Female Engineers at Mercer University; student recruitment, retention, and faculty involvement

Monika Bubacz¹, Aaisha Merali², Laura W. Lackey³, Joan M. Burtner⁴

Abstract – The goal of this paper is to report on the current status of female students and faculty in the School of Engineering at Mercer University. This study is a continuation of a previous paper entitled “Involvement of Women Engineers at Mercer University” that is published in the 2008 annual conference Proceedings of the American Society for Engineering Education Southeast Section. This paper is focused on (1) female student recruitment, retention, and admission data, and (2) the comparison of male and female freshmen student academic preparedness and its influence on students’ future educational success. From a female faculty perspective, we investigated recent departmental structural changes and its influence on student perception of the school of engineering and on the general learning and working atmosphere. The paper consists of statistical analysis of employment and enrollment data and information obtained from interviews and open discussions with students and faculty.

Keywords: engineering education, gender studies, SAT and GRE scores

INTRODUCTION

The data from authors’ prior study indicate that women at Mercer University School of Engineering (MUSE), both students and faculty, felt accepted, equal, and accomplished within the School of Engineering; Mercer University proved to be an excellent learning and working environment for both young people and professionals. Although more than 35% of engineering Bachelor’s degrees are earned by women at Mercer, the problem of low enrollment and poor retention remains valid and unsettling. New studies show that low enrollment, not low retention is resulting in the small numbers of female engineering students and graduates [De Cohen, 1]. The authors of this paper are interested in attracting more women to the field. As a result of this interest, SAT and GPA scores of Mercer University engineering students and the general perceptions of women within the school are investigated.

Female faculty as role models

Research shows that there is a significant positive relationship between retention and the percentage of female students in science, mathematics, and computer science courses taught by women [Robst, 2]. Both a greater percentage of female faculty and female students leads to increased retention, however the effect of female faculty falls as the percentage of female students in class increases. The study also shows that simply because a department has a number of female faculty, this may not be important for improving retention unless students interact with those faculty members and appreciate them as role models. From a policy perspective, the emphasis on female faculty

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being role models is greatest in science, mathematics, and engineering. Female students are unlikely to need faculty as role models in “female dominated” classes or majors. The results also suggest that departments may want to implement programs that encourage both formal and informal contact between female faculty and female students.

**SAT and GPA scores**

The SAT standardized exam is by a widely used measure of academic potential, and it plays a central role in admissions decisions at most universities in the United States. SAT scores have been interpreted in a number of different ways, both by the test’s designers themselves (Educational Testing Service) and by college administrators, high school counselors, the popular press, and researchers in fields such as education and psychology [Noftle, 3]. Moreover, the test is given nationally and is available to all students, both present and past, as are the results. The SAT score, both verbal and math, combined with high school graduation rank, high school extracurricular activities, concurrent employment, internships, math placement exams, socio-economic factors, gender and minority status and first semester GPA are widely used as indicators of engineering student success, graduation rates, and even freshman year attrition [Treuren, 4; Burtner, 5].

The SAT verbal test may be more strongly related to crystallized intelligence because of its vocabulary related content, whereas the SAT math test may be more strongly related to fluid intelligence because of its numerical and spatial reasoning related content [Noftle, 3]. Higher SAT verbal scores might influence a person’s identity as a verbally intelligent person (e.g., as an “intelligent”) and this self-perception might translate into the pursuit of activities (e.g., reading, attending the theater, engaging in philosophical discussions, interest in the arts). The mathematics portion of the SAT can be used to distinguish persisters from those who either drop out of the engineering curriculum and enter into an alternate field of study and those who no longer pursue any type of secondary education [Lackey, 6].

Previous research at Mercer University [Lackey, 6] shows that as the engineering students’ SAT score increased, the first year cumulative GPA increased. It was also indicated that only the math portion of the SAT scores were related to students’ success rates, while the SAT verbal score had no predictive value for academic success in science or engineering programs. Investigations done at Purdue University [Budny, 7] proved that first semester GPA was a much better predictor of the likelihood of retention and ultimate graduation than the math SAT score. Other papers demonstrate that many demographic factors such as SAT scores and course grades do not accurately predict which students will remain in engineering [Pieronek, 8]. Another study [Fraser, 9] shows that the influence of high school rank, ACT math, and SAT math on the probability of completion in engineering are stronger for women than for men.

Studies performed at many universities show that female engineering students often have SAT scores lower than their male peers. Female graduate students’ SAT scores were about 2.4% less than their male counterpart scores at Baylor University from 1998 to 1999 [Treuren, 4]. However, from freshmen year to graduation the percentage of female engineering students increased by 6% of the total while the percentage of males decreased by the same amount. University of Notre Dame developed an introductory engineering course sequence EG 111/112 [Pieronek, 8] which improved the program participants SAT scores over all the university’s first-year students by nearly 40 points. At the beginning of the classroom experience, women and men have comparable mean SAT scores but the College has noted an increase each year in the mean SAT scores for the women enrolled in EG 111. However, the retention rate for the women remained substantially below that observed for the men. In yet another paper [Pieronek, 10], the College investigated female and male retention rates and differences between engineering and non-engineering students. Male leavers and stayers followed a predictable pattern in that those who left engineering had lower mean SAT scores and EG 111 grades, while female leavers and stayers did not follow a similarly consistent pattern. In fact, female leavers had higher mean SAT scores than female stayers in two of the four years studied, and had higher mean EG 111 grades in one of the years studied.

