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First Generation Engineering Student Mentoring Program: A Case Study of a Large Engineering School in the U.S.

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Abstract

Retention and graduation rates are lower for engineering institutions compared to their peers in other fields across the United States. While graduation rates are improving slowly over time due to enrichment programs (such as summer bridge program, research experience, and living learning community), not all groups have performed well; this is especially true of underrepresented minority and first generation (FG) students. Literature suggests that the FG students enter college with "distinct disadvantages" as compared to their peers in many ways including academic preparation and basic knowledge about the college education; this makes their transition from the high school to college environment a difficult process. Two key factors for lack of persistence in this population are widely cited: college adjustment and lack of self-efficacy. FG students benefit from additional support as compared to their non-FG counterparts because they do not matriculate with prior knowledge on how the academic process works. To that end, effective mentoring and counselling can help them through the transitional process. In this paper, a case study of a mentoring program that is specifically designed to help FG engineering students at a major university is presented. The paper discusses the implementation process of the mentoring program including recruiting of faculty/staff mentors, student peer mentors, the mentoring relationship management platform, and the connection plan at Texas A&M University, College Station, Texas. The paper also presents the survey results of the "initial experience" of mentees and mentors and how that has informed the future strategies to sustain and grow the program.

Introduction

High college student attrition is a problem has been widely studied for the last few years. This problem is even greater in the science, technology, engineering, and mathematics (STEM) disciplines. For instance, Wilson et al. [1] report that fewer than 50% of STEM students would eventually graduate with the same degree they started as freshmen. While there are lower retention rates in STEM disciplines across a wide spectrum of students, this problem is more severe in low income and first generation students [2]. Higher education literature suggests that the first generation (FG) students enter into a college with "distinct disadvantages" as compared to their peers in many ways including "academic preparation in high school, basic knowledge about college education, educational degree expectations and plans, difficulty in cultural and social transitioning process, and family income and support" [3]. Likewise, Terenzini et al. [4] describe first generation students to have following attributes compared to their non-first generation peers: a) have low family income; b) belong to underrepresented population group; and c) have "weaker cognitive skills in math, science, and critical thinking". The authors also found a significant difference between the FG and Non-FG students with respect to their overall college experience. Their findings showed that the FG students had taken fewer number of credits hours, studied fewer hours, worked longer hours, and had overall lower academic

performance. With respect to retention, the most important challenges facing the FG students are: college adjustment, self-efficacy, lower GPA, and financial aid [5].

With respect to retention of FG students, Salinitri [6] mentions several factors that negatively affect the transition from high school to college. These factors include "new found independence, homesickness, time management, finances, or different teaching styles" ([6], pp. 854). In a recent study of freshmen engineering students at the University of Lousiville, it was found that over 50% of the freshmen who left the university came from FG students group [7]. Ishitani [8] presents the most comprehensive study on the first generation college students yet in which the author performed a longitudinal study over 12 years (1988-2000) based on the several national databases. According to this study, "first generation students were exposed to higher risks of departure through college years than their counterparts" (pp. 880). Another important finding of this research includes the effect of being "first generation". For example, while generally speaking first generation students had higher attrition rates than their average (non-first generation) peers, the attrition rate was very comparable for those with higher academic preparation (like higher SAT score, good math and science courses in high school).

Academic Preparedness and Self-Efficacy of First Generation Students

A study by the college admission aptitude testing organization ACT on students' retention issues in 4-year public institutes finds that "student-institution fit" and "social environment and student involvement" in campus life are the key contributing factors to students' attrition in addition to financial aid availability [9]. As per social psychology literature, one of the major reasons for FG students to drop out is the "cultural shock" they get in college. For example, as per the individualistic aspect often associated with American culture, they are taught to be "independent" thus they tend not to seek advice from any advisors or other peers leading to confusion and eventually to attrition [10]. In another study, researchers found a pre-engineering or a month long summer camp focused on engineering education and engineering careers to be a contributing factor for improvement in the retention rate for both underrepresented and FG STEM students at Wright State University [11]. Likewise, in a 3-year long longitudinal study of 18 four-year universities, Pascarella et al. [3] found that only academic (research experience, project based learning, etc.) and classroom activities have positive impact on student persistence. Interestingly, per their findings, other on-campus experience such as volunteer work, employment, and participation in inter-collegiate athletic experiences had a negative effect on FG students' success in their academic performances.

