Comparing the Success of Two-Year College Students and Students With Other Academic Backgrounds in a Non-traditional Engineering Program

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UM-St. Louis/Washington University Joint Undergraduate Engineering Program

Introduction

Historically, there has been considerable interest among educators in factors that influence community college students to transfer to four-year institutions and pursue baccalaureate degrees (Dworkin, 1966). Naturally, there has also been interest in what determines whether or not these students will be successful (Cantrell, et al., 1966; Keith, 1966; Laanan, 1996; Lieberman and Hungar, 1998). Kraemer (1966) found that students with higher mathematics ability at entrance to the community college and students who intended to transfer were more likely to transfer successfully. Even though many believe that community college transfer students do not do as well as four-year "native" students, the data which exist on this question suggest that they actually do about as well (Susskind, 1996).

Although there has been interest in community college transfer students in general, little is known about community college students who transfer into four-year engineering programs. Because the community college offers many students an educational opportunity they might not otherwise have, this is an important question. This study reports on the academic success of a group of community college transfer students from 1993-1999 in a unique engineering program, and compares them with native students and students transferring from four-year schools. This study also compares the academic performance of a group of non-traditional engineering students with a group of highly traditional engineering students over the 1998-99 academic year.

Description of the Joint Program

The UM-St. Louis/Washington University Joint Undergraduate Engineering Program provides a unique context for evaluating the success of community college transfer students, as well as transfer students from four-year institutions, in a rigorous engineering program. The Joint Program was established in 1992, and is a cooperative arrangement between UM-St. Louis and Washington University. The Program offers degrees in mechanical, electrical, and civil engineering. The Washington University School of Engineering and Applied Science is highly ranked nationally, and has been in existence for over 125 years. Furthermore, the Joint Program has formal articulation agreements with all of the community colleges in the greater St. Louis area.

Students complete their pre-engineering requirements at UM-St. Louis, a community college, or another institution, and then (with an acceptable GPA) are admitted to the Joint Program. Once admitted to the Joint Program, students take their upper-level engineering courses on the Washington University campus. All upper-level students take the same courses, with the same faculty, in the same facilities, and are evaluated according to the same grading standards as Washington University undergraduates. Students pay UM-St. Louis tuition, and

receive degrees from the University of Missouri, although Washington University is also recognized on the diploma. Courses are offered in the evenings and on weekends, on a part-time basis. The program was designed for "non-traditional" students---most are slightly older, place-bound, and work during the day. In fact, a "parallel" co-op option has become a popular feature of the program.

An interesting aspect of the Joint Program is that many (but not all) of the engineering courses include both Joint Program students and Washington University students. Washington University "day" students are allowed to enroll in Joint Program courses on a "space available" basis. This arrangement allows us to compare the success of the two groups of students. The two student populations are quite different. Most of the Washington University students are traditional students, and have completed their pre-engineering requirements at Washington University, or a small private college (part of Washington University's dual degree program). A large percentage of the Joint Program students have attended several institutions, including community colleges, to complete their pre-engineering requirements.

The following graphs show some basic characteristics of the Joint Program students, and how they have changed from 1992 to 1998. The first graph shows that the students have been getting younger. The mean age in the fall of 1992 was a little over 39, and it the fall of 1998 it was slightly over 33. This change is probably due to the fact that younger pre-engineering students are now entering the upper level program.

Figure 1. Mean age of Joint Program students.

