



Attracting and Retaining Women in Undergraduate Engineering Programs – A Case Study

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Abstract

Gender disparities in engineering educational programs have been a cause of concern globally. Such disparities can lead to inequalities in professions with related social effects. In this case study, gender based analysis is performed on statistical data of students admitted to undergraduate programs in electrical and biomedical engineering during the academic years 2001–2010 at Ajman University of Science & Technology, United Arab Emirates. Statistical analysis was carried out to determine the trends in admission, retention, and attrition. In each program significant changes were introduced from the academic year 2006–07. Therefore, differences observed before and after the changes were also analyzed.

During the 10-year period (2001 – 2010), cumulative intake of women was 34%. The cumulative percentage of women students increased from 33% of the total intake in the first 5-years to 35% in the last 5-years. The overall retention over the 10-year period was 57%. The retention in the group of women was 65%. Introduction of changes in the programs enhanced student retention, more so in the group of women. Further, 73% of the cumulative attrition took place in the first three semesters after admission. Comparing the first and last 5-year periods, this attrition was 68% and 84%, respectively. This trend of attrition was strikingly similar in both the groups of women and men.

The analysis suggests that the percentage of women has increased in recent years. Cumulative retention was higher in the group of women compared to that of men. Introduction of changes in the programs enhanced student retention in both groups. An important and interesting observation from this study about student attrition suggests that early period after admission is decisive for a significant majority of students, irrespective of gender.

Introduction

Gender disparities in engineering programs has been a cause of concern globally. The percentage of women in engineering is generally found to be lower than that of men^(1–10). Studies have also shown that even if women join engineering programs, they may not continue^(1, 5, 8, 9). As a consequence, such disparities in engineering education can lead to inequalities in professions with related social effects^(1, 3, 4, 6, 9, 10). Our experience suggests that, in general, the retention of students in undergraduate engineering programs is influenced by several factors, including program admission and completion requirements as well as curriculum design and content⁽⁷⁾.

In this case study, we have analyzed 10-year data of women and men students admitted to three accredited undergraduate engineering programs (in Electronics, Communication and Biomedical Engineering) in the academic years 2001–2010. The analysis gives various patterns of admission, attrition and retention related to women in comparison to men students.

Method

A gender based statistical analysis was carried out for intake, retention and attrition. The data was presented as percentage of admitted students. Analysis of data was carried out up to the 1st semester of the academic year 2013–14. An academic year consisted of two main semesters beginning in September and ending in June of the following calendar year.

The intake of students in the women group was compared with that of total intake as the sum of fresh admissions in all the three programs for each academic year of the given period. Year-by-year retention of students was compared as the total sum of students in the groups of women and men who either completed their program or were continuing at the time of this study (as the duration of each program is four years, students mostly from the recent years of admission were continuing). Students who aborted their programs contributed to the program attrition. Experience suggests that attrition in engineering programs is critical in the early years of study⁽⁷⁾. Therefore, we analyzed the attrition in the first three semesters of admission.

Also, from the academic year 2006–07, significant changes were introduced in the programs as described in the following paragraphs. Therefore, the differences observed between the periods 2001–05 and 2006–10 were also analyzed. The changes applied uniformly to both genders, were related to admission and completion requirements as well as curriculum design and content. The details have been published elsewhere⁽⁷⁾; a brief description is given below:

1. The program admission criteria were enhanced by introducing a requirement of a minimum score in an standardized English language test like TOEFL (Test Of English as a Foreign Language). Previously, non-standardized tests for English were conducted.
2. For each program, the completion requirement was reduced by at least 23 credit hours. Previously, each program required 165 credit hours for completion.
3. Program curriculums were redesigned to ensure that the students' transition from junior to senior level courses was smooth in terms of knowledge, skills and various relevant competencies.
4. Program contents were enhanced to ensure that students' interest and motivation in engineering were developed and sustained from the early stages of their program. This involved adding topics, courses and activities in the early years of study so that the students could learn about their field of study as well as interact with the specialized faculty members from their respective programs.

It may be noted here that in this study no consideration was taken into account of any academic or non-academic control factor like students' performance, GPA or their preparation level, financial, cultural or ethnic background.

Results and Discussion

Figure 1 gives normalized values of the year-by-year intake of students for the ten academic years. The intake showed distinct patterns during the initial and recent 5-year periods. This is possibly because of the changes introduced in the programs as described earlier.

Figure 2 gives the intake of women students in comparison to total intake for the ten academic years. The women were at least 32% of total intake in eight out of ten years attaining a maximum of 40%.

