Articulated Associate in Sciences Engineering Degree

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Abstract

Recent reports such as *"Rising Above the Gathering Storm"*[1] have highlighted the growing concern for the shortage of engineers in the United States. The escalating need for engineers will not be met from the pool of college-ready students who have chosen to pursue a career in engineering. This is especially true for many underserved segments of the population. There is a critical need for engineering transfer programs to provide the means for students who are not academically or financially prepared to advance towards a university degree in engineering.

Richland College is a comprehensive community college located in Dallas, Texas. It is part of the Dallas County Community College District and serves approximately 15,000 credit students[2]. The articulated engineering transfer agreements signed between Richland College and area universities resulted in the creation of an Associate in Sciences (AS) with Emphasis in Electrical Engineering degree. The AS Engineering degree replicates the first two years of a Bachelor of Science in Electrical Engineering (BSEE) degree and allows students who successfully complete the AS degree to gain automatic admission to a university and a guaranteed block transfer of 62-66 credit hours. This paper includes a description of this innovative program as well as quantitative data related to student demographics and academic performance.

Initial analyses of AS Engineering graduates provides evidence the program is providing a viable means for under prepared students to reach their educational goal of a BS Engineering degree. Results from a university study[3] indicate the performance between students who entered the university as freshmen and those who transferred from Richland College were comparable in sequenced engineering and math courses. Retention figures after transfer are encouraging, with over 89% of the AS Engineering graduates enrolling in an engineering program.

Background

The growing concern for the shortage of engineers in the United States is shared in Texas as evidenced by the Texas Higher Education Coordinating Board's (THECB) *"Closing the Gaps"* [4] initiative, which calls for an increased number of graduates in key fields, including engineering. With 46% of the undergraduate population in the United States enrolled in community colleges[5], transfer students represent a significant segment of the student body in many universities. The number of students in higher education in Texas increased by over 18,000 in 2007 with community colleges and other 2-year institutions accounting for 61% of the growth[6]. Despite the growing number of students who begin their educational journey in a community college, there are relatively few engineering transfer programs in 2-year institutions. Prior to the implementation of the articulated AS Engineering degree, the primary means for a Richland

student to transfer into a BS Engineering program was to complete the "core" curriculum or the Field-of-Study (FOS) in engineering.

Core Curriculum

Every public college or university in Texas is required by law to have a core curriculum[7] of at least 42 credit hours. The core is intended to be a set of courses common to any baccalaureate degree. The required components include communications, mathematics, natural sciences, humanities, visual/performing arts, US history, political science, and social/behavioral science[8]. Students who complete the core at a public institution may transfer the block of courses to another public institution, replacing the receiving institutions core curriculum. This can be misleading, as this does not guarantee core courses will satisfy curriculum requirements for a specific discipline. Core curricula are designed to provide students flexibility in selecting courses that align with their educational goals. The math component can be satisfied by a variety of math courses including but not limited to, college algebra or a higher level math course[8]. As a result, the possibility exists for students to complete the core without taking the appropriate level of math or science required for an engineering degree. In addition, the intent of the core to meet the general education requirements of a broad range of baccalaureate degrees does not provide for the inclusion of engineering courses.

Field-of-Study

A FOS curriculum[9] is a set of courses intended to satisfy the lower division requirements for a given academic discipline. In the case of engineering, the FOS was developed with the objective to encompass a common set of courses for all engineering disciplines. As a result, all of the courses are not applicable to every engineering program and will transfer only if the receiving institution requires a specific course[10]. The components of the Engineering FOS include Calculus, Differential Equations, Linear Algebra, Chemistry, Physics, Electrical Circuits, and Engineering Mechanics[10]. In the case of Richland students, only 19-25 credit hours could be applied to the degree requirements at the college's primary receiving institutions and of this transfer block, only 0-3 credit hours were from engineering specific courses.

Both the core and FOS provide an avenue for students to transfer credits into a baccalaureate engineering program. However, the opportunity for students to take engineering courses is minimal, or non-existent, under either plan. As a result, students transferring to engineering programs under these option are often uninformed or under prepared for the rigors of an engineering curriculum.

Program Implementation

To minimize the barriers presented by the core and FOS, Richland College and The University of Texas at Dallas (UTD) established an innovative 2+2 articulation agreement in Electrical Engineering in February 2004. The agreement resulted in the creation of an Associate in Sciences with Emphasis in Electrical Engineering degree, which replicates the first two years of the Bachelor of Science in Electrical Engineering (BSEE) degree at UTD. Students who successfully complete the AS Engineering degree gain automatic admission into the UTD College of Engineering with a guaranteed block transfer of 62 credit hours.