**MUSE Students SAT and GPA Scores**

Statistical data on SAT and GPA scores of Mercer University engineering students from 2003 to 2008 were provided by the Registrar and evaluated. SAT score data include only officially provided test results and may be slightly affected by lack of records considered as unofficial. Figure 1 shows the average total SAT scores and numbers of all engineering students who were admitted in the Fall of 2003 and 2004 that graduated within either
four or five years (with exception for Biomedical and Electrical departments which had one student that graduated in the sixth year each). As the engineering student attrition occurs the SAT score average for the remaining engineering student group changes. Higher retention of female students is strongly visible albeit lower numbers and generally lower average SAT scores of continuing students. Average SAT scores for male students show a tendency to increase indicating that primarily the well-prepared male students are retained.

Figure 1. Total SAT scores and corresponding numbers of engineering students are shown for the first five consecutive years of their study. Data from the incoming classes of Fall 2003 and 2004 were evaluated.

The 5-year cumulative GPA of students retained in the school of engineering can be seen in Figure 2. Female students tend to have higher grades than their male peers. The grades appear to be the highest in both groups for the 4th year which is a year of graduation for more than 70% of all engineering students. As expected, GPA score is lower for “super-seniors” (fifth year students).

Figure 2. Yearly GPA scores for all engineering students admitted in Fall of 2003 and 2004 for five consecutive years of their study

Figure 3 demonstrates total SAT scores and numbers of the same students divided by majors; data for Mechanical, Biomedical, Electrical, and Environmental engineering students were evaluated. Numbers of students in the Mechanical department follow national trends. The number of male students is more than double the number of female ones; however, the retention rate seems to be higher for women. The other departments show no such tendencies, and for each the situation is slightly different. Interestingly, the total SAT average score for female students in the Biomedical department are likely to have higher than their male classmates, while the opposite trend
is observed in the department of Environmental Engineering. The other two departments, Mechanical and Electrical, show mixed behavior.

Figure 3. Total SAT scores and number of students admitted in Fall of 2003 and 2004 into separate departments for five consecutive years of their study.
School of engineering admissions data were analyzed for five consecutive years. Figure 4 presents total SAT scores and 1st year cumulative GPA for all 1st year students admitted in successive Fall semesters between 2003 and 2008. Both, the average total SAT and average 1st year GPA seem to be slightly dropping as time progresses. We hope the trend is reversing as seen by the improvement during the last academic year, 2008-2009, in which female student average GPA jumped up by more than 0.6 points; however, we acknowledge that one data point does not conclusively indicate a reversing trend.

![Admitted engineering students](image1)

![Admitted engineering students](image2)

Figure 4. Total SAT and 1st year GPA scores for all engineering students admitted in consecutive Fall semesters

Figure 5 contains details on SAT scores of 1st year students. The scores are divided by verbal and math parts and presented both as total for all students and separated in specified departments: Mechanical, Biomedical, Computer, Electrical and Environmental. MUSE results follow national trends for engineering students; the SAT math scores are on average 30 points higher than verbal scores. Also, male students’ scores are in general higher than those of their female peers by almost 10 points (the difference is slightly higher for verbal SAT scores). Out of the examined departments, only Mechanical shows similar tendencies, while all the others demonstrate various mixed behaviors with Biomedical Engineering having the most uniform scores for both genders.

Table 1 shows the percentage of female engineering students predicted by the Cooperative Institutional Research Program based on surveys administered to freshmen during the first days of fall orientation. The data is compared to actual graduation rates.

<table>
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<tr>
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<th>2003 predicted</th>
<th>2003 occurred</th>
<th>2004 predicted</th>
<th>2004 occurred</th>
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<tr>
<td>MUSE total</td>
<td>21.2</td>
<td>25.3</td>
<td>20.7</td>
<td>33.9</td>
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<td>0</td>
<td>6.3</td>
<td>0</td>
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<td>40</td>
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<tr>
<td>Mechanical</td>
<td>7.6</td>
<td>36.4</td>
<td>11.5</td>
<td>27.8</td>
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Table 1. Percentage of female students predicted by Cooperative Institutional Research Program and occurred for students admitted in the Fall of 2003 and 2004
The authors investigated the general opinion of female engineering students through open-discussion interviews and a survey. The survey contained twenty-two questions on an agree/disagree Likert Scale and has been completed by twenty-five students (twenty-one females and four males). The results are summarized as follows:

