Why Do Students Leave? An Investigation Into Why Well-Supported Students Leave a First-Year Engineering Program

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Abstract

This complete research paper examines retaining traditionally underrepresented groups (URGs) in STEM fields. For the purposes of this paper underrepresented groups include women, first-generation students, and underrepresented minorities (URMs). The retention of URM students in STEM fields is a current area of focus for engineering education research. Following a literature review and examination of best practices in retaining the targeted group, a cohort-based, professional development program with a summer bridge component was developed at a large land grant institution in the Mid-Atlantic region with a programmatic goal to increase retention of underrepresented students in the engineering college which, ultimately, may increase diversity in the engineering workforce. The program focuses on cohort building, teamwork, mentorship, and developing an engineering identity. Students participate in a week-long summer bridge component prior to the start of their first semester. During their first year, students take a class as a cohort each semester, participate in an industrial site visit, and interact with faculty mentors.

Since 2016, the Academy of Engineering Success (AcES) program has been funded by a National Science Foundation (NSF) S-STEM grant which provides scholarships to eligible program participants. Scholarships start at $4,500 during year one and are renewable for up to five years with an incremental increase of $1000 annually for years two through four. Even with the professional development program providing support and scholarships alleviating the financial burden of higher education, students still leave engineering. The 2016-2017 cohort consisted of five scholarship recipients, with three remaining in engineering in fall 2018, the beginning of their third year. The 2017-2018 cohort consisted of seven scholarship recipients, with five remaining in engineering in fall 2018, their second year. While the numbers of this scholarship group are small, their retention rate is alarmingly below the engineering college retention rate. Why?

This paper presents the results of additional investigations of the overall AcES program cohorts (not only the scholarship recipients) and their non-program peers with the aim of determining predictors of retention in the targeted demographic. Student responses to three survey instruments: GRIT, MSLQ, and LAESE were analyzed to determine why students were leaving engineering, even though the program they participated in was strongly rooted in retention based literature. Student responses on program exit surveys were also analyzed to determine non-programmatic elements that may cause students to leave engineering. Results of this research are presented along with "lessons learned" and suggested actions to increase retention among the targeted population.

1.0 Introduction

To provide the context in which this research was conducted, a background summary of both current research related to student success and retention within engineering programs and previous work related to best practices in the development of student retention programs is presented along with a description of the specific program in which this study was conducted.

1.1 Background

An internal study at the institution between 2003 and 2012 revealed that 30% of first-year engineering students did not remain in the engineering college beyond their first year. The data further showed that URM students were less likely to continue in engineering than their non-URM peers. Reasons students reported leaving the engineering college included a lack of interest in and/or knowledge about engineering, low self-efficacy, not identifying with the engineering profession, and poor academic performance. Literature states the attrition of engineering students has been connected to factors such as curricular requirements [1], lack of readiness related to study and survival skills [2], loss of interest or disappointment in the field [3], poor academic and/or career advising [4], unapproachable faculty [4], and academic difficulty with mathematics [5].

First-generation students are known to lack support from family [6] [9], lack academic preparation [7], have trouble transitioning into both the social and academic college environments [8], and have greater financial concerns than non-first generation students [8]. URM students from other demographics report similar challenges as first-generation students, with the addition of the lack of minority role models in engineering faculty [16]. Financial aid has been cited as one of the most pertinent supports needed by URM students [11].

Glenn and Landis discuss the importance of the time between when a student accepts an offer from admissions and when they start classes on campus. During this time, students must navigate the realms of financial aid, housing, academic advising, registration, and the general transition to leaving home [12], which can be especially challenging for URM students who may lack the family support from which non-URM students benefit. Many institutions conduct summer bridge programs for URM students to help facilitate the transition to college, including the development of social skills/groups, math/science/communication skills, and the ability to navigate student services/campus and to provide needed counseling, advising, and mentoring [12] [13].

The most critical semester for students is the first semester in college. If students experience ineffective teaching or advising, a lack of a sense of belonging, or a poorly selected course load, they are less likely to retain in an engineering major [12]. One method of improving the academic success of URM students is with interventions aimed at improving the self-determination and motivation of the students [14]. Landis furthered this idea by recommending three structural elements be implemented in order to foster a collaborative learning atmosphere for URM students: (1) grouping URM students into common sections of classes, (2) requiring a freshman orientation class, and (3) providing dedicated study space where students can study in groups [15].

