Open Admissions and the Community College Pathway to Engineering

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Abstract - **Community colleges serve an important role in preparing students for careers in engineering. According to a study by the National Science Foundation, more than 40 percent of recent Science and Engineering graduates have attended community colleges at some point in their educational paths. These two-year programs allow students to take their core class requirements as well as freshman and sophomore-level engineering courses. These then transfer to four-year institutions where students can complete their engineering degrees. This is an attractive alternative for students who a) are coming back to school to get an engineering degree after years in the workforce; b) do not have financial or geographic access to a nearby university that offers an engineering degree; c) do not meet the admissions requirements to enter the four-year institution of their choice; or d) a combination of these factors. Community colleges, as opposed to most four-year institutions, typically have an open admissions policy. While this allows students to pursue engineering who may not have otherwise been able to, this presents challenges as well as opportunities for the two-year institutions. With proper advising and support, the accessibility that community college programs provide can increase the number of students that consider engineering as a viable career path, even if they have to begin in remediation. To better understand the impact of an open enrollment policy on student success, data from McLennan Community College's engineering students were gathered and analyzed. Several questions are addressed in this preliminary study. How does the open admissions policy impact accessibility for engineering? The engineering program at McLennan Community College has only been active since 2009. As such, this initial study focuses only on the Introduction to Engineering course. Only now are our first students beginning to complete degrees at the university level, but as this study progresses, we hope to discover if success in the Introduction to Engineering course predicts ultimate success in engineering programs.**

Index Terms - Community College, engineering education, open enrollment, student success.

Engineering programs at a community college are a complicated endeavor. Traditional engineering schools rely on admitting top-notch students, with strong backgrounds in mathematics, chemistry, and physics, who attend college full-time, possibly work part-time, and have little to no distractions outside the usual academic setting. About 8% of four-year school engineering students were part-time in 2011 [1]. Although similar statistics are not available for engineering students at community colleges, we can assume their data is similar to community college students in general, where approximately 57% attend school part-time [2].

Open admission is also a feature that, while not necessarily unique to community colleges, is far more common than at a traditional university. Very few engineering schools have no additional admission requirements beyond those required by their university in general, and many schools are moving toward a foundational curriculum that students must complete on campus before being formally admitted to the engineering school. As engineering colleges continue to place additional minimum requirements on incoming freshmen, the role of the community college becomes more marked.

Research regarding the characteristics of recent science and engineering graduates conducted by the NSF shows that about 45% of students list "financial reasons" as their main reason for attending community college. Financial need and the educational disadvantages that it entails are another reason why open enrollment is so important. It can be concluded that, were it not for open admission, many of these students would be unable to pursue higher education degrees in science and engineering [3]. However, community college engineering programs must then work with students who come into programs not ready for college-level algebra, let alone Calculus I.

Judging the level of success of a community college engineering program can also be difficult. Since students cannot be awarded a B.S. in engineering from the institution and may transfer before completing an associates degree at the community college, traditional success markers such as graduation and time-to-degree completion can be difficult to track. However, research has shown that community college transfer students who have completed an associate of science (A.S.) degree in engineering are just as likely to receive a bachelor's degree as students who attend four-year campuses only [4].

In spite of these challenges, the role of community colleges in preparing engineers is not in question. About 50 percent of science, engineering, and health (SHE) graduates at some point attended community college. For engineering graduates specifically, this number is around 38 percent [5]. Additionally, community colleges have long been recognized as providing opportunities to increase diversity in the U.S. engineering workforce, especially racial and ethnic diversity [4]. Many community college students are adults (ages 26 to 35) who attend college while maintaining jobs. Preserving the

open door is essential for these older students who require flexibility in course offerings, low cost, and proximity to their work or home [3].

Community colleges play a vital role in preparing students for careers in engineering, in particular by opening the opportunity to individuals who may otherwise never would have had a chance in such a challenging field. One of the main reasons why community colleges have not achieved their full potential is "a lack of understanding among parents, teachers, counselors, and students of the effectiveness of community colleges in producing engineering graduates" [4]. To facilitate such an understanding, this extended abstract looks at the data of an engineering program in its infancy in a "typical" community college.