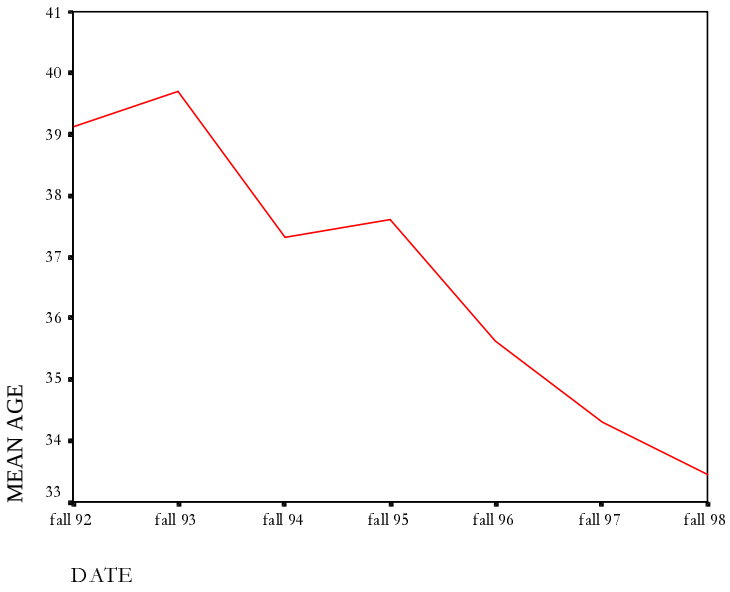


Figure 2 shows that the gender breakdown for the students has remained fairly constant (under 20%), although there was a slight increase in women in the fall of 1996. This increase has remained stable.

Figure 2. Gender.

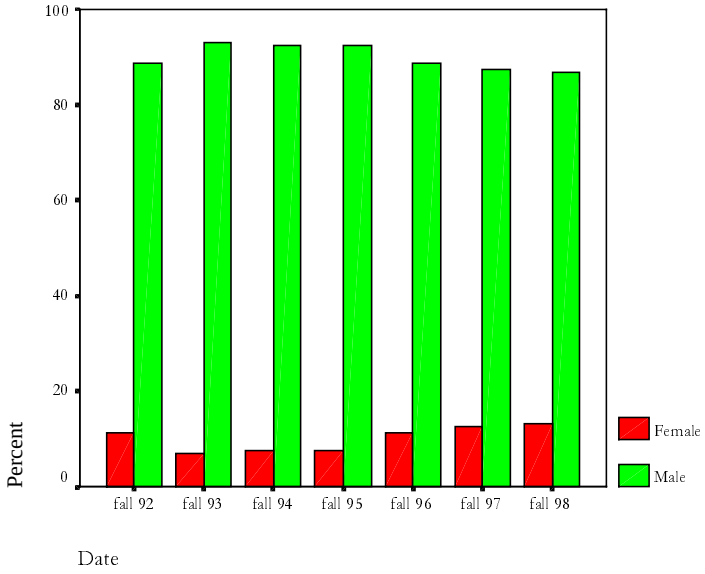
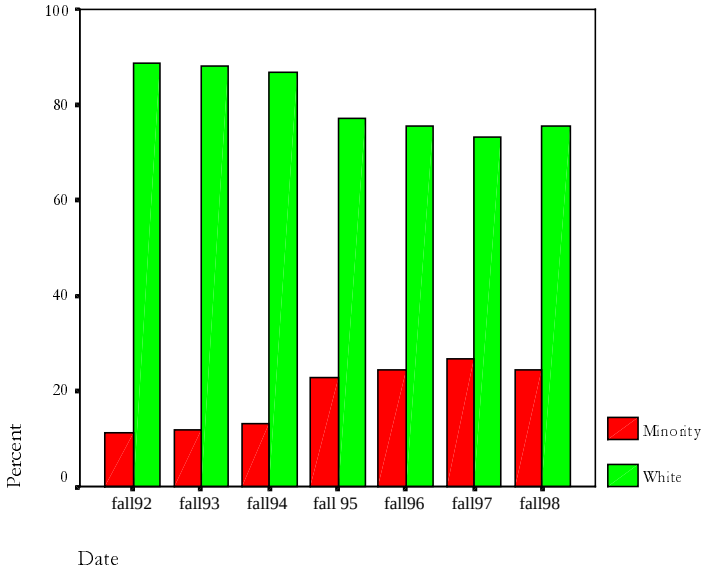


