

**AC 2008-2199: ROLE OF TWO-YEAR COLLEGES IN THE PREPARATION OF
ENGINEERING STUDENTS**

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Role of two-year colleges in the preparation of engineering students

Abstract

A major problem facing undergraduate engineering programs is attracting and retaining students. This problem is compounded for those students who do not have an adequate mathematics background upon arrival. Another issue is the high cost of college education which reduces the access to education for some students. Of interest is the role of two-year colleges in the preparation of such engineering students. This study looks at the relative success (GPA and retention) of 297 engineering students who took mathematics coursework at one of the system's thirteen two-year colleges and then transferred to one of the three universities within the system that have multiple ABET accredited engineering programs. Over half of these students were initially placed at a level of pre-calculus or below. The success of these students is compared to like groupings of engineering students who went directly to one of the three system engineering schools. This study will look at the relative success of students as a function of initial math placement. In addition, the study will look at the relative success and retention of underrepresented groups.

Introduction

Engineering education over the next decade provides numerous challenges. Our nation is currently facing a shortfall of well-trained engineers. This trend is likely to continue with the upcoming retirement of many of the nation's engineers. Due to these trends universities are looking at ways to increase the number of students entering into engineering and to retain the students already in the program. In addition, engineering is looking at ways to attract underrepresented students (female and disadvantaged minorities) to help meet the demands of industry. One of the biggest challenges of engineering student retention is the marked decrease in the mathematics proficiency of first-year college students. In 2000, nearly 15 percent of first-year engineering majors reported the need for remedial work in mathematics¹ and the problem has not been going away. Students with interest in math, science, and engineering that graduate from high school are often unprepared mathematically to enter these fields.

In the past, engineering students with such deficiencies would not be admitted into the university, and such students would attend a local two-year college to obtain the required background prior to admission into the engineering program. In recent years, due to economic and political pressures, four-year universities have been enrolling students with mathematical deficiencies directly into their pre-engineering programs. The two-year colleges have responded by offering more upper-division coursework to local students. This begs the question: What is the role of the two-year colleges in improving engineering education. This paper attempts to

investigate this question by looking at the performance of engineering students who attended a two-year school in the University of Wisconsin system and transferred to a four-year engineering program within the same system compared to those who began at the four-year system school directly as a function of their math background. In addition we will look at how well the two-year colleges are meeting the needs of underrepresented groups.

University of Wisconsin System Model

The University of Wisconsin system is made up of thirteen two-year schools (UW-Colleges) and thirteen four-year schools (See Figure 1). Of the thirteen four-year schools, only three have multiple engineering programs. The University of Wisconsin-Madison (Madison) and the University of Wisconsin-Milwaukee (Milwaukee) have both undergraduate and graduate programs in engineering. The University of Wisconsin-Platteville (Platteville) located in the southwest corner of the state, is primarily focused on undergraduate engineering education. After receiving IRB approval, data was requested from both the UW-Colleges and each of the engineering schools with all person information removed.



Figure 1 Location of University of Wisconsin System Schools²

Since all incoming students in the university system take the exact same math-placement test (independent of whether they were attending a four-year or a two-year school) we decided that this would be a good place to start. The institutional researcher for the UW-Colleges provided a list of 463 students who had initially attended one of the UW-Colleges and then transferred to one of the three engineering programs in the state over a 5-year period. The demographics of this group of students are listed in table 1a.

Gender	Male	Female					Total
# of students	376	87					463
Ethnic Diversity	White	Black	Latino	Asian	American Indian	Unknown	
# of students	444	3	6	8	0	2	463

Table 1a. Demographics of engineering students transferring from UW-Colleges

Of these 463 students, only 297 students had their initial math placement recorded in the database (87 from the University of Wisconsin-Platteville, 68 from the University of Wisconsin-Milwaukee, and 142 from the University of Wisconsin-Madison). The demographics of these subgroups of students are listed in table 1b, separated according to the engineering school they attended.