The *Lower-Division Academic Course Guide Manual (ACGM)* [11] denotes courses approved to be offered for general academic transfer by public community colleges in Texas. The freshman and sophomore level engineering courses required in the UTD BSEE curriculum are not included in the ACGM or the Engineering FOS. In order to replicate the UTD curriculum, Richland, with support of UTD, sought and received approval from the Texas Higher Education Coordinating Board (THECB) to teach four UTD engineering courses. To ensure the same rigor and learning outcomes, UTD and Richland use common syllabi, textbooks, instructional materials, and laboratory exercises for the engineering courses. Richland's commitment to this partnership was demonstrated through the significant capital investment required to upgrade the engineering labs to a level compatible with the labs at UTD. Faculty, advisors, and administrators meet on a regular basis to review the program and ensure curriculum alignment. The success of the UTD transfer program led Richland to subsequently seek and establish similar agreements with other area universities.

Evaluation and Results

In the academic year prior to establishing the UTD articulation agreement, 33 students enrolled in engineering courses at Richland. The three year average prior to the Fall 2004 implementation of the transfer program was 60 students. In the first year of the agreement, the enrollment in engineering courses rose to 228, with an average enrollment of 285 over the three year period between Fall 2005-Spring 2008. The enrollment in engineering courses, including the two semesters prior to the transfer agreement, is shown in Figure 1.

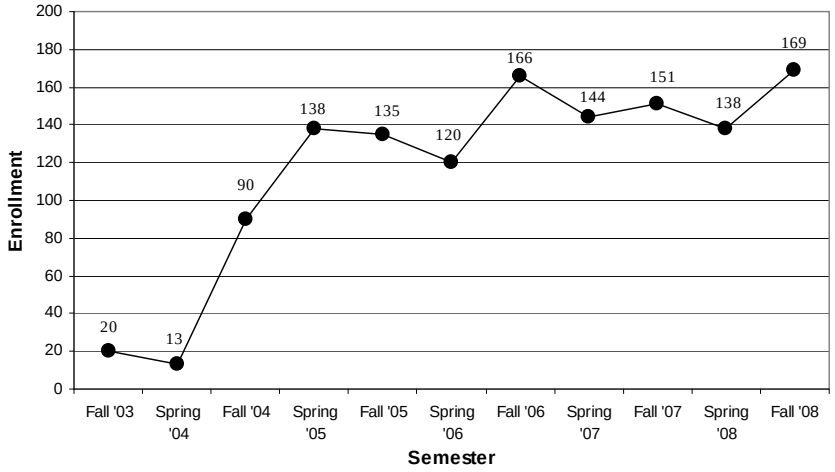

Figure 1. Richland College Engineering Course Enrollment

Student Demographics

Richland initiated a study to assess the effectiveness of the articulated engineering program to provide a means for underserved segments of the population to advance towards a baccalaureate degree in engineering. The study sample included students who graduated from Richland with the Associate in Sciences degree with Emphasis in Electrical Engineering ($n = 28$). Table 1 shows a gender comparison of the total student population at Richland[2] and the AS Engineering graduates.

Group	*N*	Male		Female	
		n	%	*n*	%
Richland College students	14,993	6,854	45.7	8,139	54.3
AS Engineering graduates	28	25	89.3	3	10.7

Table 1. Gender Comparison of Richland College's Student Population and AS Engineering Graduates

The graduation and participation rates for females in Richland's engineering program are well below the overall student population for the college. This is an ongoing issue facing many engineering programs across the country. According to the American Society for Engineering Education (ASEE)[12], only 18.1% of the bachelor's degrees in engineering were awarded to females in 2007 and females made up only 17.5% of the undergraduate engineering population.

The self-reported ethnicity of the AS Engineering graduates compared to students who earned BS Engineering degrees[12] nationally is shown in Table 2.

Group	Anglo	African-American	Asian/ Pacific Islander	Hispanic	Other
	%	%	%	%	%
AS Engineering degree, Richland	21.4	17.9	21.4	10.7	28.6
BS Engineering degree, National	67.3	4.9	13.3	6.2	8.3

Table 2. Comparison of Degrees by Ethnicity

The ethnicity of the AS Engineering graduates compared favorably to the national demographics for undergraduate engineering graduates, as evidenced by the data in Table 2. In relation to all students who earned an Associate's degree at Richland[13] in 2007-2008, the African-American graduation rates are comparable and the Asian/Pacific Islander rate is eight percentage points higher for the AS Engineering students. The percentage of Hispanic students earning the AS Engineering degree exceeds the national average but it is approximately half of the college average.

