AC 2011-1148: CHARACTERISTICS OF COMMUNITY COLLEGE TRANSFER STUDENTS THAT SUCCESSFULLY MATRICULATE AND GRADUATE IN ENGINEERING

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Characteristics of Community College Transfer Students that Successfully Matriculate and Graduate in Engineering

Background

The path from community college to an engineering degree can be filled with obstacles. "What we [still] don't know [about transfer students] is staggering[1]." Few research studies have been done from the perspective of community college graduates from accredited engineering programs. This study will help researchers, policy makers and educators understand behavior of community college transfer students that successfully matriculate and graduate in engineering. It will also help guide short-term tactical and long-term strategic programming for transfer students in engineering.

A reason community college transfers are so important is the need for more graduates in science, technology, engineering and math (STEM) fields. A logical place to look for these STEM graduates is to the community colleges. In fact the need for more STEM graduates is considered vital to the future of America by the US Department of Labor. "Science, technology, engineering and math (STEM) fields have become increasingly central to U.S. economic competitiveness and growth, and long-term strategies to maintain and increase living standards, and promote opportunity will require coordinated efforts among public, private, and not-for-profit entities to promote innovation and to prepare an adequate supply of qualified workers for employment in STEM fields[2]."

Community colleges are also endorsed for their ability to bring students from under-represented groups to the educational pathway. "Community colleges are the path of choice for many underrepresented groups in engineering[3]." This includes women, minorities, older adults, non-native speaking and lower-income groups. Due to their accessibility and affordability, students are turning to two-year colleges as a less expensive pathway to bachelor's degree attainment. "Community colleges disproportionately enroll students from groups that have been underrepresented in higher education and that are poised to grow dramatically in the next two decades[4]." "Various organizations, including the College Board have issued enthusiastic endorsements of the community-college mission and the need for a strong transfer process for students from underserved groups[1]."

However, it is known that well-qualified students at a community college are less likely to earn a bachelor's degree than students with similar qualifications who begin at four-year colleges[5]. "While all students do not enroll in community college for the purpose of attaining a degree, research has shown that the persistence patterns of those who intend to gain a degree or transfer are troubling and inconsistent[6]." Less than 20 percent of college-qualified, low-income high school graduates in from a 1992 study who enrolled in a two-year college with the intention of earning a bachelor's degree achieved that goal within eight years of high school graduation[7]. A recent Chronicle of Education report by the

Department of Education Statistics finds statistically significant differences in the graduation rates for students that begin at community colleges from those that start at a four-year institution. From a six-year longitudinal study of over 19,000 students, of those who started at 2-year public institutions, 46 percent had not received a certificate, associate's degree or bachelor's degree. This compares with only 24 percent who started at four-year institutions that had not received a degree[8]. Because of this difference, data analysis is a critical part of understanding what factors influence student success as measured by attainment of a bachelor's degree.

Specifically in engineering, transfer is difficult because of how Universities' apply transfer credit toward a degree program. This can be an unpredictable variable for transfer students. A student may have to repeat courses unexpectedly adding time and expense to the degree budget. This added burden may be too much for a lower-income transfer student to bear, ending their engineering career before it gets started[9].

The successful transfer student has to display both adaptability and tenacity to withstand the transfer process. In his Commentary *Silent Partners in Transfer Admissions*, Stephen Handel calls the pathway "more a gantlet than an educational pathway." He goes on to say "Transfer works-or not-to the degree that four-year institutions recruit, admit and serve community college students[1]."

From the perspective of the university, transfer students are labor intensive. Recruiting transfer students is not a goal of admissions directors because transfer students require extra time, effort and they are more difficult to advise. Transfer students become important to admissions directors only when the freshman enrollment lags. Otherwise they may be indifferent toward transfer student's altogether[1].