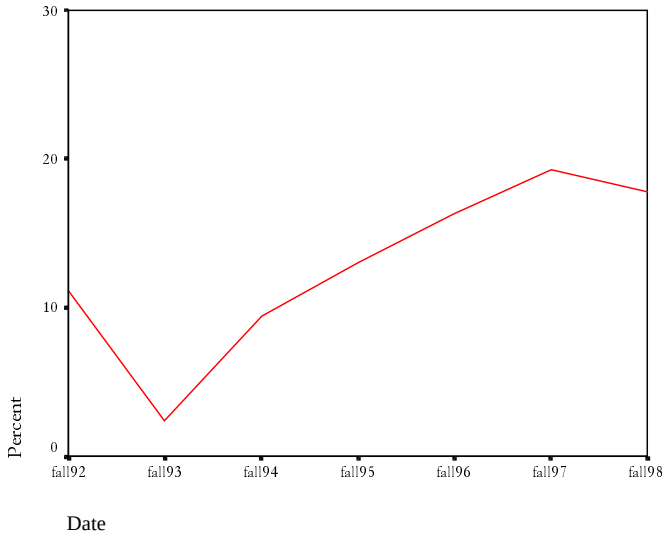
Figure 3 shows that minority students are well represented in the program. Currently, about 20% of the students are minorities. There was a increase in minority students in 1995, which has remained fairly constant. This classification includes Asian-American students, who are underrepresented at UM-St. Louis. There have been a small number of international students in the Program, which were deleted from this analysis.

Figure 3. Minority status of Joint Program students.



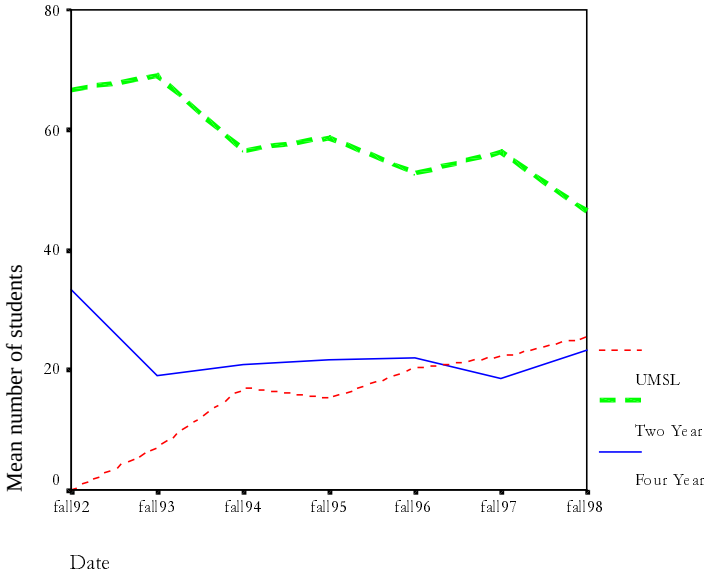
An option for students in the Joint Program is a "parallel" co-op placement Students who choose the parallel co-op work part-time or full-time during the day, and attend classes in the evening. This allows them to take more classes over an academic year, since all classes are offered in the evening and on a part-time basis. Figure 4 shows that this option has increased in popularity over the years. In 1998, almost 20% of the students had placements.

Figure 4. Percent of Joint Program students placed in co-ops.



Over the years, the number of community college transfers has dropped somewhat, while the number of native students has increased. The number of four-year transfers has remained reasonably constant. However, community college transfers still represent the largest group of students in the Program, about 50%.

Figure 5. Type of pre-engineering education.



Methodology

Our goal was to compare the academic success of Joint Program students with Washington University students, and to compare the relative success of Joint Program students with different pre-engineering backgrounds (predominately UM-St. Louis, another four year institution, or a community college). We were also interested in whether other factors, such as gender and ethnicity were related to academic success in the Program. Using existing student records, we were able to construct two different data sets to analyze these issues.

The first data set consists of the grades of Joint Program and Washington University students who were in the same course sections during the fall of 1998 and the winter of 1999. There were 581 grades for Washington University students and 211 grades for Joint Program students. We were also able to classify the grades according to whether they were for mechanical, electrical, or civil engineering courses. This reduced the size of the data set to 396, and 175, respectively, as there were additional Program courses that did not fit into one of these categories (such as engineering mathematics, or engineering communications). Finally, we were able to classify the Joint Program students according to their pre-engineering backgrounds: native students (N=44); community college transfer students (N=111); and four-year transfer students (N=45). This classification was based on the type of institution where they had completed most of their pre-engineering requirements (mathematics, chemistry, physics, statics, and dynamics).