- both groups agreed that female engineering students tend to work in teams, seek help outside classroom, and have high interactions with their professors as much as their male peers; however, while female students believed that they participate in classroom discussions equally, their male peers were neutral/disagreed with this perception;

- all students disagreed with stereotypes such as “female students are more suitable in other fields,” “have worse analytical, problem solving, mathematical and computer skills,” or “are less confident on their abilities;” all surveyed students agreed that women are just as likely as men to succeed in an engineering
classroom and can handle complex engineering problems; still, while female students strongly agreed/agreed that they can handle the engineering academic stress, their male peers were neutral (due to a possible lack of acquaintance);

- both groups agreed on a “female friendly” engineering environment and faculty; yet, while female students were neutral about the need for additional female faculty, the male students did not agree that such a change could improve female student retention;

- all students were of the same opinion regarding female academic success issues - female students do not have to put more effort in the classrooms to be successful in the engineering field and had a neutral attitude about: the attrition rate for female engineering freshmen and poor grades on assignments discouraging female engineering students; finally males were neutral/agreed and females tended more towards “agree” about the majority of the graduated female engineering students becoming very successful working engineers and having a greater number of job offers than a typical male student.

Views on female faculty members at the university and whether gender of the professors played a role in the students’ experience in the program was reviewed. A request for participation in interviews was sent to all female junior- and senior-level Mechanical, Industrial and Environmental engineering students. Participation in the study was voluntary and information relayed in this paper is garnered from those who responded to the request. The interview consisted of a total of five questions. Students were encouraged to answer openly about their experiences and opinions regarding female faculty members. They were also questioned if and how the gender of the faculty influenced their experience in the program.

In the fall of 2007 the Mechanical Engineering department added a female member to the formerly all male faculty. Students were asked during the interview what, if any, impact this addition to the engineering faculty had on their thoughts or experience in the program. While a small number of the responding students felt the addition of a female to the faculty was neutral to their experience, the majority responded positively to the addition. Many felt they could relate better to a faculty member of the same gender and that having a female on staff gave the females in the program more of a “voice” in the male dominated Mechanical Engineering department.

Recently female faculty members became department chairs of both the Industrial Engineering and the Environmental Engineering departments. Students in the interview were asked if the gender of the new department chairs had any noticeable impact on their experiences in the program. All interviewed students stated that they did not notice a change in the day-to-day operations of the departments but they were pleased with the choices of new department heads as they like the professors as individuals, regardless of their gender.

When the students were asked if they see the female faculty members as role models at Mercer University, all students replied that they do. Students see the female faculty members as inspiring. The students are encouraged by seeing females in the engineering profession who have succeeded in a largely male dominated field. These young female engineering students are also encouraged by seeing how their female professors are continuing to contribute in various aspects in their respective industries. One student stated that it is nice to see someone who is successful, saying “If she can, I can too.”

Since male faculty members form the majority in all engineering departments at Mercer, except for the Industrial Engineering and Technical Communication departments, a large majority of students at Mercer University have male advisors. Students were asked if given a choice, they would have preferred a female advisor and if so, when would having a female as an advisor have been the most beneficial. A few students responded saying that having an advisor of the same gender would have benefited them most at the beginning of their academic career. These students felt that having a fellow female as an advisor would have put them more at ease during the advisement process. The majority, however, felt that gender was irrelevant to the advisement process with male advisors being just as effective as female advisors.

The final question posed to students centered on whether or not Mercer University’s chapter of the Society of Women Engineers (SWE) has played a part in their academic engineering career or if it has influenced their happiness with the engineering school in any way. All students responded saying they feel SWE has enriched their
experience and that it is good to know there is an available network of strong, intelligent women as a resource for students as they transition into the engineering community.

**CONCLUSIONS**

As was the case in our previous paper the authors showed the Mercer University School of Engineering is an excellent learning and working environment for women, both students and professionals. Female students have higher retention and higher GPA than their male peers albeit lower numbers and generally lower average SAT scores. The survey and interviews proved that both male and female students have similar perceptions on women-engineers and that having mostly male faculty does not influence their success rate. The recent election of two women faculty members as department chairs is another indication that the working environment at Mercer is positive for both professionals and students.

**ACKNOWLEDGMENTS**

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Monika Bubacz
Dr. Monika Bubacz is an Assistant Professor in the Department of Mechanical Engineering at Mercer University. She received both her B.S. and M.S. in Mechanical Engineering from Poznan University of Technology in Poland, and the Ph.D. in Engineering and Applied Science from the University of New Orleans (UNO). Before her appointment at Mercer she has worked for the Metal Forming Institute in Poznan, Poland, and the Center for NanoComposites and Multifunctional Materials at Pittsburg State University in Pittsburg, Kansas. While at UNO, Dr. Bubacz did summer research at the Oak Ridge National Laboratory and the Indiana University Cyclotron Facility. Her teaching and research interest areas include materials science, polymers and composites for aerospace applications, nanotechnology, and environmental sustainability.

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