In Fall 2009, McLennan Community College (MCC) in Waco, Texas (population 234,906), revitalized its engineering program, with the hiring of a full-time dedicated faculty member and a new science building. This timing coincided with efforts at the Texas Higher Education Coordinating Board to review community college engineering curriculum. Initial expectations were modest, with 32 seats filled for an Introduction to Engineering course. Four years later, the program boasted two full-time engineering faculty, and 125 seats were filled for a wide variety of engineering classes, including Introduction to Engineering, Engineering Graphics, Statics, and Engineering Economics. From a sheer numbers perspective, this would seem a clear success in the program. However, there is a larger story these numbers can tell.

As an initial peek into the data, we look at students enrolled in the Introduction to Engineering course. This course has changed moderately from 2009 to the present, but overall has had two primary goals: one, to give students a realistic picture of engineering both as an academic pursuit and as a career, and two, to give students practice with concepts and skills that a typical engineering or science professor would expect of a freshman engineering student. Topics vary from resume writing and interview skills to unit conversions, polar coordinates, vectors, and working with Excel. The class is only taught face-to-face and classes are almost exclusively scheduled during the day (8 am to 5 pm), twice per week.

For the 2009-2010 academic year, enrollment in this course was 44. In Fall 2013/Spring 2014, there were 72 students enrolled, an increase of 170%. A total of 273 students have been enrolled in this course from Fall 2009 to Spring 2014. About 48% of MCC students finish Intro with a B or better. About 62% of students pass Intro with a C or better. Hesitant to define "success" as a "C or better" in an introductory engineering course, for the remainder of this study, we will define "success" as a B or better, whereas "passing" will refer to a C or better.

Intro to Engineering students do tend to be younger than the typical MCC student. The average age in engineering is around 22 (median of 19), whereas the overall average age at MCC is 26. As such, about one-third of the Intro students have been out of high school for at least three or four years. An analysis of the data shows that 46% of the students in the 16-21 age bracket were successful in the course, compared to 48% of the 22-30 students and 57% of the 30+ students. The data show that non-traditional students tend to do better in Introduction to Engineering that their fresh-out-of-high-school counterparts.

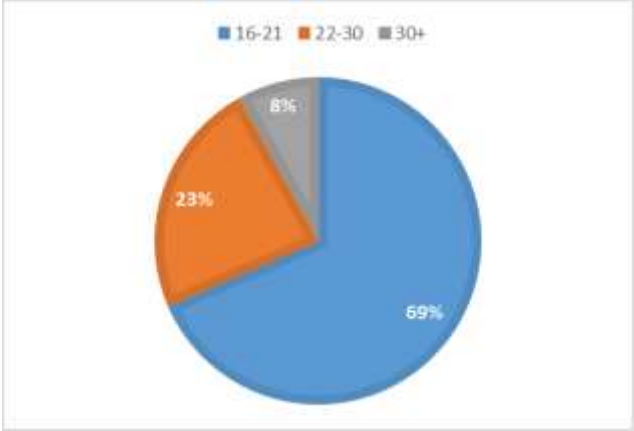

FIGURE 1
INTRODUCTION TO ENGINEERING AGE DISTRIBUTION AT MCC

It is important to note that 73% of the Intro to Engineering students are attending school full-time (12 or more credit hours) during the semester. In an ideal world, this would mean that students are entirely focused on their academic pursuits. Anecdotal evidence shows, however, that many full-time students are still working part-time or even full-time jobs as well. Financial aid is often dependent upon full-time status so students are often taking more classes than they can handle just to get the financial assistance for tuition and books.

About 49% of full-time students and 46% of part-time students earn a B or better in the course. Additionally, full-time students pass at a rate of about 65% and about 54% of part-time students pass. Although we have a small sample size, this shows that in general, full time students tend to do slightly better than their part time counterparts. However, there may be more factors than just their part-time status that contribute to this.