Research is needed to determine what student services best facilitate transfer. This includes advising policy on intervention strategies at both the community college and university level to increase the number of graduates. Enrollment-related resources are critical to the success of transfer students. "Four-year colleges need to do at least as much to assist transfer students as they do incoming freshman[10]." "Transfer students are more likely to be neglected or ignored in retention efforts[11]." Institutional leaders concerned about retention of transfer students should develop helping strategies not only during the critical first few weeks for transfer students but also long-term strategies to ensure their academic and social integration within the institution[10, 11].

Study Goals/Objective

The objective of the study is to compare characteristics of engineering bachelor's degree graduates from Iowa State University (ISU) based on the transfer admission status to the university and determine if significant differences exist. The hypothesis is that once in-state community college (State CC) students successfully matriculate and graduate from ISU that no distinctions will exist at

graduation from non-transfer students. The differences or lack of differences will assist in assessment and programming for transfer students. This study is based on graduation data from recent semesters combined with data from Institutional Research at ISU.

This study is part of a National Science Foundation grant. The goal of this project is to increase the number of engineering graduates from Iowa State University's College of Engineering. Another goal of the NSF Student Enrollment and Engagement through Connections (SEEC) grant is to increase the diversity of engineering graduates at ISU. The specific goals of SEEC are to increase the number of engineering graduates by 100 per year to obtain a total of about 900 per year with approximately 10% from minorities and 20% females[12]. The key to meeting these goals is the creation of meaningful connections between ISU and the state community colleges to support transfer students. This project has focused on five such connections: 1) a new admission partnership program, 2) coordinated advising and activities planning, 3) expansion of learning communities at ISU and state community colleges, 4) creation of an engineering orientation class at the community college level and 5) gateway engineering courses offered at state community colleges to better engage students. Working with State CC and the STEM Pathway project, student-centered advising is also being coordinated to broaden the diversity of students enrolled in engineering and to make students aware of the various paths to successfully completing an engineering degree, including transfer from a community college. This study enforces the new American Board of Engineering and Technology (ABET) accreditation model of outcome based education[13].

Methods and Resources

Retrospective research data was obtained from Institutional Research at ISU and the Career Services office for the college of engineering for three recent semesters of engineering graduates. ISU is a large Mid-Western research institution with a high level of research and a large number of engineering graduates. The data was combined and the following fields were included in the analysis:

- Admission type
- Admission term
- Transfer status
- Semester of graduation
- Degree
- Major
- Minor
- Residency status
- Cumulative grade point average
- Citizenship
- Ethnicity
- Gender
- Work experience in engineering

    - Internship
    - Cooperative employment
    - Summer employment
    - No work experience
- Employment status (employed, graduate school or seeking employment)
- For employed graduates
    - Employer
    - City and State of employer
    - Starting salary
    - Title
    - Bonus (if any)
- For transfer admit students
    - Transfer institution
    - City and State of transfer institution
    - Number of transfer credits
    - Grade point average (GPA) for transfer credits

The data was separated by admission status to the University into two categories; those entering directly from high school (DFHS) and those entering from an in-state community college (State CC). The data was separated this way because of the interest in recruiting and retaining community college transfer students to engineering. This is one way to see if the pathway to an engineering degree still influences characteristics of the student at graduation.

A student is considered a transfer to ISU, not by the number of credits they bring to college but by the timing of the college credits. A student entering in the semester directly following high school is considered a direct entry from high school (DFHS) even if they bring 'transfer credit' for dual enrolled or advanced placement courses. A student is considered a transfer student if the credits earned were after high school graduation.

One limitation of the data for this study is that the transfer institution listed may not be the school where the student had the most transfer credit but where they attended most recently. It is not unusual for a transfer student to bring credit from multiple institutions.