Similarly, higher education literature also reports that self-efficacy level among the FG students is lower compared to their non FG peers. Self-efficacy is defined as "beliefs in one's capabilities" to perform things to achieve a certain goal [12]. Self-efficacy beliefs act as a key factor behind a persons' thinking, feeling and behavior, and provides confidence in his or her ability to succeed in a specific situation [13]. A higher sense of self-efficacy provides a person with greater assurance in his/ her skills and capabilities, which in turn can motivate that person to approach a seemingly difficult task instead of avoiding it [14]. People with high self-efficacy tend to set goals that are more challenging and maintain a stronger sense of commitment. This outlook leads to greater personal accomplishments, less stress, and reduces risk of depression [13]. Individuals who possess a lower sense of self-efficacy tend to perceive themselves as incompetent, do not partake in challenging tasks, and surrender when faced with adverse situations [15].Therefore the "traditional support services" offered by an academic institute are

not adequate to meet the "unique needs" of the FG students[5]. FG students need "interventions" that can help boost their self-efficacy levels. Sanchez and Nicholas ([5], p. 15) recommend "providing psychoeducational support groups for first generation and non-first generation college students with low self-efficacy levels that would focus on one or more sources of self-efficacy". Those sources include "vicarious experiences, emotional arousal, verbal persuasion, and performance accomplishments". The above mentioned support systems of interventions can be provided by a group of seniors from FG and Non-FG groups along with faculty. Industry speakers can also join the support systems and discuss the job prospects to boost the confidence of the students. Gibbons and Shoffner [16] list the following five areas in which FG students may have different "personal experiences and personality traits" compared to their non-FG peers:

1. *Prospective first generation college students face the daunting task of applying to college without the assistance of parental experience.*
2. *Lack of preparation for college life while still in high school, because of which many FG students leave without completing their degree. These students are unable to handle the university level stress compared to their non-FG peers.*
3. *FG students may be less prepared academically. For example, SAT scores, high school GPAs and the performance in the first year in the college.*
4. *First generation college students perceive the college experience differently than other college-bound youth.*
5. *Personality and basic living style differences exist for FG students compared to their non-FG counterpart. Research finds relatively lower levels of self-esteem, social acceptance, humor, and creativity in the FG students compared to non-FG students*

Mentoring

In order to deal with high attrition rate in engineering and other STEM disciplines, several intervention programs have been reported in the literature. Such intervention programs include mentoring, peer tutoring, living learning community, financial aid, and a summer bridge program for math and science courses. Mentoring helps with socializing and academic preparation by fostering loyalty and building a sense of community [17]. Recent studies exploring the effect of university mentoring programs have revealed that mentoring may have a significant impact on positive mentee outcomes, especially self-efficacy [5-6]. Furthermore, Mentoring has been recognized as important for retention and enrichment of undergraduate students [7]. According to Wilson et al. [1], students who are a part of mentoring program tend to perform better academically and have higher retention rates compared to their un-mentored peers. Other researchers have also supported this idea as mentoring services help students (especially those from underrepresented population groups) with building a strong community and, therefore, help them with integrating with campus academic community and other social groups [18-21]. Wilson et al. [1] presented Louisiana State University's Howard Hughes Medical Institute Professors Program as a case study of mentoring program that contributed to higher retention rate of STEM students who were part of mentoring program (62% for mentored students compared to 55% non-mentored students). Similar results were reported in a prior study by Salinitri [6] at a Canadian University and by Dennis et al. [22] at an urban commuter university in California, USA.

While benefits of mentoring program have been cited in the prior literature, there are very few publications that provide a holistic view of the whole implementation process. More importantly,

there is a wide variability in the implementation approach of such programs (e.g., type of mentors, mentor-mentee ratios, connection plans, relationship management, etc.) depending upon the size of the institutes and nature of the program. This paper narrows that gap by providing a holistic view of overall implementation process at a major engineering college (with more than 15000 UG students) in the U.S.

FGEn Mentoring Program at Texas A&M University: A Case Study

The FGEn mentoring program at Texas A&M University was officially launched on August 22, 2017. This event was preceded by a series of activities that included initial study, mentor recruiting and training, setting up of software platform for mentoring relationship management, and student recruitment. The following paragraphs describe each activity in detail.

Initial Study

The initial study team included three engineering faculty members who worked along with Executive Associate Dean and Senior Associate Dean for Academic affairs. This team prepared a white paper on the current state of Texas A&M FGEn student retention and graduation rates along with the existing research on first generation students. The findings and recommendations of initial study are presented below (see Table 2).

