

The Effect of the Scheduling of the First Engineering Course on the Retention of Underrepresented Minority Engineering Students

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Abstract

The retention of freshmen engineering students has received much attention and research focus in the last few years. Direct exposure to engineering during the first two semesters of the freshman engineering student is an area being studied as a retention factor. When the introductory engineering course at Arizona State (ASU) was in a different format, studies suggested that if engineering students took the course during their first (fall) semester, their rate of retention was higher than those who took the course in the spring. However, due to staffing and space limits, only about half of the new freshmen can take the course in the fall. In a more recent study, women and minority students showed a trend of higher retention by taking ECE 100 in the fall. Because the numbers were low, more study needed to be done to strongly suggest a change in the semester in which students took ECE 100.

During the past five years, the Office of Minority Programs (OMEP) has expanded and become very active in its efforts to recruit and to retain underrepresented students. As we look to further refine our efforts, it would be useful to learn if the semester in which an underrepresented minority student took ECE 100 had a significant effect on retention. This paper will look at the records of the FFF minority students who enrolled in the past three falls and investigate their trend of attrition. If there is evidence that minority students who do not take ECE 100 in the fall are more likely to withdraw from the CEAS, then special programs to help increase this retention would be indicated. One purpose of the special programs would be to help these students, already isolated by small numbers, to feel a part of the college and also to give them a vision until they have a chance to take a course on engineering.

Surprisingly, this study did not show any significant difference in the retention rates of FFF minority students who took ECE 100 in the fall or the spring. However, there was a significant difference in the retention of FFF minority students who took ECE 100 and those who did not take the course. An alarming number of students withdrew from the CEAS before they had taken even one engineering course. Minority focus groups with FFF taking ECE 100 in the spring and those freshmen who have not taken ECE 100 will be used to clarify their program needs.

Introduction

It is well known that the retention of engineering students is a national problem. Many approaches are being implemented to increase retention. These approaches range from special design courses¹ and experiences² to integrated curricula³ and integrated learning and cluster

classes⁴ and cluster housing,⁵ to special programs, workshops and seminars.⁶ Learning communities are being formed to help engineering retention.⁷ Other programs inform professors

about learning preferences.⁸ Studies have been done on the characteristics of freshman engineering students including how their attitudes relate to performance and retention in the freshman engineering program. One study found that the attitudes of students who left the freshman engineering program in “good academic standing” had significantly different attitudes about engineering and themselves than those held by comparison groups.⁹ Recruitment programs that inform potential engineering students about the engineering career and help shore up the science and math skills are also retention programs.¹⁰ Many science and engineering students transfer to another major because their reasons for choosing the technical field no longer seem appropriate.¹¹ The students lack a vision of what engineering really is and therefore are not motivated to persevere through the tough “tools classes” that are required.

Nationally only about half of all engineering students actually graduate. The proportion is even lower for underrepresented minority students and women. Therefore curriculum changes and retention programs are especially concerned with these students.¹² Since a large proportion of the attrition occurs after the first or second semester,¹³ the freshman year experiences are critical to graduate rates. Direct exposure to engineering during these first two semesters could be a critical factor in retention.

ASU is a metropolitan institution. ASU is a large university, with 43,732 students enrolled on the main campus. The CEAS enrollment for Fall 98 was 3,818 undergraduates and 1,729 graduate students.¹⁴ On average, only about 20% of the students in the CEAS and at ASU live on campus. Over half of the freshmen engineering students work with 25% of them working over 20 hours per week. All of these factors point to high attrition rates and in addition, as a state institution, necessarily our selectivity rate is low. In a study by the National Action Council for Minorities in Engineering, Inc. (NACME) on the retention of minority and non-minority students, selectivity was found to be the most important predictor of degree attainment for both minority and non-minority students. Selectivity ratings are self assessments made by each college based on three criteria: percentage of applicants accepted, high school class rank, and standardized test scores of freshmen who actually enrolled in the institution.¹⁵

When the introductory engineering course was in a different format, studies suggested that if engineering students took the course during their first (fall) semester, their rate of retention was higher than those who took the course in the spring. Due to staffing and space limitations, only about half of the new freshmen in the College of Engineering and Applied Sciences (CEAS) at Arizona State University (ASU) take the course in the fall. In a more recent study,¹⁶ a comparison was made of one and two year retention rates for first-time, full-time freshmen (FFF) who enrolled in Fall 1995 at ASU. The comparison was done by the semester in which the survey students took the Introductory Engineering course ECE 100, as well as by gender, ethnicity, and FFF status. ECE 100 “Introduction to Engineering Design,” is an “Introduction to engineering design philosophy and methodology: computer modeling of systems, processes, and components; design for customer satisfaction, profitability, quality and manufacturing; economic analysis; flow charting; sketching CAD; and teaming. A term design project is included. Prerequisites: high school computing and physics and algebra courses or equivalents.”¹⁷ Due to the contract nature of the course, it is reasonably easy to earn a C grade. However, the required teaming, strict deadlines, and large amount of required homework makes the class quite challenging for most students. Surprisingly, for all groups: men, women, and minority students,

retention was higher after two years for those students who took ECE 100 in the spring. This difference was significant for male students. Among FFF students, while men did better taking ECE 100 in the spring, women and minority students showed a trend of higher retention by taking ECE 100 in the fall.

