

Enriching the Diversity of the Engineering Workforce: Addressing Missed Opportunities to Support Student Transition from a Two- to a Four-Year Institution

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Jackie Perez is the Director for the Texas A&M Engineering Academies. She is responsible for the development and programmatic aspects of each partnership including each of the Texas A&M-Chevron Engineering Academies. She is excited about the innovative pathway that the Engineering Academies provide students and the opportunity to impact students who may have otherwise never considered a baccalaureate degree, much less a B.S. degree in engineering.

Mrs. Perez has over 15 years of experience in advising and leadership roles. In 2001 she completed her baccalaureate degree in Psychology from Texas A&M University. She spent the next 8 years working for the Department of Family and Protective Services. In 2009 Mrs. Perez returned to Texas A&M University working for the College of Engineering. Her responsibilities have included student advising, overseeing recruiting initiatives and program development, scholarship awarding, and working in partnership with various institutional entities.

Mrs. Perez is married and has three children. She also serves on the Brazos County Child Welfare Board. In her career, she appreciates seeing the confidence develop in her students. She believes one of the best compliments someone in academia can receive is being told by a student that your support and encouragement helped them persist and succeed.

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I. Introduction

Educators across the State of Texas and nation are engaged in efforts to answer calls including: (a) the 2011 President's Council on Jobs and Competitiveness goal of 10,000 more engineering students from US colleges and universities each year, (b) the 2012 President's Council on Science and Technology recommendation for one million more science, technology, engineering and mathematics (STEM) degrees in the next decade, and (c) the Texas Workforce Commission estimated state projected need of 62,000 more engineers by 2022 (25% increase)^{1,2,3}. Therefore, developing strategic pathways to increase students, and underrepresented students in particular, achieving STEM degrees is essential⁴.

Nearly half (49%) of students earning a bachelor's degree in science and engineering reported attending a community college at some point in their education⁵. Two-year college students represent an increasing proportion of all undergraduate enrollment growing from 43% in 2011 to 46% in 2013 and are historically over-represented populations underrepresented in engineering with over half of the Hispanic (57%), Native American (61%), and Black (52%) college students^{4,6,7}. However, students starting in two-year colleges face many challenges, such as a lack of information about clear pathways, supportive policies, and systemic support between two-year and four-year institutions^{8,9,10}. To enrich the diversity of the engineering workforce, we must recognize and recruit from the two-year institution talent pool and provide a clear and transparent pathway that is student centered and institutionally supported.

This paper highlights the Texas A&M Engineering Academies co-enrollment partnerships between two-year institutions in the state of Texas and the Texas A&M University – College Station College of Engineering (CoE). Students earn engineering course credits from the CoE beginning with the first semester that they are admitted to the program. This unique co-enrollment model allows students to remain close to home, earning measurable progress towards completing a bachelor's degree while simultaneously completing an associate's degree. Programs are imbedded in the partnerships to help students develop an institutional and professional identity and adapt to the academic and social environment of Texas A&M University. The US Census Bureau reported that as of 2011, Texas was one of five majority minority states¹¹. These partnerships increase educational opportunities and support efforts to produce engineers reflective of the community. This paper shares the challenges and successes learned during the first three years of the program and the planned expansion to further recruit, retain, and graduate a more diverse engineering demographic through a pathway of co-enrollment and partnership with two-year institutions.

II. Background of the Partnerships

The Texas public education system includes 39 public universities, 50 public community college districts with multiple campuses and 75 of the 409 designated Hispanic Serving Institutions

(HSIs) in the United States (18.3%)^{12,13}. From 2000 to 2015, the number of students enrolled in a Texas public community college increased 62.3% to 700,894¹⁴. The African American and Hispanic student enrollment in Texas public community colleges reached 92,356 and 294,388, an increase of 2.3% and 13% during the same the 15 years¹⁴. Comparably, the enrollment in four-year public universities rose 49.4% to 619,284 students¹⁴. The African American and Hispanic student enrollment reached 73,612 and 192,712, an increase of 2.1% and 11.5% over the 15 years¹⁴. Recognizing the enrollment trends in Texas and the state and national call for increasing the number of students graduating in STEM fields, the CoE created the Texas A&M Engineering Academies - innovative co-enrollment partnerships with select two-year institutions.