Table 2: Average Retention and Graduation Data for Texas A&M COE Students (2006-2014 Cohorts)

Student Group	First Generation (FG)/ Non-First Gen. (NFG)	Head-count (Average of Cohorts)	% 1-yr Retained	% 4-yr Graduated	% 5-yr Graduated	% 6-yr Graduated
Total	FG	414	71%	14%	38%	43%
	NFG	1,461	79%	25%	55%	59%
Male	FG	322	72%	13%	39%	44%
	NFG	1,129	80%	24%	56%	60%
Female	FG	92	69%	16%	37%	38%
	NFG	332	74%	30%	53%	55%
Blacks	FG	19	68%	7%	29%	32%
	NFG	29	74%	18%	46%	45%
Hispanics	FG	165	73%	11%	36%	41%
	NFG	168	77%	16%	47%	54%
Whites	FG	193	69%	15%	39%	45%
	NFG	1,139	79%	27%	56%	60%
Family Income < $60K	FG	217	71%	14%	37%	41%
	NFG	154	77%	19%	48%	52%
COE Overall	**All Groups**	**1886**	**77%**	**23%**	**52%**	**55%**

Source: Texas A&M University Accountability website, accessed on 10/22/2016

An analysis on Texas A&M's accountability data in Table 2 revealed that the average First Year Retention (FYR) for the College of Engineering (COE) students from 2002-2014 (12 years) ranged from 69% to 79%, which was significantly lower than that for overall university level FYR data (91%) for the same period. On the other hand, if we break it down by First Generation (FG) and Non-First Generation (NFG) students within the COE, the average FYR for FG students is about 8% lower than that for NFG students (71% to 79%). Interestingly, amongst FG students within COE, there is a smaller difference in FYR with respect to gender (72% to 69%, male FG to female FG students). Most concerning is the overall average 5-year graduation rate for COE is an already low (52%), but that for the FG students it is much worse (38%) than that.

As for extant research on FG students, the faculty team found that the central factors behind the attrition of FG students were lack of self-efficacy and difficulty in social transitioning into college life. Based on their research, the faculty team made the following recommendations to improve the self-efficacy and academic preparation of Texas A&M FGEn students.

1. Strategies to enhance self-efficacy of FG students:
    a. Effective mentoring and counselling at multiple levels (Peer students, academic advisors, and faculty) to provide a social capital for FGEn students by building a strong community
    b. Industry meetings and guest speakers in freshmen engineering classes
    c. Socialization and informal meetings: power lunches and industry business meetings
    d. Dedicated faculty advisors for each student who can serve as mentors for longer periods. While there may be multiple advisory staff members for course advising, these faculty advisors are more like mentors who would also track the progress of their students.
    e. Dedicated financial aid and scholarship programs
    f. Enrichment programs like research experiences, internships, honors programs, GRE workshops, and industry exposure. Research experiences and internships can begin as early as the summer before sophomore year.

2. Strategies to improve the academic preparation
    a. Scaffolding in math and science courses
    b. Scaffolding in freshmen engineering courses
    c. Living learning communities: providing afterhours tutoring services to help students with HW and test review in a dedicated residential hall where they live
    d. Summer pre-engineering programs targeting potential FG students while they are in high school

In this paper, we focus on the first recommendation (1.a) to improve provide students, which is providing social capital to our FGEn students by building a strong community through an effective mentoring program.

Mentors Recruiting and Training

In order to both generate the sufficient mentoring capacity to cover the large number of FGEn students at Texas A&M University as well as provide them with multiple mentoring options, mentors were recruited from various quarters within the college of engineering including faculty, staff, and peer students (junior and seniors). An email call was sent out to all engineering faculty and staff by the Executive Associate Dean of College of Engineering. Based on the email response, an initial meeting was called on March 10 of 2017 to discuss the mentoring program and the mentors' roles and responsibilities. Upon completion of that initial March meeting, about 50 faculty and staff signed up to become the FGEn mentor. For student peer mentors, a job advertisement was sent out to all first generation engineering juniors and seniors explaining the benefits and responsibilities of peer mentors. Over the summer of 2017, more than 80 student applicants were interviewed to select 50 peer mentors. A peer mentor was offered $800 stipend and had to have a commitment for the entire academic year. Student interest, interview response, and diversity were considered while selecting the peer mentors. Each mentor can support maximum up to two mentees.

The March 10 (2017) meeting also recommended a face-to-face mentoring training for all mentors. The prior literature also highlights the importance of mentor training as it is very likely that the non-FG mentors lack the basic knowledge on the background of a FG mentee and their needs [23].

In total, five training sessions were conducted by the mentoring experts from Texas A&M's Academic Success Center. The multiple sessions were conducted to accommodate the summer schedule of the mentors and peer mentors.

Mentoring Relationship Management System

Chronus® system has been used as a platform to manage the mentoring relationship for FGEn program. This system allows users to create their own profile, customize the matching questions, and send the automated reminders to both mentees and mentors. Currently, there are are five matching questions outlining the background (e,g., gender, race, engineering major, high school location) and their mentoring need (e.g., career, leadership, campus life). It also has an in-built tracking mechanism which allows the administrators to send out customized check-point surveys in 30 days, 60 days, and 120 days. The software platform was setup over the summer along with completion of mentor profiles before inviting the mentees to join the program.