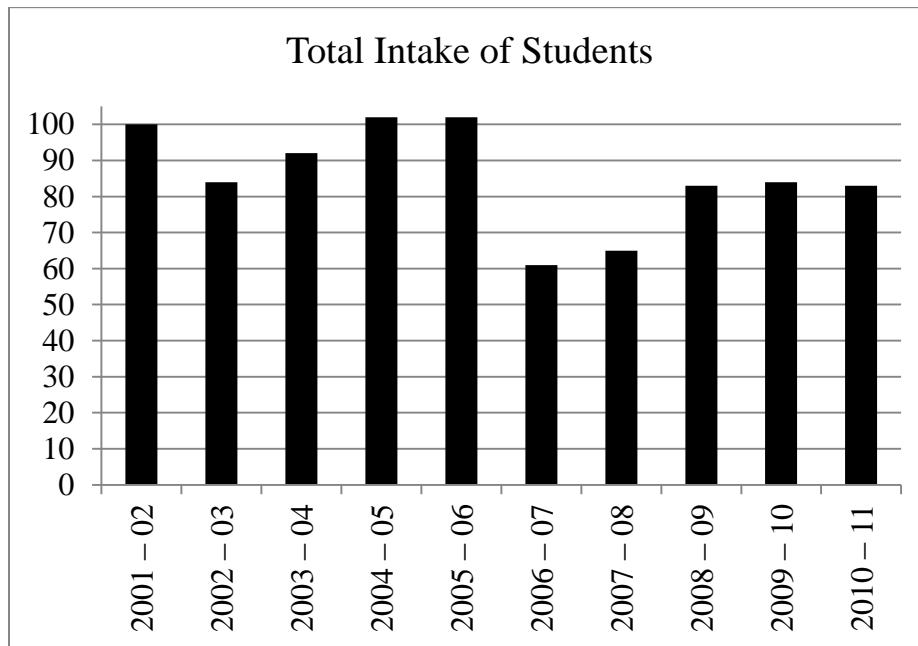


Figure 1: Total intake of students during the academic years 2001–2010. For each year, the data is normalized with respect to the total intake of the year 2001–02.

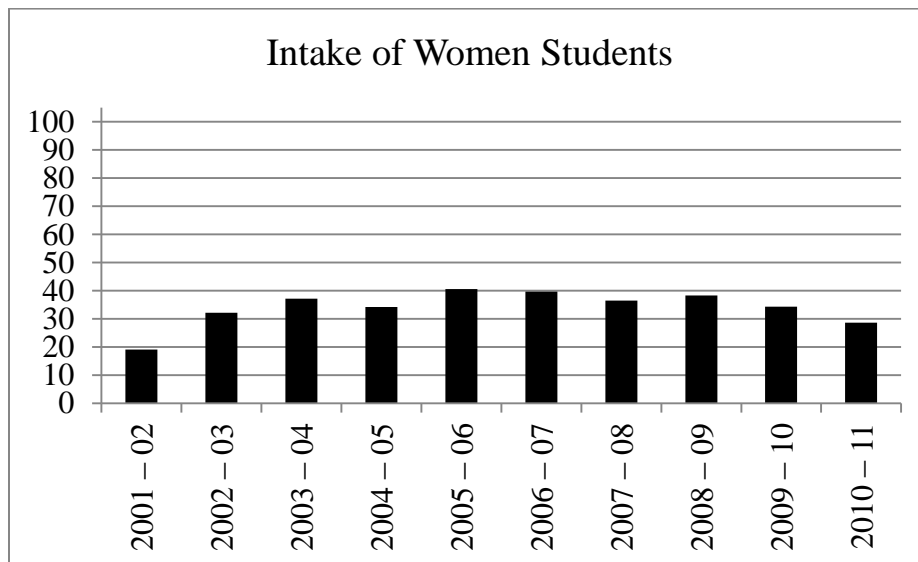


Figure 2: Intake of women students given as a percentage of total intake for each academic year during the 10-year period.

Though overall intake of students dropped in the recent five years, the average percentage of women intake increased from 33% in the initial five years to 35% in the recent five years. Average intake of women during the ten years was 34% of the total. This is nearly double of a recently reported female enrollment data in undergraduate engineering programs with an average of 18% for the years 2007 to 2010 ⁽²⁾.

For each batch of admitted students, Figure 3 gives cumulative percentage of the retained women and men students. The retention among women was higher or equal to that of men students. Average 10-year cumulative retention was 65% for the women and 54% for the men in their respective groups.

In each group of students, there was significant improvement in retention from the initial to the recent 5-year period. For women, the average was 54% and 76%, respectively. For men, these averages were 47% and 61%. Retention data for the two 5-year periods was tested statistically using t-test with significance level, $\alpha = 0.05$. For the group of women, result of t-statistic was 4.44 and t-critical (one tail) was 1.94. For the group of men, result of t-statistic was 2.08 and t-critical (one tail) was 2.02. The null hypothesis that “the two means were equal” was rejected for both groups of men and women.