Academic Preparation

In a testimony before the United States Senate, Dr. Kristina Johnson[14] identified math proficiency as one of the primary barriers to engineering programs, especially for women and

minority students. The first math course taken in college was used as an indicator of the academic preparedness for the AS Engineering graduates. Results from the analysis are shown in Table 3.

Math Course	%
Developmental Math	46.4
College Algebra	21.4
Trigonometry	7.1
Pre-Calculus	7.1
Calculus	18.0

Table 3. First College Math Course for AS Engineering Graduates

In addition, 39.3% of the AS Engineering graduates required developmental writing and/or reading.

Graduation and Retention

Since the inception of the engineering transfer program, 28 students have graduated with an AS Engineering degree. Over 89% (n = 25) of these students transferred to a university and enrolled in an engineering program. Two students have subsequently changed majors resulting in an overall transfer retention rate of approximately 82%. Five of the AS Engineering graduates earned their BS Electrical Engineering degree as of Fall 2008. In addition, 36 individuals transferred to one of the partner universities and enrolled in either an Engineering (n = 34) or Computer Science (n = 2) program prior to completing their associate degree. Like the AS Engineering graduates, a high retention rate after transfer (88.9%) has been realized, with only 4 students reported as having changed their major.

Academic Performance

Richland College and The University of Texas at Dallas initiated a study[3] in 2007 to assess the success of the transfer students by looking at academic performance in upper level engineering courses. The study population was a group of engineering transfer students from Richland. The courses selected for the study were sequenced courses in which students took the prerequisite course at Richland as part of the AS Engineering program. The courses included Electrical Network Analysis Lab (EE 3101), Digital Circuits Lab (EE 3120), and Digital Circuits (EE 3320). Results from the study are shown in Table 4.

Course	*n*	A+	A	A-	B+	B	B-	C+	C	C-	D	F	GPA
EE 3101	10	4	2	2	0	1	0	0	1	0	0	0	3.63
EE 3120	11	10	0	1	0	0	0	0	0	0	0	0	3.97
EE 3320	12	1	1	1	2	3	1	0	1	0	1	1	2.75

Table 4. Academic Performance of Transfer Students in Sequenced UTD Courses

The University of Texas at Dallas reported the performance of the Richland transfer students in the sequenced engineering courses was comparable to the remaining students in the class. In a related study[3], UTD evaluated the academic performance in the Advanced Engineering Math, EE 3300, course related to a student's Calculus experience. The University of Texas at Dallas reported no significant difference in performance between students who entered the university as freshmen and transfer students who completed Calculus at Richland. This is significant, as the freshman class at UTD has one of the highest SAT averages in the state of Texas.

Summary and Conclusions

Richland College developed and implemented an innovative articulated engineering program with area universities. The program allows students to complete the first two years of a BS Electrical Engineering degree at Richland with a guaranteed block transfer of 62-66 credit hours. The program has resulted in an average increase of 225 students per year taking engineering courses at Richland College. Initial studies were conducted to determine the effectiveness of the program in providing a viable pathway towards a bachelor degree in engineering for students who are academically under prepared as well as underserved segments of the population. Ethnicity, gender, academic preparedness, graduation rates, transfer retention rates, and academic performance in next level courses were used as key indicators in the analyses.

Based upon the study sample of students who earned an AS Engineering degree ($n = 28$), the program compares very favorably to the national statistics[12] for engineering degrees awarded to African-American, Asian/Pacific Islander, and Hispanic students. However, the percentage of female students is below the national and college averages. Over 89% of the students who earned an AS Engineering degree transferred and enrolled in an engineering program upon graduation. The high transfer retention rate is encouraging given that almost 75% of the AS Engineering graduates entered college with a math proficiency level below college Pre-Calculus. Under most engineering program standards, these students would have been considered academically under prepared. Results from a university study[3] indicate there is no difference in performance in the next level engineering or math courses, regardless of whether a student entered the university as a freshman or transferred from the engineering program at Richland College.

The findings from these studies emphasize the vital role of engineering transfer programs within underserved segments of the population, if there is an expectation of closing the gaps in the number of engineering graduates produced in the United States. The affordability and access offered by Richland College, and other community colleges, makes engineering available to a group of individuals who otherwise might not have considered this career field.

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