One of the first comparisons made was for experiential education of the two groups. Experiential education combines classroom studies with supervised work experiences. Students are employed by industry, business, and government organizations in positions related to their major field of study. The College of Engineering has the following three programs in which students can acquire practical work experience: 1) cooperative education (coop), 2) internship (intern) and 3) summer work experience. Cooperative education is alternating academic classes with periods of engineering related full-time work experience of approximately equal length. An internship is a single work period of engineering related full-time employment of at least one semester. Summer experience is a

single work period of engineering related full-time employment of at least 10 weeks.

A second comparison was made for the employment status of the graduates in the two groups. Three types of employment status at graduation were considered: 1) employed, 2) those planning to attend graduate school and 3) those seeking employment. For the employed graduates, a comparison of starting salaries was made for those that reported a starting salary.

The next comparison was made to determine if students from IA CC had different GPA's from DFHS students. This comparison was made at three levels: 1) for all students 2) for employed students and 3) for students still seeking jobs at graduation.

The gender and ethnicity of the two groups (IA CC and DFHS) were also compared to see if one had a higher percent of graduates for the typically under-represented populations in the college of engineering. In addition, the overall percent of women and non-white citizens for all graduates was made to compare this to SEEC goals for graduates.

The percent of graduates that took jobs in-state was the next statistic for comparison. This is important information for both state educational institutions and also state government.

The engineering major chosen was compared between the two groups to see if State CC graduates gravitated to different majors than the DFHS group. This identifies which engineering degree programs are effective in attracting, maintaining and graduating State CC transfer students in the college of engineering.

This data was analyzed statistically for significant differences between the groups in the categories. For categorical or binary variables, the Pearson Chi-Square analysis with one degree of freedom was used. In each test the expected frequency assumption which allows for the normal approximation to a binomial variable was met. This means that $np>=5$ and $n(1-p)>=5$, where n is the sample size and p is the estimated proportion[14]. This also assumes large populations and sampling without replacement. For numerical variables, the t-test for the equality of two means assuming equality of variance was used. The assumption of equality of variance between the groups was tested using an F-test for the ratio of variances before the t-test for equal variance was used. The level of significance used was 0.01, but cases where $p <0.05$ were noted.

Results

This study included a total of 1281 engineering graduates from three recent semesters; spring 2009, spring 2010 and fall 2010. There were 1022 graduates

that attended ISU directly from high school (DFHS). This accounts for 80.0% of the total graduates. There were 103 graduates that transferred to ISU from State CC's which accounts for 8.0% of the graduates. The remainder of the graduates came from other transfer institutions.

The groups (DFHS and State CC) brought different amounts of transfer credits. DFHS graduates brought an average of 10.3 transfer credits from dual-enrolled or advanced placement courses taken while in high school. The State CC graduates brought an average of 58 credits taken after they graduated from high school.

The most important self-reported factor at graduation is the employment status of the graduate. Three types of employment status at graduation were considered: 1) employed, 2) those planning to attend graduate school and 3) those seeking employment. Employment status was reported for 93.2% of the State CC students and 94.2% of the DFHS graduates. These high percentages allow for conclusions comparing employment status between the groups.

Table 1 summarizes the parameters in this analysis where there was no significant difference between the DFHS group and the State CC group.

Table 1 Graduation Parameters with No Statistically Significant Difference ($p>.01$)

Graduation Parameter	n	Direct Entry from HS	n	Entry from State CC	P value
Starting Salary*	286	$56,804	24	$57,477	0.6755
Ethnicity-Other than White	1022	10.0%	103	8.6%	0.6659
Total with Work Experience**	1022	81.0 %	103	72.8 %	0.0462
Coop ***	1022	1.9%	103	0%	0.1628
Internship	1022	32.0%	103	25.2%	0.1592
Summer	1022	47.2%	103	47.6%	0.9366
No Experience	1022	19.7%	103	21.4%	0.6814
Employed	963	48.1%	96	41.7%	0.2302

*Self-Reported

**This difference is significant at 0.05 level of significance

***Sample size for State CC too small for normal approximation to the binomial

An important finding of this research is the number of parameters that were not different between the two groups at graduation. One finding that was consistent throughout the study was that no matter how the graduates were grouped, there were no differences in starting salaries. The percent ethnicity, work experience (in internship and summer) of the State CC graduates was not different from the DFHS graduates. Those with cooperative work experience did not appear to be different but due to the null sample size from State CC's, the statistical significance of this comparison could not be determined without using a more complex method of analysis. Also the percent with no work experience at graduation was about the same.