Gender	Male	Female					Total
Madison	128	14					142
Milwaukee	60	8					68
Platteville	69	18					87
Ethnic Diversity	White	Black	Latino	Asian	American Indian	Unknown	
Madison	136	1	2	3	0	0	142
Milwaukee	64		2	2			68
Platteville	85		2				87

Table 1b. Demographics of engineering students transferring from UW-Colleges having recorded initial math placement data.

Most of the ethnic diversity in the state of Wisconsin exists in the larger metropolitan areas. Since none of the thirteen UW-College campuses reside in the four largest counties, we have added a final column in Table 2 which subtracts off the contributions of these larger counties to provide an estimate of the population that the UW-College campuses draw from.

Ethnic Diversity	State of WI	Milwaukee County	Dane County	Brown County	Racine County	Rest of WI
White	85.7%	57.6%	84.9%	87.3%	77.7%	93.60%
Black	6.0%	26.6%	4.4%	1.7%	10.7%	1.20%
Latino	4.7%	11.4%	4.6%	5.7%	9.6%	2.77%
Asian	2.0%	3.0%	4.4%	2.3%	0.9%	1.51%
American Indian	0.9%	0.8%	0.4%	2.2%	0.5%	0.93%

Table 2. Ethnic diversity numbers for the state of Wisconsin, its largest counties, and the rest of the state. (US Census Estimated (2006)³)

The distribution of the initial math courses taken by pre-engineering students at the UW-Colleges is provided in table 3. In addition, the average number of credits taken and their average GPA at the two-year school prior to transfer is listed in table 4.

University (# of students)	% Calculus or above	% Pre- Calculus	% College Alg./Trig.	% Intermed. Alg.	% Remedial Math	% Stats
Madison (142)	63.4%	19.0%	12.0%	2.8%	0.7%	2.1%
Milwaukee (68)	23.9%	32.4%	32.4%	10.3%	0%	0%
Platteville (87)	39.1%	33.3%	20.7%	5.7%	1.1%	0%

Table 3. Distribution of the initial math courses taken by pre-engineering students at the UW-Colleges prior to transfer to the engineering program at the school listed.

University (# of students)	Number of Credits Taken (Std. Dev.)	UW Colleges GPA (Std. Dev.)
Madison (142)	40.2 Credits (25.45)	3.45 (0.508)
Milwaukee (68)	56.8 Credits (23.43)	2.92 (0.460)
Platteville (87)	47.6 Credits (25.33)	3.06 (0.563)

Table 4. The average number of credits taken by pre-engineering students prior to transfer and their average GPA prior to transfer to the engineering program at the school listed.

Follow-up Data

Having identified students who began their studies at one of the UW-Colleges, it would appear on the surface to be relatively easy to obtain follow-up data on these students from other schools within the same university system. In fact, it has been quite the opposite. Although the UW Colleges, the UW-Madison, the UW-Milwaukee, and the UW-Platteville all belong to the same university system, their institutional data is not centralized. Since they are separate, it is not surprising that each institution has different identifying numbers or codes making it very difficult to share data between schools. Once all the approvals had been obtained, we had to come up with a way to match up data provided by the other institutions with the data from the UW-Colleges with much of the personal information removed. To accomplish this we had the institutional researcher from the UW Colleges create a numbered list of students for the institutional researchers at the engineering schools and a look-up table for us. That way the other engineering schools can look up the required data (degree in engineering received Y/N, overall GPA, engineering major, etc.) and place it into an excel file in the same order for our use. The only difference is that our data set will have personal information, such as names, removed.

Data has been successfully exchanged between the UW-Colleges and the UW-Platteville. From the initial UW-Colleges list of 87 students that started at the UW-Colleges and transferred to UW-Platteville over a six-year period, 43 have received their Bachelor's Degree in Engineering and 2 others are still enrolled. In addition we have a list of 29 students from UW-Milwaukee that started at the UW-Colleges and graduated with their Bachelor's Degree in Engineering. For both these sets of data we have information about their initial math placement as well as their Degree GPA. This information is summarized in Tables 5 and 6. A summary of the demographics of the engineering graduates who were on the UW-Colleges list of 87 students is provided in Table 7.