Student (Mentee) Enrollment

Texas A&M University admits about 3000 engineering freshmen each year. Of those 3000, nearly 700 students are self-identified First Generation students. The university also has a Regents Scholar program that is dedicated to low income and first generation students. Each year, about 150 engineering (first generation) freshmen are awarded Regents scholar program which comes with its own mentoring program (although it is somewhat less structured than the proposed FGEn mentoring program). All those set aside, an email invite was sent to the

remaining 550 students to join the mentoring program, two weeks before the Fall semester started. The email invite was followed up by a welcome social dinner (on Aug 22, 2017) during which a live enrollment session was conducted to boost the enrollment. About 105 FGEN freshmen had joined the mentoring program in Fall 2017. Since its official launch on Aug 22nd, one more FGEn social program was organized in which a highly famed First Generation engineer spoke to students. The objective of the talk was to help encourage and engage (or enhance the self-respect of) the FGEn students. As of December 2017, there were 103 relationships were active in the Chronus system. In Spring 2018, two additional FGEn social cum seminar programs are being organized to build a strong FGEn learning community on campus.

30 Day Check Point Survey

As mentioned earlier, the Chronus system allows to send a 30-day check point survey to each connection (both mentor and mentee). It may be interesting to note that the 30-day count kick-off date can vary depending upon when a mentee and a mentor have established their connection. The survey questions dealt with the usability of the system, connection plan and mentoring resources (for both mentees and mentors), ease of relationship, mentoring goals, and few open ended comments. As of December 15, 2017, there were 123 responses recorded in the system of which the results are presented below (see Figure 1-4).