For employment status at graduation, the percent employed was not statistically different between the groups, even thought the employment percentage for State CC students is lower than DFHS graduates. This changed when the percent that go to graduate school were included with the percent employed as 'placed' graduates. Factors that were different between the two groups will be discussed in the next section.

Table 2 summarizes the parameters in this analysis where there was a significant difference between the DFHS group and the State CC group.

Table 2 Graduation Parameters with Statistically Significant Difference (p<=.01)

Graduation Parameter	n	Direct Entry from HS	n	Entry from State CC	P value
Graduate School*	963	15.9%	96	6.3%	0.0117
Placed**	963	64.0%	96	47.9%	0.0020
Seeking Jobs	963	36.0%	96	52.1%	0.0018
GPA at Graduation	1022	3.19	103	2.97	<0.0001
GPA Employed	463	3.25	40	3.10	0.0302
GPA Seeking Jobs	347	3.00	50	2.77	0.0005
Employed in State	379	41.2%	34	82.4%	<0.0001
Female Graduates	1021	14.6%	103	4.85%	0.0057

*Considered significant for p<.0117

**Employed or Graduate School

There were a number of significant differences between the graduates that started at ISU from those that came from a State CC. The first one listed on Table 2 is that a higher percent of students from ISU planned to go to graduate school following graduation than those from State CC's.

The percent placed at graduation which includes those employed and those in graduate school was significantly lower for state community college graduates. Those seeking jobs were significantly higher for State CC graduates than for DFHS graduates.

The lower GPA of State CC graduates from DFHS graduates were in three different areas: 1) overall GPA, 2) GPA of employed graduates and 3) GPA of graduates seeking jobs. Not shown on the table is the average transfer GPA of all State CC graduates of 3.18, which dropped to 2.97 (ISU GPA) at graduation.

Another finding was that State CC had a much lower percent of female graduates. There were less than 5% female graduates from State CC's in three semesters of graduation data. All of these where white and all were still seeking employment at graduation. However, if all female graduates were included the percent of female graduates was 14.2%. This was still not at the SEEC goal of approximately 20% female graduates.

An important finding for State CC's was the much higher percent of graduates that took jobs in state as compared to DFHS graduates. Over 82% of State CC

graduates took jobs in state compared to 41% of DFHS graduates. This shows that money spent on increasing transfer graduates in engineering could be helpful to the state economy.

For all graduates apart from where they began their education, there is an expected significant difference in GPA between employed students (3.22) and those seeking jobs (2.95).

Table 3 shows the number of graduates by department. There is a significant difference between the percent of graduates from State CC's and the percent entering directly from high school that majored in mechanical engineering. This was the only major where the difference was statistically significant. However, 71.8% of the graduates from State CC's are listed in the first four majors below; mechanical, electrical, civil and industrial engineering. The graduates that entered directly from high school were more diversified among the engineering majors. Only 58.2% of these graduates were from mechanical, electrical, civil and industrial.