The second data set consists of all of the students who have ever been enrolled in the Joint Program, and includes the variables of pre-engineering GPA (math, chemistry, physics, statics and dynamics), cumulative GPA after entering the Joint Program (based primarily on engineering courses), and the average number of credit hours completed in the Joint Program during the semesters the student was enrolled. The students were classified again according to the type of institution where they had done the most work prior to being admitted to the Joint Program---UM-St. Louis (N=80), another four-year institution (N=73), or a community college (N=146). We were also able to obtain gender, ethnicity, and whether or not the student had participated in a co-op placement from our student record system.

Findings from the “mixed sections” data set

The first analysis compares the grades of Joint Program and Washington University students in the same course sections. All of the grades from all of the sections were compared for the two groups of students. The mean Washington University grade was 3.16 and the mean Joint Program grade was 2.81, on a four point scale. The standard deviations were quite similar, .907 for the Washington University grades, and 1.04 for the Joint Program grades. An independent t-test was computed to determine whether the two grade point averages were significantly different ($t = 4.983$; $df = 790$; $p = <.001$). The result suggested that the Washington University grades were indeed significantly higher. However, it should be noted that although the difference is statistically significant, in substantive terms it is less than the difference between a B+ and a B-.

We were also interested in whether the grades differed by whether they were for mechanical, electrical, or civil engineering courses for the two groups of students. Accordingly, a two-way analysis of variance was computed with type of student and major as the independent variables, and grades as the dependent variable. Both major ($F = 14.131$; $df = 2, 565$; $p < .001$) and type of student ($F = 26.102$; $df = 1, 565$; $p < .001$) had highly significant main effects, and the interaction between major and type of student was also significant ($F = 5.062$; $df = 2, 565$; $p < .01$). The results are as follows:

Table 1. The effects of major and type of student on upper-level engineering course grades.

Major	Type	Mean	SD	N
Civil	WU	3.30	.80	157
	Joint	3.23	.84	70
	Total	3.28	.81	227
Electrical	WU	3.07	1.08	120
	Joint	2.44	1.09	65
	Total	2.85	1.12	185
Mechanical	WU	3.36	.77	119
	Joint	2.76	1.02	40
	Total	3.21	.88	159
Total	WU	3.25	.89	396
	Joint	2.83	1.04	175
	Total	3.12	.96	571

Overall, the civil engineering course grades were the highest, followed by mechanical engineering. Electrical engineering course grades were the lowest. Compared with the Washington University grades, Joint Program grades were highest for civil engineering (about the same as the WU grades), and lowest for electrical engineering courses. The mechanical engineering Joint Program grades were between the civil and the electrical engineering course grades, but the biggest discrepancies between the Washington University and Joint Program grades were in mechanical and electrical engineering. These findings may reflect the fact that some of the upper-level mechanical and electrical engineering courses tend to be more mathematically based than some of the civil engineering courses, and for some of the Joint Program students it had been some time since they had completed the pre-engineering mathematics sequence.

Finally, the grades of the Joint Program students were compared by where they had done their pre-engineering coursework. The results are as follows:

Table 2. Mean grades of Joint Program students in mixed sections by where they completed their pre-engineering coursework.

Pre-engineering work	Mean	SD	N
UM-St. Louis	3.00	1.01	44
Community college	2.78	1.02	111
Four year institution	2.79	1.06	45
Total	2.83	1.02	200

A one-way analysis of variance was conducted to determine whether the means were significantly different. Although native students had slightly higher mean GPAs, the analysis revealed that the difference between the three categories was not statistically significant ($F = .8$; $df = 2, 197$; $p = .45$).