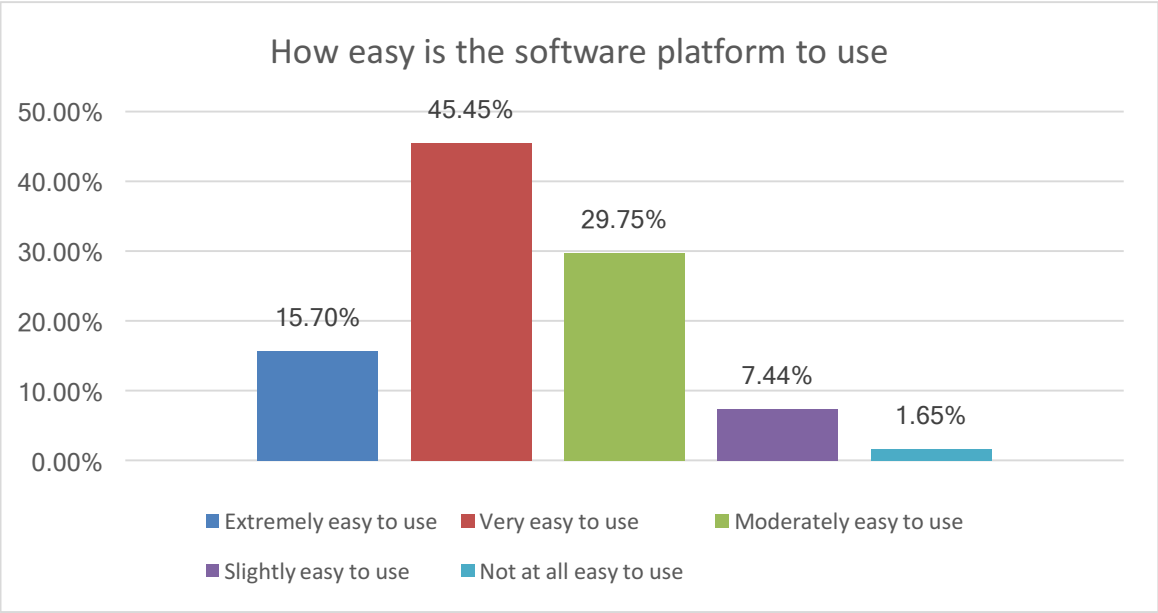
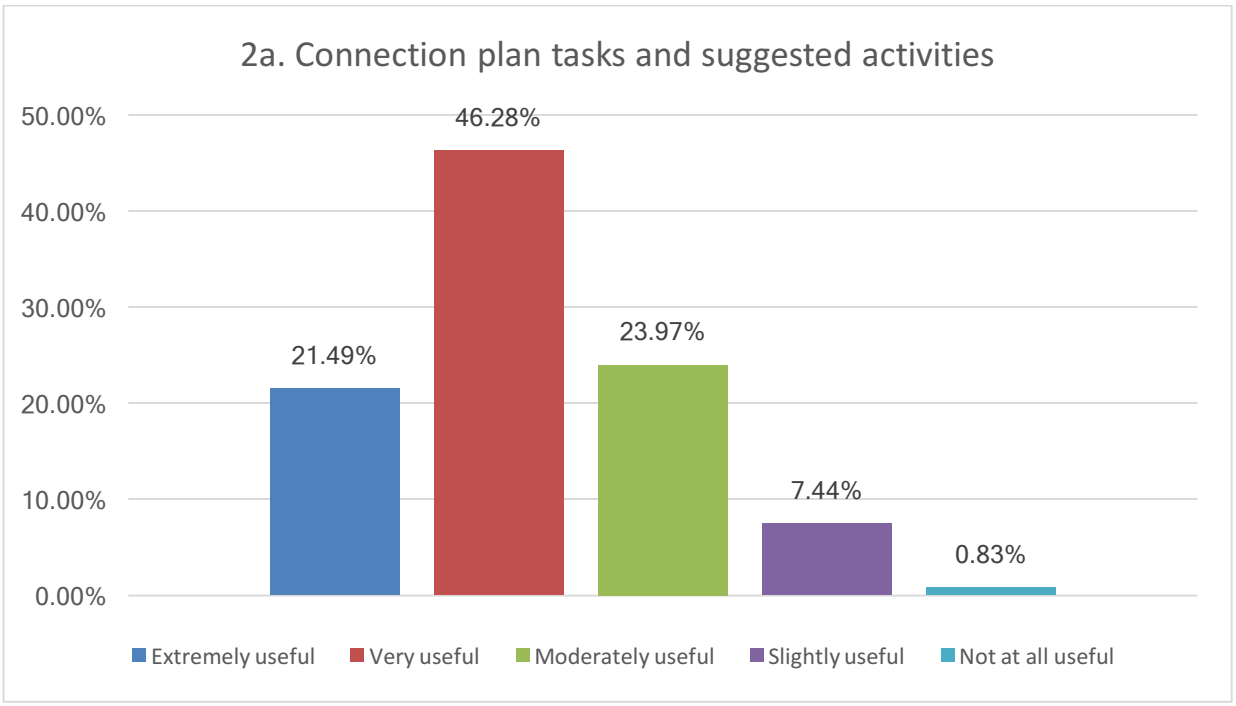
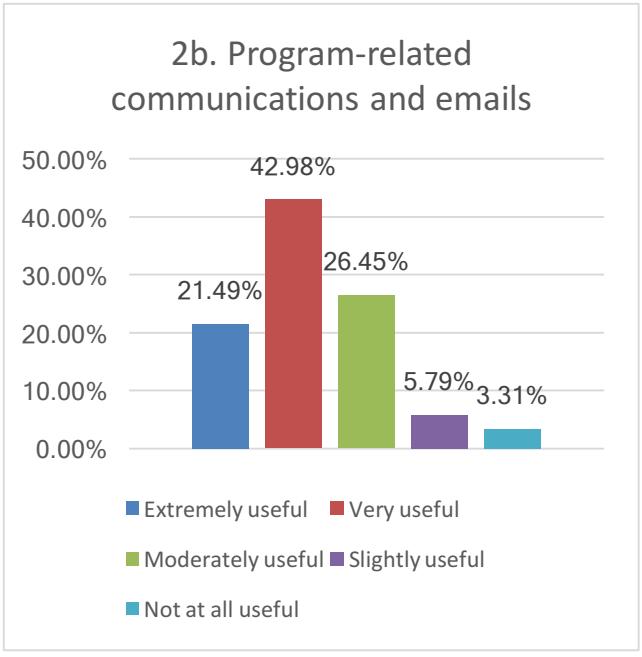