Table 3: Distribution of Graduates by Major

	Direct Entry from HS		Entry from State CC		Difference
Engineering Major	Number of Graduates	% of Graduates	Number of Graduates	% of Graduates	P Value
Mechanical	254	24.9%	38	36.9%	0.0080
Electrical	126	12.3%	14	13.6%	0.7139
Civil	115	11.3%	12	11.7%	0.9059
Industrial	99	9.7%	10	9.7%	0.9968
Aerospace	92	9.0%	7	6.8%	0.4497
Construction	82	8.0%	7	6.8%	0.6581
Agricultural	76	7.4%	5	4.9%	0.3328
Chemical	60	5.9%	5	4.9%	0.6719
Computer	59	5.8%	3	2.9%	-
Material	46	4.5%	2	1.9%	-
Software	12	1.2%	0	0.0%	-

Summary

This research identifies positive characteristics of transfer students that need to be sustained to ensure that differentiation does not arise in the future. These positive characteristics indicate that once a State CC student makes a successful transition to the university, no further differentiation exits at graduation. This research also identifies negative distinctions that need further study to identify ways to reduce or eliminate them.

The hypothesis of this study is that once a community college student matriculates to the college of engineering, they will have similar characteristics and therefore similar opportunities at graduation as a student that began their educational

pathway at the four-year university. Based on a three-semester sample of all engineering graduates (1281), this hypothesis is true (based on the sample statistics) for starting salaries, ethnic background, work experience prior to graduation and percent employed. This hypothesis is not true based on the sample statistics for the percent attending graduate school and the total percent placed (employed and graduate school combined) at graduation. These factors are significantly lower for community college graduates. The percent of community college graduates seeking jobs at graduation was also significantly higher. The hypothesis of equality is also not true for GPAs. ISU grade point averages of transfer students from community colleges were consistently lower at graduation than their non-transfer counterparts. Also, significantly less graduates from community colleges were female than non-transfer students. However, significantly more community college graduates took jobs in-state than those that start at the university.

One positive distinction is that the SEEC goal of 10% ethnicity for the college of engineering graduates has been met. In this study 10.4% of the graduates were non-white citizens.

Some of the distinctions may be expected due to differences in demographics. For example, research shows that CC transfer students are more likely to stop with the bachelor's degree than non-transfer students[15], explaining differences in the percent attending graduate school.

Another distinction somewhat explained by demographics is that community college graduates may be older and more established in their communities[4] therefore looking for jobs in-state. If there are less engineering jobs in state, this could account for the increased percent of graduates from State CC that are still looking for jobs at graduation.

It is still disconcerting that the percent seeking jobs is so much higher for State CC graduates. This is an important distinction and one that will be the detailed focus of further study. Having a job after graduation is ultimately the factor that matters the most to each graduate, and shows the success of the institution.

Needing immediate attention is further study into the differences in female graduates. This is not consistent with research[3, 4, 15, 16] that shows State CC's are a promising pathway for more female students to enter engineering. It also poses problems with the SEEC goal to graduate more women in engineering.

Also needing immediate attention is an explanation for the lower GPA's of community college graduates. It could point to the need for additional academic preparation by State CC transfers, especially in remedial math courses[4]. Perhaps some of the differences in job placement can also be attributed to the differences in GPA. A detailed analysis of transfer grades for engineering courses is underway to examine GPA differences further.

One of the most positive findings of this research is that over 82% of State CC graduates take jobs in-state compared to 41% of DFHS graduates. This is one reason why it is worthwhile for continued time and state resources to be directed toward transfer student programming.

In addition to research, all of these changes will require continued community efforts between ISU and State CC's which are vital for success of the graduates. Fortunately, efforts between ISU and Iowa CCs are already underway as part of a National Science Foundation (NSF) grant. The NSF Student Enrollment and Engagement through Connections (SEEC) project has focused on five such connections: 1) a new admission partnership program, 2) coordinated advising and activities planning, 3) expansion of learning communities at ISU and state community colleges, 4) creation of an engineering orientation class at state community colleges and 5) gateway engineering courses offered at state community colleges[12]. Each of these practices addresses several key barriers that transfer students' face[17]. Although this project is only in its fourth year, recent data shows an increase in the number of State CC students transferring to the College of Engineering at ISU. All of these combined efforts will optimistically allow more of them to matriculate and graduate in the future.

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