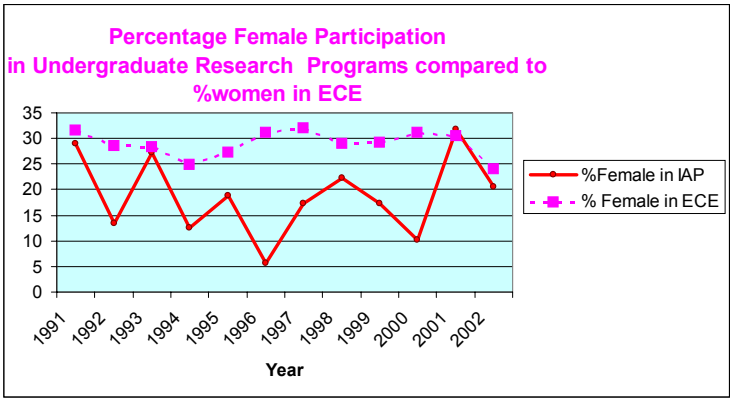

FIGURE 6.
PERCENTAGE OF WOMEN PARTICIPATING IN UNDERGRADUATE RESEARCH PROGRAMS AS COMPARED TO PERCENTAGE OF WOMEN IN THE DEPARTMENT.

CONCLUSIONS

With this study it was observed that female students made the decision late in high school years to continue studies in engineering. This indicates that pre-engineering programs and workshops and other outreach programs geared toward high school students can have a positive impact toward increasing the number of women in engineering. It was also interesting to note the fact that most of their mothers have a post college degree, serving as a role model to their daughters. The non-hostile environment and support from classmates of both genders was also pointed out in the survey. In addition, we found that UPRM students thought cultural reasons were a key factor. At UPRM students have easy access to moderate cost studies.

In conclusion, we have identified some factors at UPRM that promote the high numbers of women in Engineering College, but there are some cultural issues that are inconclusive. It is recommended to perform a more complete study which includes social scientist to try to identify these factors.

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