Findings from the Joint Program data set

The second data set was composed of all students who have ever been enrolled in the Joint Program through the summer of 1999 (N=314). We were interested in comparing the academic performance of the students according to their pre-engineering backgrounds, and to simultaneously assess the effects of age, gender, ethnicity, and whether they had participated in a co-op placement. The descriptive statistics for these variables are as follows:

Table 3. Descriptive Statistics

Variable	Mean or %	SD	N
Age	33.45	8.5	314
% co-op	18%		314
% minority	24%		314
% men	87%		314
Credit hours/semester	5.27	2.39	314
Pre-engineering GPA	2.79	.89	299
Upper level GPA	2.85	.8	299

The first dependent variable that was analyzed was the average number of credit hours completed during the semesters that the student was enrolled. An analysis of variance was conducted with pre-engineering background, whether or not the student had had a co-op placement, ethnicity, and gender as the independent variables, and the variables of age and pre-engineering GPA as covariates. The only variables that had significant main effects were pre-engineering GPA ($p = .05$) and gender ($p = .02$). The higher the pre-engineering GPA, the more credit hours the students completed, and women completed more credit hours on the average. There was a significant interaction between ethnicity and gender ($p = .01$). Caucasian women completed more credit hours than Caucasian men, and minority men completed more credit hours than minority women. The type of institution where the student completed his or her pre-engineering requirements did not have a significant effect (at the .05 level or better) on the average number of credit hours completed.

The same analysis was repeated, with upper-level engineering GPA as the dependent variable. In this case, pre-engineering GPA was the only variable that had a significant main effect, and there were no interactions. Once again, pre-engineering GPA had a positive effect. Students with higher pre-engineering GPAs had higher upper-level GPAs as well. The type of institution where one's pre-engineering coursework was completed had virtually no effect on GPA at the upper-level.

Discussion

Our first analysis demonstrated that the Washington University engineering students did in fact do better academically than the Joint Program students, but in practical terms, the difference was not great--- less than the difference between an average of B+ and B-. There is

some indication that the difference in the performance of the two groups might be attributed to differences in their mathematics backgrounds, with the Washington University students completing the math sequence much more recently than some of the Joint Program students. Of particular importance was the finding that the type of institution where the student completed his or her pre-engineering program had no effect on performance in these upper-level engineering courses.

When a number of demographic and academic variables were analyzed in terms of their possible effects on average number of credit hours completed and average upper-level GPA, it was clear that the most powerful predictor of how a student performed (both in terms of credit hours completed and average GPA) was the pre-engineering GPA. In addition, gender and ethnicity had effects on the average number of credit hours completed. Overall, women did better, but when men and women were compared according to ethnicity, Caucasian women and minority men completed more credit hours on the average. Why minority women and Caucasian men did not do as well is an area for further investigation.

Perhaps the most important finding of this study is that the type of institution where the pre-engineering coursework was completed had no effect on any of the measures of academic performance. It is important because it disputes the common belief among many educators that community college students are at a disadvantage compared with native students and four-year transfer students when they transfer to a four-year college or university. The performance of these students is especially impressive in the context of a highly rated and demanding engineering program.

Bibliography

Cantrell, E. D., et al. (1996). Meeting the needs of rural students through distance advising of transfer guides in three measures of student success. ERIC Document Reproduction Service No. ED 394 782. Online. ERIC. 1996, September.

Dworkin, S. L. (1996). Persistence by 2-year graduates to 4-year colleges and universities. Community College Journal of Research and Practice, 20, 445-54.

Keith, B. (1996). The context of educational opportunity: States and the legislative order of community college systems. American Journal of Education, 105, 67-101.

Kraemer, B. (1996). Meeting the needs of non-traditional students: Retention and transfer studies. Paper presented at the 101st Annual Meeting of the North Central Association, Chicago, IL (ERIC Document Reproduction Service No. ED 395 603).

Laanan, F. S. (1996). Making the transition: Understanding the adjustment process of community college transfer students. Community College Review, 23, 69-84.

Lieberman, J. and Hungar, J. Y. (1998). Transforming students' lives: How "exploring transfer" works and why. American Association for Higher Education, Washington, DC (ERIC Document Reproduction Service No. ED 414 983) Online. ERIC. 1998, May.

Susskind, T. Y. (1996). Opportunities and challenges: Bridging the two-year four-year college gap. Paper presented at "Articulation from 2- to 4-Year Colleges: Is it an Allowed or Forbidden Transition?" A symposium sponsored by Oakland Community College, Auburn Hills, MI. (ERIC Document Reproduction Service No. ED 399 990).