DO WOMEN HAVE THE ABILITY TO STUDY ENGINEERING? DO GOOD STUDENTS LEAVE ENGINEERING?

Kathy Belknap, Ph.D.

University of Idaho
Boise, Idaho

INTRODUCTION

Two **myths** continue to impact engineering education: women do not have the ability to study engineering and poor students should be "weeded out" from engineering. The author led a Discussion Group on the two topics and presented the results from her dissertation. The study provided further evidence to counteract the two myths.

The discussion began with a brief review of the literature on four topics related to women's ability to study engineering: brain differences, spatial and mathematics ability, standardized achievement testing and grade point averages. The overall conclusion of many studies was that there were more similarities in the abilities of males and females than differences.[1,2,3] Many authors also agreed that the differences in abilities between men and women counted for much less than people thought. They found the difference between males and females too small to warrant different educational goals or careers for males and females.[4,5,6]

The "weed out" tradition in engineering was the second topic. Early engineering education originated in the military and the concept of engineering education as "ordeal" lives on today. Through the ordeal, students are challenged as a rite of passage into manhood. This tradition is meant to test one's ability to tolerate stress, pain, or humiliation.[7] Engineering faculty are an "elite fraternity" whose job is to "weed out" weak students.[8]

STUDY SETTING

The populations studied were engineering students at a large eastern public urban university. Freshman engineering students entered college and then, at the end of the first year, students applied for admission to one of the six engineering departments. In 1993, the college of engineering enrolled 15.9% women students.

STUDY DESCRIPTION

A freshmen engineering class was a required course for engineering students. The rosters from the class from 1992-1997 were used for study. Twenty males and twenty females were randomly selected from each year.

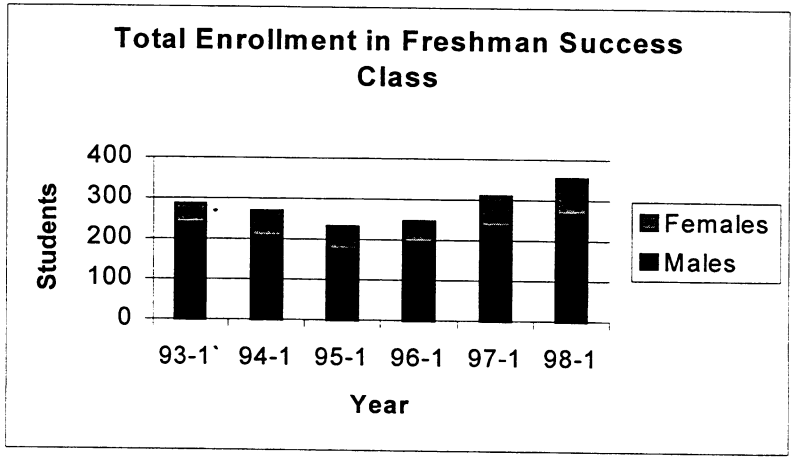
The academic records of the selected students were reviewed to get the GPA from the spring of 1993 through the spring of 1998. Students were checked to see if they were still enrolled in engineering. Those staying within the college of engineering were labeled Stayers. Those who changed into other majors at the school were labeled Changers. Those students who left the university were labeled as Leavers. The student's ACT/SAT test scores were also gathered to use as a covariate in the data analysis.

A t test compared the SAT scores of men and women students. One-way ANOVA's were done to examine the GPA of men and women engineering students and the SAT scores for Stayers, Leavers, and Changers. Finally, a chi-square test compared male and female retention.