Because the numbers were small, this paper will look at the records of the FFF underrepresented minority students who enrolled in Falls 95-97 and investigate this trend of attrition by minority students. If this trend were indeed prevalent, then special programs to help increase retention would be indicated for FFF minority students not in ECE 100 in the fall. One purpose of the special programs would be to help these students, already isolated by small numbers, to feel a part of the college and also to give them a vision about engineering until they have a chance to take a course in engineering. Focus groups with FFF taking ECE 100 in the spring and freshmen who have not taken ECE 100 could be used to clarify their program needs. The CEAS is comprised of Aerospace and Mechanical, Chemical, Bio and Materials, Civil, Computer Science, Electrical, and Industrial Engineering, and the Del E. Webb School of Construction. The Computer Science Department is comprised of a Computer Systems Engineering Program and a Computer Science Program. All students in the CEAS, except the Computer Science students are required to take ECE 100.

Office of Minority Engineering Programs

Although a minority engineering office had existed for some years in the CEAS, the program was quite limited in its support of minority engineering students. In 1993, a new director and program coordinator were hired who expanded the program. In 1994, the current director was hired. She and the Office of Minority Engineering Programs (OMEP) have greatly expanded the support available to minority engineering students. A very important component of this program is the CEMS (Coalition of Engineering Minority Societies) Room, a place where minority students can study in teams or alone, receive tutoring, socialize, relax, and do homework. Six up-to-date, fully loaded computers donated by industry provide the students with a network to ASU information system support. The CEMS Room (pronounced "seams" as in a seam binding together different pieces of cloth) is located right across the hall from a suite of offices housing the administrative and support staff for the OMEP. The administrative team includes a Student Support Liaison Officer who directs the Minority Engineering Program and the Mathematics, Engineering, and Science Achievement (MESA) Program, a Program Coordinator, Sr., a Program Coordinator for MESA, an Administrative Assistant, several graduate students, and several undergraduate students. The close proximity of the CEMS room to the OMEP administrative offices results in students stopping by and chatting with OMEP staff often resulting in suggestions to assist the student in their studying (form a study group), possible isolation, and finances.

Although the percentage of minorities enrolling in and graduating from engineering schools has not changed much nationally during the last few years, through much effort by the college, the enrollment of undergraduate minority students in the CEAS has nearly doubled in the last seven years. It has increased over 31% in the past two years and 13.6% from last year to over 650 students. Minority students now make up 17.2% of the undergraduate CEAS enrollment. In Fall 97, for the first time, over 100 Native American and over 100 African American students were enrolled as undergraduates in the CEAS.

The OMEP is a part of the Office of Student Affairs, along with a Women in Engineering Program, a Recruitment Office, and an Internship/Coop Office. These programs are dedicated to the recruitment, retention, and placement of engineering students. In summer 1999, twelve programs will be run, all with the purpose of recruiting more students into the CEAS. The OMEP will host four summer programs: two for rising freshmen and sophomores, one for rising juniors and seniors, and a bridge program for freshmen entering the CEAS in Fall 1999. These programs are targeted, but not exclusive, for underrepresented minority students. The primary recruitment for these programs is done through MESA. Our ASU Mesa Program works with 15 junior high and high schools and some 600 students. The MESA Program in these schools is conducted through either a class or an after school club. The ASU MESA conducts Saturday Academies throughout the school year, provides industry tours, conducts a regional MESA Day with academic competitions, as well as hosting the state MESA Day every other year. The OMEP works with the MESA advisors in the state to give them training in computer skills and in engineering background. In addition, underrepresented minority students can enroll in special summer sessions for women and in open enrollment sessions.

The Bridge Program targeted for underrepresented students has been particularly successful recruitment and retention tool.⁶ This program stresses an introduction to engineering processes, design, and teamwork, the skills that are necessary to survive as an engineering student, and the building of community. Approximately 40 students, approximately one-third of each entering freshmen minority cohort, have attended the program for the past three summers. All but three of the students have enrolled in the CEAS at ASU. In addition, each Bridge student takes a math placement exam and is counseled and then enrolled in the proper math class.