The first Texas A&M Engineering Academy partnership was created in fall 2013 with Blinn College-Bryan located approximately 5 miles from the Texas A&M University campus and within the same county lines. Partnerships with Houston Community College-Spring Branch (HCC) and Blinn College-Brenham launched in fall 2015 and a partnership with El Centro College-Dallas County Community College District will begin in fall 2016. Additional expansion plans include launching partnerships with Texas Southmost College and Alamo Colleges scheduled to begin fall 2017. All of the Engineering Academy partnerships, except Blinn College-Bryan, are with institutions located at a distance and four of the six partnerships are with HSIs. In addition to looking at the demographics of the two-year institution, other factors considered when identifying new partners included the record of how many students had successfully transferred from the two- to the four-year institution, the number of students the institution believed they could identify with an expressed interest in engineering, and the two-year institutions' willingness to commit faculty, administrative, and facility support in developing the partnership with the CoE. Expanding the co-enrollment partnerships across the state and intentionally identifying Minority Serving and HSIs addresses missed opportunities to support student transition from a two- to a four-year institution and enhance the diversity of students pursuing a bachelor's degree in engineering.

III. Results and Successes of the Partnerships

In fall 2013, a total of 113 students enrolled in the Texas A&M engineering co-enrollment program known as TEAM-E (See Table 1). The Texas A&M University Office of Admissions identified academically talented freshman applicants who, due to capacity, could not be offered a space in the CoE taking all their courses on the Texas A&M University campus. These students were offered an alternative admission that provided enrollment in general studies at Texas A&M University with access to engineering courses previously reserved for students with full admission to the CoE. Admission required the students to be co-enrolled with Blinn College-Bryan. Additional components of the co-enrollment model included: (a) students received dedicated advising from the CoE along with advising from Blinn College; (b) the students completed one to two courses at Texas A&M University each term including freshman/sophomore engineering courses; (c) the students took their math, science and engineering courses as a cohort; and (d) the students had access to housing, health services, student facilities, student organizations, etc. to the extent available on both campuses with the exception that they were not eligible to participate in NCAA sports. The program allowed the CoE to increase access while offering an undergraduate experience on the Texas A&M

University campus from their first year of admission. Table 1 shows that 51% of the students were admitted to a degree granting major in the CoE by the end of four semesters.

Table 1. Fall 2013 Texas A&M Engineering Academy at Blinn-Bryan (Formerly TEAM-E)

Category	Subgroup	Original Cohort (<i>n</i> = 113)	Enrolled in a CoE Major: Four-year Retention* (<i>n</i> = 58)
Race/Ethnicity	Hispanic	23.9%	44.4%
	Asian	0.9%	0.0%
	American Indian	1.8%	50.0%
	Black	0.9%	0.0%
	White	68.1%	51.9%
	Multiracial	4.4%	100.0%
Sex	Male	81.4%	54.3%
	Female	18.6%	38.1%
Total		100.0%	51.3%

Note. *Retention rate is a percentage of students retained from the original cohort by race/ethnicity and sex.

The Engineering Academy team found that an additional 25% of the students were admitted to a degree granting major outside the CoE. Furthermore, as of spring 2016, 97% of the co-enrolled students admitted to a degree granting major in the CoE are still retained in the CoE. In result, accessibility to an engineering education is expanded to more students through this model.

In fall 2014, the admission process for the Engineering Academy at Blinn-Bryan changed to admit the students to the CoE but not into a degree granting major. The same admission process occurred for freshman admits fully enrolled in the CoE. The co-enrollment program known as TEAM-E changed to the Texas A&M Engineering Academy at Blinn-Bryan. The number of new students enrolled doubled from 2013 (See Table 2).

Results continue to be promising when observing the number of students transitioning into a degree granting major in the CoE. After three semesters, preliminary numbers show a 76.2% (*n* = 173) retention to the CoE which includes 59.0% (*n* = 134) of the students fully enrolled in a degree granting major in the CoE and 17.2% (*n* = 39) of the students continuing co-enrolled in the engineering program (See Table 2). This is an 8% increase in entry into a CoE degree granting major after just three semesters versus the 51% of students from the 2013 cohort that entered a major within four semesters.