RESULTS

The data showed an increase in the freshman engineering student enrollment. The total enrollment increased from 230 to 353. There was also an increase in the number of women engineering students. In 1993, 16% of the freshman students were women. In 1998, the number of women students nearly doubled to 88, which represented 25% of the freshman students. This percentage of female engineering students exceeded the national average of 14%, but matched Brazelton's claim that growth in engineering enrollment would come from the inclusion of women.[9]

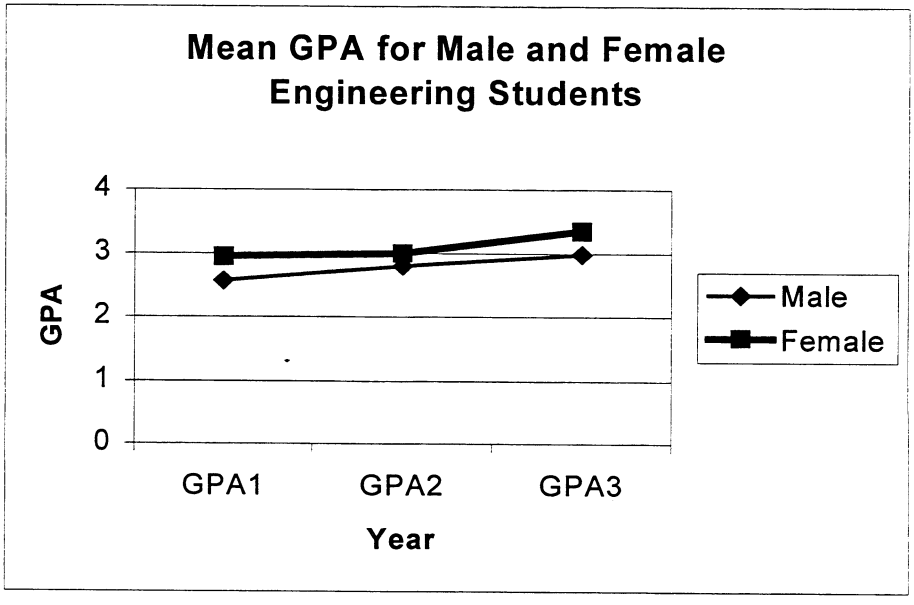
Figure 1



SAT and ACT information was available and gathered for 238 of the students. A t test was then run on the SAT test scores. A t test found no significant difference in the SAT scores of the men and women engineering students. With an alpha level of .05, $t(236)=1.53$, $p=.127$. The male mean SAT score was 1174 (N=118) and the female mean SAT score was 1200 (N=120). Equivalent SAT scores for men and women engineering students at the school matched the conclusion reached by others that there were few significant differences between the ability of men and women.

However, there was a difference in the GPA of the women and men engineering students, with the women having higher GPA's. Figure 2 illustrates the mean GPA for the women and men engineering students at the end of the first (GPA1), second (GPA2) and third (GPA3) years.

Figure 2



An analysis of variance revealed there was a significant difference in male and female GPA's at the end of the first year (GPA1). Table 2 displays this analysis.

Table 2

One-way ANOVA for Female and Male GPA

Source	SS	df	MS	F	Significance
GPA1	4.177	1, 178	4.177	8.804	.003*
GPA2	1.123	1, 105	1.123	1.996	.161
GPA3	1.749	1, 49	1.749	3.614	.063

*=significance at the .05 level

Finally, there was not a significant difference in the retention of women and men engineering students. A chi-square analysis of the retention of men and women revealed X^2 (2,N=240)=1.113, p=.573 at the .05 level. The data analysis in this study showed that women engineering students at this school were not more likely to drop out of engineering.

There was no significant difference in the SAT scores for the engineering students who stayed, left or changed majors. The results of a one-way analysis of variance at the .05 level showed F(2,235) = 2.728, p=.067. Table 3 displays the mean SAT scores for the different retention groups.