An Academic Excellence two semester hour class is offered to the Bridge students and other minority students during the fall of their freshmen year. During the first two years of the Bridge Program attendance in this class was optional. Free tutoring was also offered to these students. Not surprisingly, we have found that those students who participate in the Bridge Program and the tutoring are more likely to be retained in engineering.⁶ A university retention goal of 78% has been set for the entering freshman class of Fall 1999. The average overall retention rate of underrepresented minority students enrolled as FFF in the CEAS in Falls 93 and 94 was approximately 63% at the University level and only 50.5% in the CEAS. The last two years, after the addition of the Minority Bridge Program, there has been a significant improvement in their retention at both at the university and the CEAS level. The Fall 97 engineering minority students had a 80.7% retention rate at the university level and a 69.3% level at the college level. The Fall 98 engineering FFF were retained at 75.0% in the university and 66.9% in the CEAS. See Figure 1.

Additional retention programs run by the OMEP include free tutoring, advising, workshops and seminars (such as time management, resume writing, and interviewing), and support of the student organizations AISES, NSBE, and SHPE. The Office of Student Affairs provides financial support to these, as well as other, organizations to help support a trip by many of the student members to their National Convention and Career Fair. The student organizations repay the support by volunteering at the rate of \$8/hour to assist in recruitment events sponsored by the college.¹⁸

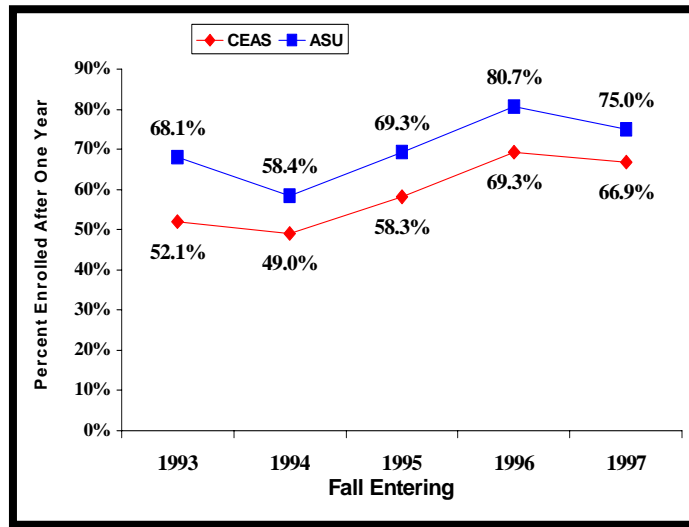


Figure 1. One Year Retention of First-time Full-time Freshmen Underrepresented Minority Students

As encouraging as these retention statistics are, the OMEP continues to seek improvements in the retention rates of its students. The purpose of the study was to investigate if there were other steps that could be initiated to improve the retention of minority students.

The Study

The records of all minority full-time, first-time freshmen for the Falls of 95, 96, and 97 were obtained. First-time, full-time freshmen (FFF) are defined as those students carrying at least 12 semester hours and who have transferred in less than 12 hours or who have enrolled within one year of their high school graduation. In this last case, the number of transfer hours is not a factor in their FFF status. Although many students at ASU are part-time, in this study less than 10 minority freshmen were actually part-time in each of the fall semesters studied. From the records, the semester in which the student took ECE 100 was noted, as well as their enrollment each fall in the CEAS or in another college of ASU. The retention statistics for the FFF minority students of each of these falls is shown in Tables 1 and 2. Since the records come from different sources and some students drop out for a time and then return to the university, the data in Tables 1 and 2 does not coincide exactly with Figure 1, nor with the other tables to follow.

	F 95	F 96	F 97
Beginning semester	90	112	136
After one semester	81	110	130
Return after 1 yr	60	91	101
Return after 2 yrs	56	78	
Return after 3 yrs	51		

Table 1 – Returning FFF Minority students, ASU retention

	F 95	F 96	F 97
Beginning semester	90	112	136
Return after 1 yr	49	78	90
Return after 2 yrs	47	59	
Return after 3 yrs	35		

Table 2 - Returning FFF Minority students, CEAS retention

It can be seen from these tables that the retention of the students from year one to year two varies considerably from year to year. The Fall 95 class had a 96% retention from year one to year two, while the Fall 96 class had only a 75.6% retention rate from year one to year two in the CEAS.