Table 2. Fall 2014 Texas A&M Engineering Academy at Blinn-Bryan Cohort

Category	Subgroup	Original Cohort (<i>n</i> = 227)	Three-Semester CoE Retention* (<i>n</i> = 173)	Enrollment in a CoE Major* (<i>n</i> = 134)
Race/ Ethnicity	Hispanic	17.6%	75.0%	52.5%
	Asian	9.7%	81.8%	68.2%
	Black	2.2%	80.0%	80.0%
	Native Hawaiian	0.4%	100.0%	100.0%
	White	68.3%	75.5%	58.1%
	Multiracial	1.3%	100.0%	100.0%
	Unknown	0.4%	0.0%	0.0%
Sex	Male	82.4%	75.4%	58.8%
	Female	17.6%	80.0%	60.0%
Total		100.0%	76.2%	59.0%

Note. *Retention rate is a percentage of students retained from the original cohort by race/ethnicity and sex. The difference between three-semester CoE retention and enrollment in a CoE major represents CoE students continuing in the Engineering Academy program.

In fall 2015, the CoE expanded the Engineering Academies to HCC and at Blinn College-Brenham. Both institutions are located at a distance and outside of the same county as Texas A&M University. Both freshman and continuing college students are eligible for admission to these Engineering Academies, expanding access to students who may not have been prepared to relocate and commit to an engineering education directly out of high school. Students first apply and are admitted to the two-year institution. The two-year institution pre-qualifies students with an expressed interest in the engineering co-enrollment program and provides them the application to the Texas A&M Engineering Academy program. Texas A&M University makes the final admission offer, granting student's admission to the CoE. Students admitted and enrolled in the Engineering Academy take one Texas A&M CoE course, taught by Texas A&M CoE faculty on the two-year campus each semester during the two-year co-enrollment program. This provides the CoE students in an Engineering Academy the ability to begin earning Texas A&M engineering course credit. They receive dedicated advising from the partner institution and the CoE. They take their math, science and engineering courses as a cohort, developing a community of academic peers. They also have access to offices and services at the University including the career center, Academic Success Center, and Engineering Innovation Center. Expanding the partnerships to Blinn College-Brenham provided an opportunity for CoE students located at a distance to be in a living learning community. The partnership with HCC is our first partnership in a major city and with an HSI.

Table 3 shows a comparison of the student demographic of the fall 2015 new CoE student enrollment in each partnership compared to the demographic of the new CoE student enrollment on the Texas A&M campus. The 2015 enrollment numbers demonstrate the increase in diversity from the new Engineering Academy partnerships at a distance with Blinn-Brenham and HCC compared to the new student enrollment of first-time in college (FTIC) and first-time transfer students (FTT) on the Texas A&M campus. Hispanic student enrollments in both of the distance

partnerships exceeded both FTIC and FTT new CoE student enrollment by more than 10%. Both female student enrollment and black student enrollment in the Engineering Academy at HCC exceeded new CoE student enrollment on the Texas A&M campus by more than 16%.

Table 3. Fall 2015 Texas A&M Engineering Academy Cohorts Compared to FTIC and FTT New Undergraduate CoE Student Enrollment on the Texas A&M University Campus

Category	Subgroup	Texas A&M University		Two-year Partner Institutions		
		FTIC (n = 2,586)	FTT (n = 358)	HCC (n = 31)	Blinn-Brenham (n = 61)	Blinn-Bryan (n = 381)
Race/						
Ethnicity	Hispanic	25.2%	20.4%	35.5%	36.1%	24.6%
	Asian	9.7%	12.3%	16.2%	3.3%	10.5%
	American Indian	0.2%	0.3%	0.0%	0.0%	0.0%
	Black	2.7%	3.3%	19.4%	1.6%	3.7%
	Native Hawaiian	0.0%	0.0%	0.0%	0.0%	0.3%
	White	59.6%	47.5%	19.4%	52.5%	58.0%
	Multiracial	2.3%	0.9%	3.2%	3.3%	2.9%
	International	0.2%	14.8%	6.4%	0.0%	0.0%
	Unknown	0.1%	0.6%	0.0%	3.3%	0.0%
Sex	Male	71.1%	83.0%	54.8%	93.4%	82.7%
	Female	28.9%	17.0%	45.2%	6.6%	17.3%
Total		100.0%	100.0%	100.0%	100.0%	100.0%