University (# of students)	% Calculus or above	% Pre- Calculus	% College Alg./Trig.	% Intermed. Alg.	% Remedial Math
Platteville (43/87)*	32.6%	27.9%	30.2%	7.0%	2.3%
Milwaukee ^a (29)	41.4%	0%	51.7%	0%	7.0%

Table 5. Distribution of the initial math courses taken by students who transferred from the UW-Colleges and received Bachelor's Degrees in Engineering

*UW-Colleges Originated List of students

^aUW-Milwaukee Originated List of students

University (# of students) [overall GPA]	% Calculus or above (Std. Dev.)	% Pre- Calculus (Std. Dev.)	% College Alg./Trig. (Std. Dev.)	% Intermed. Alg. (Std. Dev.)	% Remedial Math (Std. Dev.)
Platteville (43/87)* [3.17]	3.32 (.441)	3.18 (.505)	3.12 (.412)	2.67 (.487)	3.17
Milwaukee ^a (29) [3.01]	3.12 (.517)		2.97 (.461)		2.72 (.264)

Table 6. Average Degree GPA as a function of initial math courses of students who transferred from the UW-Colleges and received Bachelor's Degrees in Engineering

*UW-Colleges Originated List of students

^aUW-Milwaukee Originated List of students

Gender	Male	Female					Total
# of students	39	4					43
Ethnic Diversity	White	Black	Latino	Asian	American Indian	Unknown	
# of students	42	0	1	0	0	0	43

Table 7. Demographics of engineering graduates at UW-Platteville transferring from UW-Colleges

Discussion

Of particular interest in this study is the retention of underrepresented groups. Table 7 gives the demographics of the engineering graduates at UW-Platteville transferring from UW-Colleges who were on the list provided by the UW Colleges. Here we see an apparent 50% decrease in student retention across the board. In addition we see a marked decrease in the number of female engineering students who graduated from those shown in Table 1b. As a result we have requested the institutional research office at UW-Platteville to look at what happened to the other 42 students (14 of whom are female) that supposedly were transferring from the UW Colleges to UW-Platteville to pursue an engineering degree. The previous request to UW-Platteville’s institutional research office included 31 additional engineering graduates (7 of whom are women) that transferred from the UW-Colleges, however, these students were lacking initial math-placement data. In addition we noticed that a disproportional number of female entries in the UW-Colleges database were missing the initial math placement data (many fewer women in the UW-Colleges list of 297 students than were in the previous list of 463 students). We were expecting numbers closer to those listed in Table 8 shown below.

Year	UWP	MSN	MIL	UWS
2002-2003	14.70%	22.10%	18.10%	19.90%

Table 8. Percentage of Engineering Bachelor's Degrees by Women in the UW System Schools for 2002-2003 Academic Year (Reported through UWS)

The data in tables 5 and 6 support the theory that the UW-Colleges do a better job teaching the lower level mathematics courses. From a previous study looking at the success of engineering students⁴ at UW-Milwaukee, no students who began at a remedial Math level at UW-Milwaukee graduated with a degree in engineering. Part of this is due to the fact that these low-level courses are often assigned to instructors with the least teaching experience (often TAs) and class sizes are often quite large. Also by comparing the average GPA of engineering graduates who took their initial coursework at the UW-Colleges (3.17), versus those who took all their coursework at UW-Platteville (3.12) shows that the UW-Colleges provide quality foundation for engineering students.

We plan to communicate additional results from this on-going project as data becomes available.

Conclusion

The UW-Colleges still play an essential role in the education of future engineers. They provide opportunities for students who have deficiencies in their mathematics background. In general, they allow for an easier transition for students from high school to college offering smaller classes, quality instruction, and more personalized attention. They also can provide opportunities for place-bound and non-traditional students that might not be available to them otherwise.

Areas for improvement include increased outreach to underrepresented students in engineering and commitment to student retention. It is also important that four-year engineering schools and two-year schools work together and build partnerships to provide quality and accessible education to future engineers.

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