Next we looked at the retention of the FFF minority students based the semester in which they took ECE 100. Since the Computer Science (CS) students are not required to take ECE 100, those students were pulled from the rest of the students. Table 3 shows the three year retention at ASU and in the CEAS of the FFF minority students who enrolled in Fall 1995. Table 4 shows the two year retention at ASU and in the CEAS of the FFF minority students who enrolled in Fall 1996. Finally, Table 5 shows the one year retention at ASU and in the CEAS of the FFF minority students who enrolled in Fall 1997. Table 3 shows that only one student still in the CEAS and not a CS major had not taken ECE 100 by their fourth fall. Table 4 shows that only 3 students still in the CEAS had not taken ECE 100 by their third fall. Table 5 shows that nearly a third of the students still in the CEAS had not taken ECE 100 by their second fall.

	Took ECE 100				
	1st Sem	2nd Sem	Later	Never	CS-Never
In CEAS	14	13	6	1	1
At ASU, not in CEAS	4	3	0	8	1
Not at ASU	7	7	3	19	3

Table 3 - Three Year Retention for Fall 95 FFF Minority students in the CEAS based on when ECE 100 was taken

	Took ECE 100				
	1st Sem	2nd Sem	Later	Never	CS-Never
In CEAS	34	15	4	3	4
At ASU, not in CEAS	7	2	0	5	4
Not at ASU	14	5	2	11	2

Table 4 - Two Year Retention for Fall 96 FFF Minority students in the CEAS based on when ECE 100 was taken

	Took ECE 100				
	1st Sem	2nd Sem	Later	Never	CS-Never
In CEAS	25	20	7	25	10
At ASU, not in CEAS	2	1	1	7	3
Not at ASU	10	3	1	15	6

Table 5 - One Year Retention for Fall 97 FFF Minority students in the CEAS based on when ECE 100 was taken

Although there is no significant difference in the retention of the students based on the first or second semester in which they took ECE 100, surprisingly a large number of students never took ECE 100. The attrition rate for those students is significantly higher than the attrition rate for those students who took ECE 100. The three year retention rates in Table 3 are very highly significantly different based on when or if ECE 100 was taken ($p=.0005$, although some cells are <5). The CS students are not included in this analysis nor the ones following. The two year

retention rates in Table 4 for students who took ECE 100 in their first or second semester or never are significantly different at $p=.0062$ (some cells <5). The one year retention rates in Table 5 for students who took ECE 100 in the first or second semester or never are different at $p=.11$ (some cells <5). Unfortunately, these students left engineering before they had taken an engineering course. These students may have left engineering based on their experiences with math and physics. Also, these students may never have been in a class with a large number of other engineering students, felt isolated, did not have study groups with other engineers, and left the CEAS.

Next we considered the academic standing of the FFF minority students who left ASU. As can be seen in Table 6, a large proportion of the students leaving had a GPA less than or equal to 2.0. Finally, if we consider the students who left ASU and who never took ECE 100, other than CS students, most of them did not have a GPA greater than a 2.0. See Table 7. Several of the students who left ASU without having ECE 100 did have good GPAs. Perhaps taking ECE 100 would have broadened their vision of engineering as an exciting career choice.

	Fall 1995		Fall 1996		Fall 1997	
	GPA		GPA		GPA	
	≤ 2.0	> 2.0	≤ 2.0	> 2.0	≤ 2.0	> 2.0
Left after one semester	7	2	2	0	5	1
Left after one yr	18	1	14	5	20	9
Left after 2 yrs	6	1	6	7		
Left after 3 yrs	3	2				

Table 6 - GPA Status of FFF Minority students who left ASU

	Fall 1995		Fall 1996		Fall 1997	
	GPA		GPA		GPA	
	≤ 2.0	> 2.0	≤ 2.0	> 2.0	≤ 2.0	> 2.0
Never took ECE 100	16	3	6	5	12	3

Table 7 - FFF Minority students who left ASU without taking ECE 100 (CS students not included)

Conclusions

The one-year retention of FFF minority students increased substantially after the introduction of the Minority Bridge Program. Our study showed that the retention in the CEAS of FFF after two years varied tremendously from year to year. There is no apparent explanation for this: perhaps focus groups of these students could give us some insight. There was no significant difference in the retention of FFF minority students by the semester in which they took ECE 100. Perhaps the students enrolled in an engineering class their first semester receive peer support to continue their engineering studies, but the students taking the course in the spring have acclimated to college life so that they can better survive and thrive in the challenging ECE 100 class.

The study turned up two unexpected results. First, in spite of the number of part-time students at ASU in general, there were less than 10 part-time first-time freshmen among the freshmen

minority students. Second, the large number of students who leave the CEAS without having taken ECE 100 was alarming. It is known that many CEAS freshmen engineering students have difficulty with their first math class¹⁶. Perhaps a combination of not doing well in math and not having a vision of engineering from the ECE 100 class is too overwhelming for the student to be retained. Focus groups of minority students will be held to shed further light on this study. Based on that information, the OMEP will continue to refine their retention programs.

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