Table 3

SAT Means for Retention Groups

Stayers	1198
Leavers	1162
Changers	1146

CONCLUSIONS

Two findings in this study were not matched by the literature. First, there was no significant difference in the SAT scores of the men and women engineering students in this college of engineering. Second, previous research said women were more likely to drop out of engineering than men were. In this study, there was not a significant difference in the retention of women and men engineering students. The author offers two explanations for this. First, this college of engineering had female recruiters, female freshman engineering advisors, and, the director was a woman. I anticipate these women served as role models and sent the message to women that they were welcome in engineering. A second reason for the similar retention rates was the urban campus setting. This trend was also mentioned by Felder who said women were more likely to attend an urban school.[10]

There was a significant difference in the GPA of the women and men engineering students, with the women having higher GPA's at the end of the freshman year. This result was consistent with previous research.

Clearly, women in this college of engineering were prepared and capable of studying engineering. This study provided further evidence to counteract the myth that women do not have the ability to be engineers.

This study found no significant SAT difference for Stayers, Leavers and Changers. The military background in engineering education where only best survive is still present in the engineering culture. Too often faculty take pride in weeding out weak students. Faculty should know that good students leave engineering. We should try to retain good students who start out wanting to be engineers. Recent research at the University of Washington[11] and Virginia Tech[12] also found similar results. At Virginia Tech, "poor academic performance does not appear to be as directly related to voluntary nonretention as does poor social attachments." Personally connecting with students is what retains students. Many students with strong academic ability leave engineering not because they are "weeded out" of a difficult program, rather they leave because they do not personally connect with a program.

The discussion concluded with participants identifying ways they could counteract the two myths. Ideas included encouraging engineering leaders to bring in outside pressure from legislators, respected authorities and private industry spokespersons. The group also suggested awareness campaigns and to learn from other institutions that successfully attract female students and retain more students. Additionally, mentor programs were encouraged in both academic and industry settings. Industry representatives said they could sponsor more faculty and mentor more students. Finally, the business leaders encouraged educators to look at the financial impact of losing both women and good students from the engineering pipeline.

REFERENCES

[1] Friedman, L. (1989, Summer). Mathematics and the gender gap: A meta-analysis of recent studies on sex differences in mathematical tasks. *Review of Educational Research, 59*(2), 185-213.

[2] Campbell, P. B., & Storo, J. N. (1994). *Girls are..boys are..: Myths, stereotypes & gender differences.* Washington, DC: US Department of Education.

[3] Hedges, L. V., & Nowell, A. (1995, July 7). Sex differences in mental test scores, variability, and numbers of high-scoring individuals. *Science, 296,* 41-45.

[4] Benderly, B. (1987). *The myth of two minds: What gender means and doesn't mean.*

[5] Rhode, D. L. (1997). *Speaking of sex the denial of gender inequality.* Cambridge, Massachusetts: Harvard University Press.

[6] Mann, V. A., Sasanuma, S., Sakuma, N., & Masaki, S. (1990). Sex differences in cognitive abilities: A cross-cultural perspective. *Neuropsychologia, 28*(10), 1063-1077.

[7] Gregg, M. H., Hirschfeld, D., & Watford, B. (1996, June). Student retention strategies gender clustering ASEE (Ed.). ASEE. Washington, DC.

[8] Seymour, E., & Hewitt, N. M. (1997). *Talk about leaving: Why undergraduates leave the sciences* (Westview Press, Ed.). Boulder, Colorado.

[9] Brazelton, W. T. (1996, June). A quarter century of women and minorities in engineering at Northwestern University ASEE (Ed.). ASEE. Washington, DC.

[10] Felder, R., Gelder, G., Mauney, M., Hamrin, C., & Dietz, J. (1995, April). A longitudinal study of engineering student performance and retention: Gender differences in student performance and attitudes. *Journal of Engineering Education,* pp. 151-163.

[11] Brainard, S. G. & Carlin, L. (October 1998). A six-year longitudinal study of undergraduate women in engineering and science. *Journal of Engineering Education*, 369-375.

[12] McLaughlin, G. W., Brozovsky, P. V., & McLaughlin, J. S. (1998). Changing perspectives on student retention: A role for institutional research. *Research in Higher Education*, 39 (1), pp. 1-17.