Figure 4 gives attrition in the first three semesters of admission as a percentage of total cumulative attrition for women and men. From those who aborted their programs during the 10-year period, 73% did so within three semesters of admission. A comparison of the initial and recent 5-year periods suggests that 68% and 84% students of the attrition group, respectively, aborted their programs within three semesters of admission. Interestingly, this behavior averaged over the 10-year period or averaged over the two 5-year periods showed nearly the same percentages in the groups of women and men. This may be an important observation suggesting that the students, perhaps, took an early decision about their academic interests. However, no investigation was conducted to elaborate on any specific reason or factors which may have contributed to the attrition.

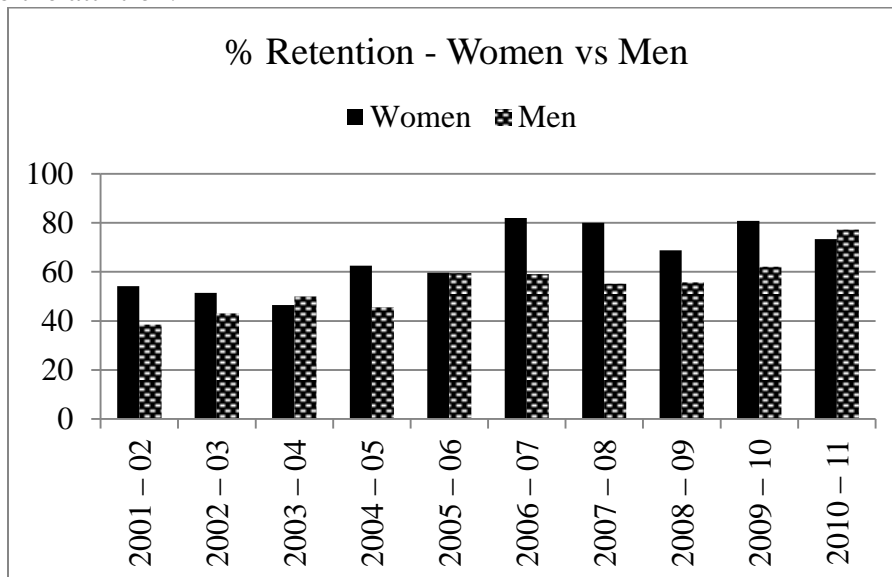


Figure 3: A comparison of cumulative retention among women and men students given as percentage of their respective intake for each batch during the 10-year period.

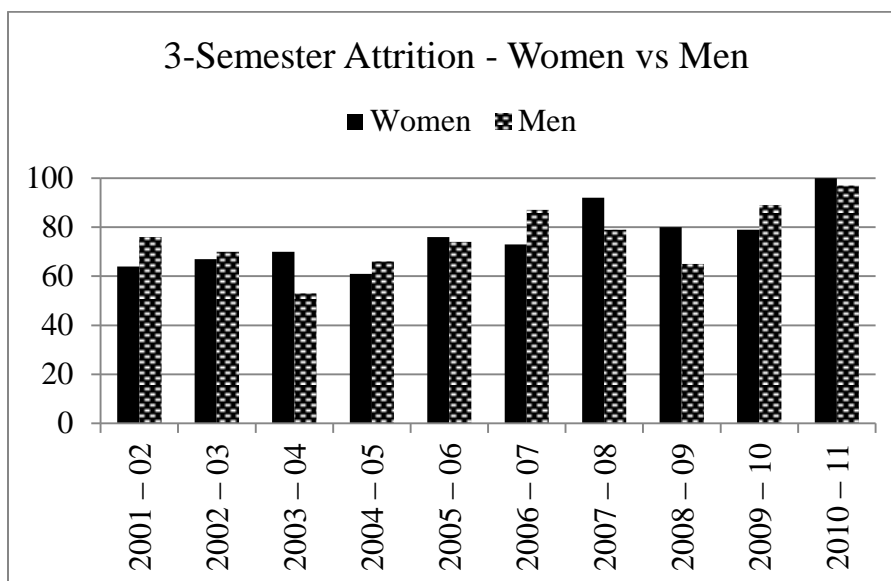


Figure 4: Attrition in the first three semesters of admission given as percentage of total cumulative attrition from each batch of women and men students during the 10-year period.

Based on the data presented in Figures 3 and 4, overall attrition in the first three semesters was reduced from 31% to 20% for women and from 36% to 32% for men in the initial and recent 5-year periods, respectively. This may suggest that the changes introduced in the programs helped in developing and sustaining students' interest and motivation from the early stages of their programs.

Conclusion

The analysis in this case study suggests that the percentage of women in engineering programs has increased in recent years. The percentage of retention was higher for women than men. Conversely, the percentage of attrition was lower in the group of women students. Introduction of various changes in the programs enhanced student retention in both groups. The enhancement was more for the women group.

Further, an important and interesting observation from this study about student attrition suggests that early period after admission is decisive for a significant majority of students, irrespective of gender.

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