The next factor to examine is the need for math remediation (requiring additional courses in math to be considered college-ready). The Intro to Engineering course has a math prerequisite of College Algebra, so a student must complete at least one college-level math class (or have equivalent preparation) before enrolling in the course. Eight percent of Intro to Engineering students required remediation when first admitted to MCC, and 11% took math remediation at some point, whether needed or not. Of those students, about 46% ultimately succeeded in the course with a B or better, and an additional 13% passed the course. Despite the relatively small sample size, these percentages are close to those for the entire student population, and could indicate that students that began college in remediation can be just as successful as students that did not need remediation.

Since financial obligations can be a significant barrier to college success, another interesting analysis is to look at Pell-grants and other federal grants. In 2010-2011, 39% of students at public four-year institutions received federal grants (including the Pell grant), whereas 56% of students at public two-year institutions received such grants [6]. At MCC, approximately 46% of students are on Pell grants, but only 42% of engineering students are. Of those 42%, three-fourths have additional financial aid on top of the Pell grant.

Perhaps not surprisingly, a higher percentage of non-Pell recipients earn a B or better in the Intro course than Pell students. Pell recipients are also more likely to withdraw from the class entirely. The grade distribution between Pell and Non-Pell students is shown below.

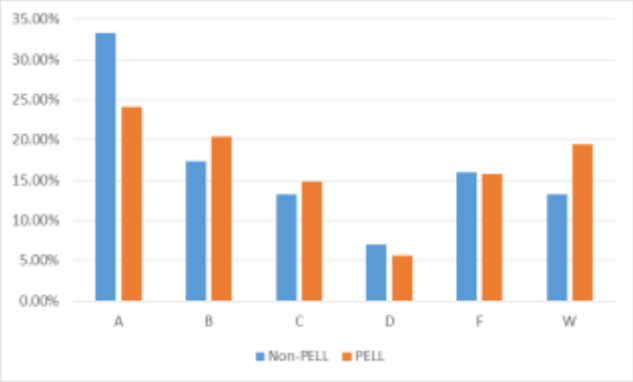

FIGURE 2
INTRODUCTION TO ENGINEERING LETTER GRADES WITH AND WITHOUT PELL GRANT AT MCC

Finally, we look at the impact of college experience on success in the Intro course. Four year institutions, in general, tend to discourage students from staying "undecided" for too long. Factors such as over-crowded classrooms and concerns over higher tuition and fees push four-year students to "just pick something" and finish a major. Some institutions even have financial incentives for students to complete a degree within a certain period of time or number of hours. At a community college, however, with lower costs, smaller class sizes, and a focus on getting a generally broad education, students have the opportunity to explore several options before focusing down a direct path. By the time students enroll in the Intro course, a little over 50% (53%, to be exact) have completed 30 credit hours or less. This indicates that many of MCC engineering students originally came to the college to get their "basics," or originally were thinking about another major, and later chose to take the Intro course as they explored their interests. Our data also suggests that students with more college experience, whether it is in engineering or not, do better in our Introduction to Engineering course.

As our program matures, future studies will looks at how success in the Intro to Engineering course predicts success in the larger series of coursework, and then, ultimately, graduation with a four-year degree in Engineering. Multivariate analysis will help us find those factor which have the most impact. It is already clear that students receiving an A or B in Intro do have an increased tendency to continue the pattern by earning similar grades in Dynamics, Circuits, Calculus 3, and Differential Equations. We hope to additionally track students that have transferred after finishing their A. S. in Engineering or at least successfully finished the Math and Physics. Future work will show a comparison of our data with that of 4-year schools, something we believe will further show the necessity of community colleges in engineering studies.

Our data supports the principle that the community college can play an important role in training engineering students and that the open admissions policy does in fact allow students to succeed in engineering who might otherwise not have such an opportunity. Therefore, it is imperative that efforts to facilitate pathway to engineering that begin at community colleges continue to be encouraged and improved. This will lead to increased diversity, a stronger workforce, and increased opportunities to enter the engineering field.

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