In fall 2016, the CoE will expand the Engineering Academies to El Centro College and in fall 2017, we plan to enroll the first CoE co-enrolled students at Texas Southmost College and Alamo Colleges. These planned Engineering Academies will follow the same admission, enrollment, CoE faculty, advising and access to University offices as provided to the CoE students in the Texas A&M Engineering Academy at HCC and Blinn-Brenham. In addition, the CoE students pay tuition and fees (T&F) for the courses registered through the two-year institution at the two-year institution rate and tuition and fees for the CoE courses at the Texas A&M rate in each of these partnerships with institutions at a distance. Table 4 shows average semester savings per student with three partner institutions. Nationally, the average annual tuition and fees for an in-district student at a two-year public institution is \$3,347, which is nearly 1/3 the average annual tuition and fees of \$9,139 for an in-state student at a four-year public institution¹⁵. Administrators found that in creating these partnerships, the savings for the co-enrolled students registered for a combined total of 15 credit hours averaged \$3,400 per semester or \$6,800 per academic year. Financial aid is processed by the two-year institution. Through a consortium agreement, students choosing to register for fewer than 12 credit hours at the two-year institution can combine the credit hours from both institutions for full-time classification and financial aid eligibility.

Table 4. Average Semester Savings per Student with Three Partner Institutions*

Two-year Institution	Two-year T&F for 12 credit hours (in-district)	Texas A&M T&F for 3 credit hours (in-state, in-absentia)	Total T&F for Engineering Academy	Average Semester Savings
Blinn-Brenham	\$1,130.00	\$1,250.00	\$2,380.00	\$3,160.00
HCC	\$820.00	\$1,250.00	\$2,070.00	\$3,470.00
El Centro	\$700.00	\$1,250.00	\$1,950.00	\$3,590.00

Note. *Estimated savings are based on the 2015-2016 tuition and fee rates. Comparison is with the average T&F for an in-state CoE student enrolled at Texas A&M University in 12+ credit hours estimated at \$5,540 per semester

The aforementioned processes for admission, advising, and financial aid are examples of how leadership at each institution strategically identified ways to support the co-enrolled student's academic progression even in institutions located 40-390 miles away from Texas A&M University. The institutionally supported programs are proving to expand access to a more affordable engineering degree by allowing students to remain close to home and pursue an associate's degree while earning measurable progress towards a bachelor's degree in engineering.

IV. Discussion and Challenges

Success of the Texas A&M Engineering Academies depends on more than providing the academic opportunity for the students. Working with students, who are not physically located on the Texas A&M University campus but supporting the formation of an identity as an engineering student, is a challenge. In higher education, transfer shock is frequently used to describe the student's experience transitioning from a two- to four-year institution. Laanan points out, "The community college student who transfers to the four-year institution faces new psychological, academic, and environmental challenges" (p. 5)¹⁶. Miller (2013) describes one of the greatest challenges facing community college transfer students in Texas is a lack of engagement or integration at the four-year institution¹⁷.

Administration responsible for this co-enrollment program are imbedding an extended bridge program consisting of a series of campus engagement experiences geared at increasing the motivation and persistence of the students and fostering the development of an institutional identity. This program is complimentary to the course work already taking place on the 2-year campus. Academic year 2015-2016 campus engagement experiences on the Texas A&M University campus include attending sporting events, participating in dedicated sessions with the student career center, campus academic success center, engineering labs, and participating in the engineering career fair. The experiences connect the students to both academic services and campus life, physically integrating them into the culture and activities at the University. The development of this "institutional identity" will provide a structure and support system that equips participating students with a sense of belonging. The students improve their understanding of Texas A&M University resources available to them while co-enrolled and once they fully matriculate to help them adjust in the transition and successfully persist to graduation. Currently, funding from the CoE covers the expenses for CoE students co-enrolled on the Blinn

College-Brenham campus. The Engineering Academies at HCC, El Centro College, Texas Southmost College and Alamo Colleges are all HSIs and have all been named “Chevron” Academies. Funding from Chevron provides the financial support to cover expenses related to these experiences located on the Texas A&M campus for the Chevron Academies.