Figure 1: Feedback on ease of use of Chronus system





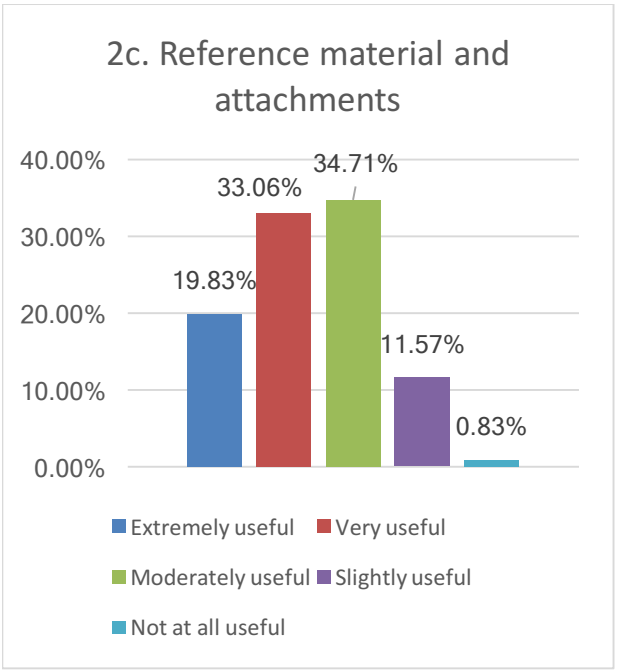
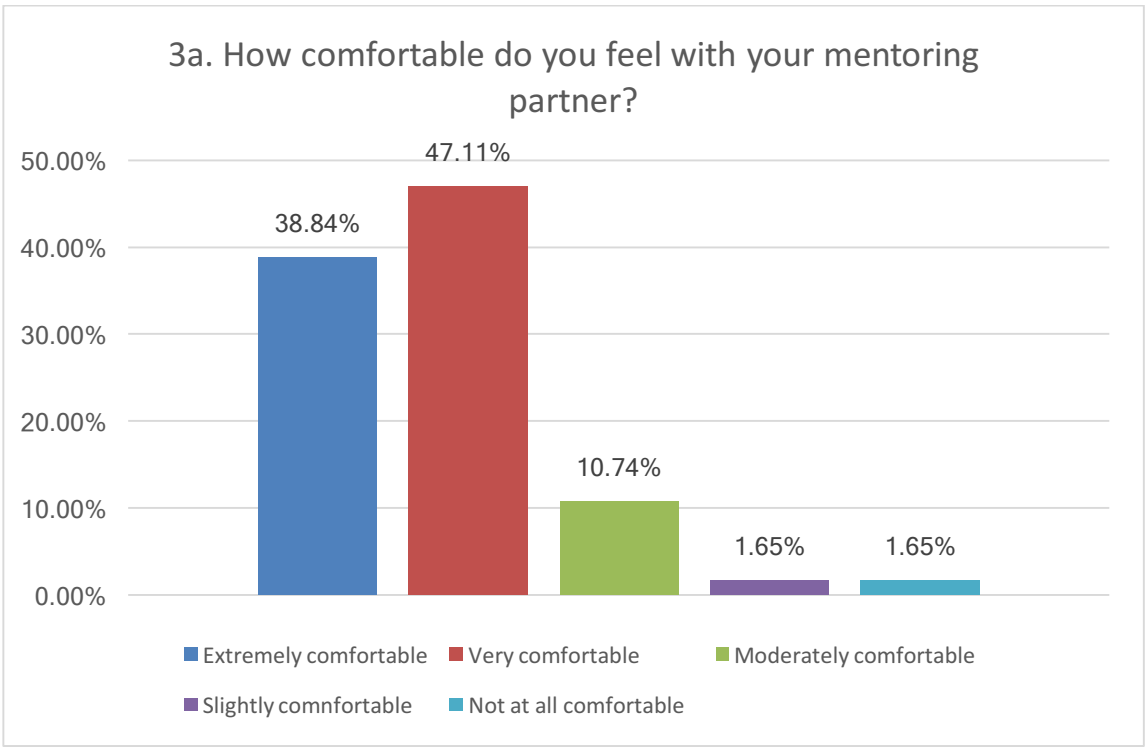


Figure 2: Feedbacks on the usefulness of mentoring resources provided by the program admin



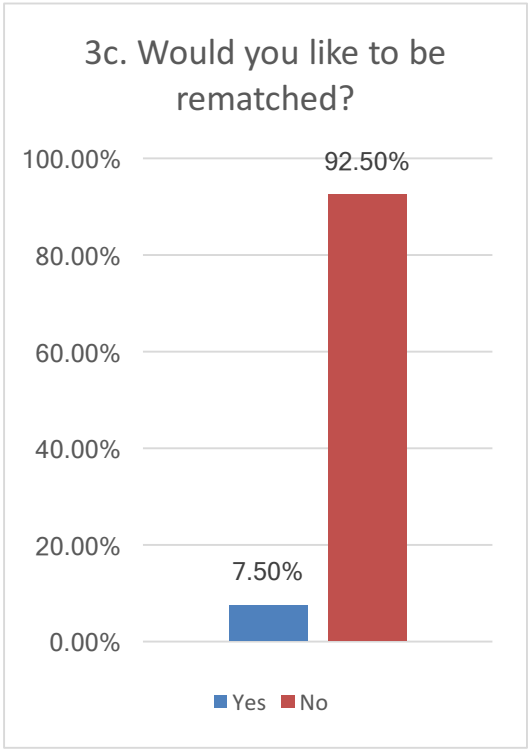


Figure 3: Feedbacks on the utility of the mentoring relationship (goals setting, ease of relationship, and desire to continue the relationship)

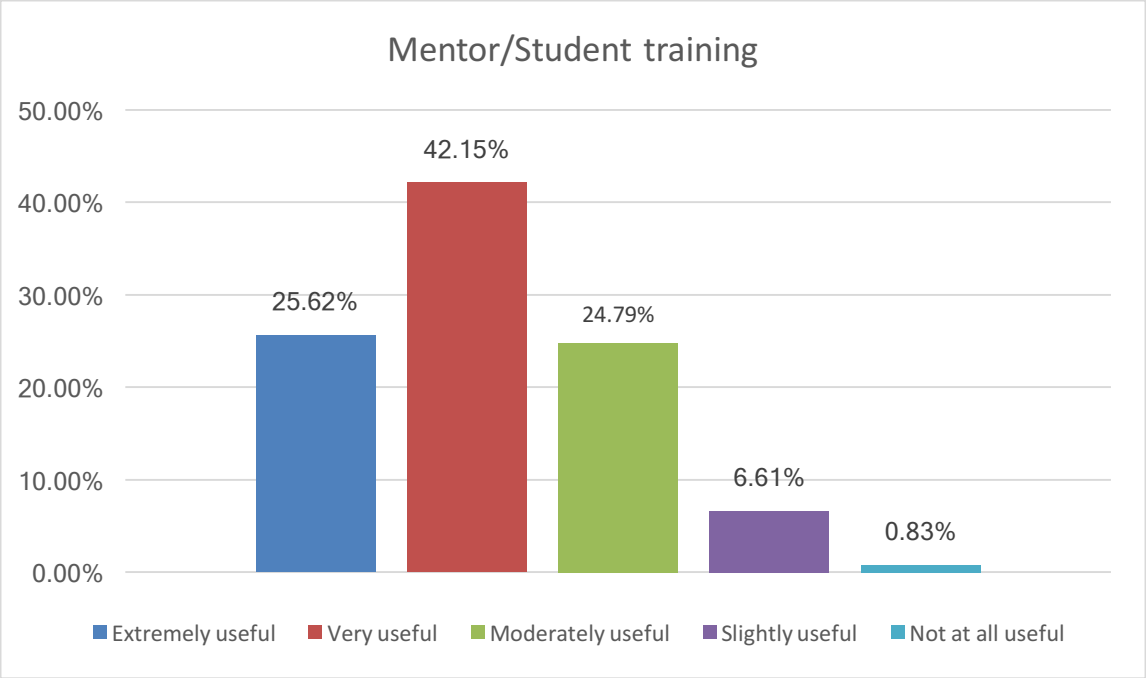


Figure 4: Feedback on the value of the mentor training

The bar charts in Figures 1-4 clearly show that the mentoring relationship is going extremely well for both mentees and mentors. Both mentors and mentees are finding the Chronus system not only being easy to use but also the features and mentoring resources provided by the program administration are perceived to be very valuable. The most important findings included the utility of the relationship. Over 85% of the respondents reported that they are either very comfortable or extremely comfortable with their current mentoring partners and over 90% said that they want to continue the current relationship. Similarly, over 89% of the respondents have already either setup their mentoring goal or have already discussed and about to setup those mentoring goals. All these outcomes are very strong indicators of the successful implementation of the program. Furthermore, although it is not reported in this survey, a separate analysis of mid semester grades in Fall 2017 showed that (on average) the FGEn students who were part of the program performed better than their FGEN peers who did not join the program. In other words, the percentage of less than 2.0 GPA was lower for mentored FGEn compared to their non-mentored peers. Lastly, the mentors overwhelmingly liked the training program conducted by academic success center.

Based on these early positive results the college of engineering has decided not only to continue the freshman mentoring program but also extend this support service to second year students beginning Fall 2018. An FGEn program advisory committee has been established under the leadership of FGEn program director to determine the new strategies to expand the program. For example, a special effort was made to recruit those who had less than 2.0 GPA in the midterms. The committee is also working with the marketing and communication team to develop new social media strategies to recruit more mentees into the program.

Conclusions and Future Research

Our literature revealed that the lower retention and graduation rates among engineering students have been gaining an increased attention of many educational researchers and administrators. This problem was more severe in first generation and low income student groups than in their non-FG peers. The FG students enter college with significant disadvantage as compared to their peers in many ways including academic preparation and basic knowledge about the college education. This paper has presented a case study of a First generation engineering student mentoring program at a major U.S. university. The mentoring program was launched in the fall of 2017. The paper described the overall process that was adopted in developing and implementing the mentoring program including the early results of the mentoring relationship. The early results obtained from the 30-day check point survey were clearly in favor of the mentoring program as it has positively contributed to the student academic success as well as in building a sense of community for FGEN students within the college. The survey results also revealed a positive feedback on the ease of use of mentoring relationship management system, the Chronus.

While this paper has presented a comprehensive framework on implementation case of a large engineering college (over 15000 undergraduate students) at Texas A&M University, the data presented in the paper is limited to one semester. Therefore, there are two important directions in which this research can be extended further. First, it would be interesting to see how this mentoring would directly impact the first year and second retention rates. Lastly, since the student persistence and graduation rate depends upon several factors such as academic preparedness, financial support, and social capital (to name a few), it would be interesting to see how mentoring can increase the participation in the other student support programs like living learning community, research experience for undergraduates, and supplemental instruction thereby study their combined effect on overall student retention and graduate rates.