Increasing the pathway for students from underrepresented populations and supporting the transition from the two- to the four-year institution will not achieve the full potential of success without engaging parents/families. Even though the students admitted to the Engineering Academy are co-enrolled, it is vital that their personal and family obligations may be more similar to that of traditional transfer students than native students; characteristics including non-traditional-aged, employed off-campus and facing multiple responsibilities, such as caring for dependents¹⁷.

Particularly, there is a dire need of an efficient parent orientation program for minority students that include Hispanic students¹⁸. Hernandez²⁰ addressed the importance of family involvement in Hispanic students’ retention and argued development of parent orientation programs to provide their parents with opportunities to meet with college staff and to familiarize with the college setting, so they can understand the academic rigor and institution/college goals and provide appropriate support for students^{19,20,21,22}.

The Texas A&M Engineering Academy partnerships with institutions at a significant distance from the four-year campus is still in the early stages. Ongoing efforts are in place to secure financial support for students to offset the increase in tuition and fees that will occur when they transition to the Texas A&M University campus to complete the bachelor’s degree. Evaluation of both qualitative and quantitative data on the effectiveness of the campus engagement and family engagement programs is needed. Administration will continue to monitor the time to degree completion for students that begin in the co-enrollment program. A comparison of educational outcomes for students that start co-enrolled in the engineering program compared to native students and a comparison of performance of students that transition to the four-year campus after co-enrollment versus students that transition via the traditional transfer pathway is warranted.

IV. Conclusion

Overall, early results of the Texas A&M Engineering Academies are promising. The Texas A&M University College of Engineering and two-year partner institutions have developed strategic and intentional processes supporting areas including admission, enrollment, advising, financial aid, and acculturation to the University. This innovative co-enrollment model, with support from Chevron, demonstrates industry commitment to increasing the diversity of the engineering field and supporting clear pathways for students to transition from a two- to four-year engineering education onto the workforce.

The partnership with Blinn College-Bryan provides an undergraduate experience for students to be on the University campus earning engineering course credit. Of the 340 CoE students who started in the Engineering Academy at Blinn-Bryan in 2013 and 2014, 68% enrolled in a CoE major and an additional 11% from the 2014 cohort are continuing co-enrollment. The partnership

with Blinn College-Brenham provides a living learning community for the engineering students similar to communities formed on 4-year campuses. The Chevron named partnerships with HSIs including HCC, El Centro College, Texas Southmost College and Alamo Colleges increase access and affordability to a more diverse student population allowing the students to remain close to home for the first two years of co-enrollment. The Engineering Academies team will continue to evaluate the matriculation of co-enrolled students including the 446 new students that entered an Engineering Academy in fall 2015. The Engineering Academies are increasing access to an engineering degree for students across the State of Texas and concurrently positively impacting the diversity of the engineering student body.

In a June 2015 report, the Texas Higher Education Coordinating Board (THECB) noted that public institutions awarded 21,591 STEM baccalaureate degrees in fiscal year 2014 (12,207 specifically in engineering, 6,205 in computer science)²³. The number of STEM awards was an increase of 8.6% over the number awarded in 2013. Hispanics earned 803 STEM awards, an increase of 13.4% from awards earned in 2013 and the largest and fastest growth from Hispanic, White and African American degrees awarded. The report went on to state, “Texas has a better chance of remaining competitive in technological fields if STEM production continues to grow. Without appropriate representation in this growth from all of the state’s major demographic groups, particularly Hispanics and females, Texas could lose its competitive edge” (p. 15)²³. Despite the challenges ahead, the Texas A&M University College of Engineering and partner two-year institutions are confident in the opportunities the Engineering Academies present to the students and the potential to enrich the diversity of the engineering workforce in the State of Texas and the nation.

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