References

[1] Z. S. Wilson *et al.*, "Hierarchical mentoring: A transformative strategy for improving diversity and retention in undergraduate STEM disciplines," *Journal of Science Education and Technology,* vol. 21, no. 1, pp. 148-156, 2012.

[2] P. B. Thayer, "Retention of students from first generation and low income backgrounds," 2000.

[3] E. T. Pascarella, C. T. Pierson, G. C. Wolniak, and P. T. Terenzini, "First-generation college students: Additional evidence on college experiences and outcomes," *The Journal of Higher Education,* vol. 75, no. 3, pp. 249-284, 2004.

[4] P. T. Terenzini, L. Springer, P. M. Yaeger, E. T. Pascarella, and A. Nora, "First-generation college students: Characteristics, experiences, and cognitive development," *Research in Higher education,* vol. 37, no. 1, pp. 1-22, 1996.

[5] L. Ramos-Sánchez and L. Nichols, "Self-efficacy of first-generation and non-first-generation college students: The relationship with academic performance and college adjustment," *Journal of College Counseling,* vol. 10, no. 1, pp. 6-18, 2007.

[6] G. Salinitri, "The effects of formal mentoring on the retention rates for first-year, low achieving students," *Canadian Journal of Education/Revue canadienne de l'education,* pp. 853-873, 2005.
[7] N. Honken and P. A. Ralston, "Freshman engineering retention: A holistic look," *Journal of STEM Education: Innovations and Research,* vol. 14, no. 2, p. 29, 2013.
[8] T. T. Ishitani, "Studying attrition and degree completion behavior among first-generation college students in the United States," *The Journal of Higher Education,* vol. 77, no. 5, pp. 861-885, 2006.
[9] W. R. Habley and R. McClanahan, "What Works in Student Retention? Four-Year Public Colleges," *ACT, Inc.,* 2004.
[10] N. M. Stephens, S. A. Fryberg, H. R. Markus, C. S. Johnson, and R. Covarrubias, "Unseen disadvantage: how American universities' focus on independence undermines the academic performance of first-generation college students," *Journal of personality and social psychology,* vol. 102, no. 6, p. 1178, 2012.
[11] K. Yelamarthi and P. R. Mawasha, "A pre-engineering program for the under-represented, low-income and/or first generation college students to pursue higher education," *Journal of STEM Education: Innovations and Research,* vol. 9, no. 3/4, p. 5, 2008.
[12] A. Bandura, *Self-efficacy: The exercise of control*. Macmillan, 1997.
[13] A. Bandura and S. Wessels, "Self-efficacy," 1994.
[14] T. Williams and K. Williams, "Self-efficacy and performance in mathematics: Reciprocal determinism in 33 nations," *Journal of educational Psychology,* vol. 102, no. 2, p. 453, 2010.
[15] J. E. Maddux, "Self-efficacy theory," in *Self-efficacy, adaptation, and adjustment*: Springer, 1995, pp. 3-33.
[16] M. M. Gibbons and M. F. Shoffner, "Prospective first-generation college students: Meeting their needs through social cognitive career theory," *Professional School Counseling,* pp. 91-97, 2004.
[17] H. J. Shotton, E. S. L. Oosahwe, and R. Cintrón, "Stories of success: Experiences of American Indian students in a peer-mentoring retention program," *The Review of Higher Education,* vol. 31, no. 1, pp. 81-107, 2007.
[18] J. M. Good, G. Halpin, and G. Halpin, "A promising prospect for minority retention: Students becoming peer mentors," *Journal of Negro Education,* pp. 375-383, 2000.
[19] P. Gurin, E. Dey, S. Hurtado, and G. Gurin, "Diversity and higher education: Theory and impact on educational outcomes," *Harvard educational review,* vol. 72, no. 3, pp. 330-367, 2002.
[20] S. P. Redmond, "Mentoring and cultural diversity in academic settings," *American Behavioral Scientist,* vol. 34, no. 2, pp. 188-200, 1990.
[21] M. F. Summers and F. A. H. III, "Preparing minority scientists and engineers," *institutions,* vol. 17, p. 18, 2006.
[22] J. M. Dennis, J. S. Phinney, and L. I. Chuateco, "The role of motivation, parental support, and peer support in the academic success of ethnic minority first-generation college students," *Journal of college student development,* vol. 46, no. 3, pp. 223-236, 2005.
[23] G. Crisp and I. Cruz, "Mentoring college students: A critical review of the literature between 1990 and 2007," *Research in higher education,* vol. 50, no. 6, pp. 525-545, 2009.