A sense of belonging, defined as a "student's sense of identification and affiliation with the campus community [18]," has been defined as a basic motivator [17], and as a factor contributing to the persistence of engineering students towards the completion of their degrees [19]. Osterman found that intrinsic motivation and a strong identity are more prevalent in students who feel a strong sense of belonging [20]. URM students, most notably females, want to be part of an academic community and desire mentors such as faculty and alumni [21]. Faculty and alumni mentors can provide personal experiences and advice related to academia that the other sources of support in a URM student's life may provide different experiences.

In response to the aforementioned internal study and a review of relevant literature, the AcES program was developed with the goal of diversifying the STEM workforce by increasing the number of URM students who pursue and complete engineering degrees. AcES incorporates many of the best practices from literature, such as experiences intended to foster a sense of belonging, academic success skills instruction, a summer bridge component, faculty and industry mentors, a designated space for team learning and tutoring, common courses, quality academic advising, a freshman orientation course, social events, and financial aid in the form of renewable scholarships.

1.2 Brief Description of the AcES Program

AcES, founded in 2012, has evolved to include a one week summer bridge experience, a two credit hour professional development course, a three credit hour course designed to communicate how engineers throughout history have shaped society, an industrial mentor program, and scholarship opportunities. Since cohort building, student success skill development, career guidance, and support system creation are main objectives of the program, the program enrollment is limited each year to 20-25 first-time full-time (FTFT) freshmen entering the engineering college. Since 2016, AcES has been funded by an NSF S-STEM grant, which provides operating funds and scholarship money for eligible students. First priority for scholarships was given to students who identify as an URG, earned a high school GPA of at least 3.0, and demonstrated significant financial need. If additional scholarships remained, non-URG students who met the high school GPA requirements and demonstrated significant financial need, typically an expected family contribution of less than $5,000, were considered for scholarship awards.

2.0 Methodology

Quantitative data was collected via three survey instruments administered at the beginning and end of each fall semester and at the end of each spring semester. The three surveys utilized were the 12 question GRIT survey, a reduced version of the Motivated Strategies for Learning Questionnaire (MSLQ), and a modified version of the Longitudinal Assessment of Engineering Self-Efficacy (LAESE). During the fall semester the surveys were taken during the professional development course and provided to all scholarship recipients from previous cohorts via an email link (e.g. Fall 2018 the entire 2018 cohort, scholarship and non-scholarship recipients, took the surveys in class and the scholarship recipients from 2016 and 2017 were supplied a survey link.)

At the end of each spring semester the survey links were emailed to the entire current cohort and all previous cohort scholarship recipients (e.g. Spring 2017 the entire 2017 cohort, scholarship and non-scholarship recipients, and the scholarship recipients from 2016 were supplied a survey link via email.). Table 1 displays when each of the surveys was administered.

Table 1: Survey Schedule

Times Administered					
Survey	Beginning of Fall 2017	End of Fall 2017	End of Spring 2017	Beginning of Fall 2018	End of Fall 2018
GRIT	X	X	X	X	X
LAESE	X	not administered	X	X	X
MSLQ	X	X	X	X	X

The GRIT survey is a questionnaire consisting of 12, 5-point Likert scale (1 = not gritty to 5 = very gritty) questions that were developed by Angela Duckworth from the Department of Psychology at the University of Pennsylvania. [23]. Duckworth has identified grit as a unique trait, defining it as “perseverance and passion for long term goals” [22].

During the first-year, students’ academic self-efficacy has been directly related to academic performance [10]. Among other things, the LAESE survey measures a student’s academic self-efficacy. The LAESE survey instrument is a validated instrument developed via the NSF-funded Assessing Women in Engineering (AWE) project and consists of 31 questions (items 16-46 on the AWE LAESE survey) [25]. In the full LAESE survey there are 10 questions that have two separate scales per a question, one scale is a 7-point Likert scale asking “to what extent do you agree” and the other scale is a 5-point Likert scale asking “how important is this”. For purposes of calculating the subscale scores, only the 7-point scale was employed. Jordan defined this method of survey response analysis in her dissertation titled “Intervention to Improve Engineering Self-Efficacy and Sense of Belonging of First-Year Engineering Students” [26]. The other 21 questions in the survey are 7-point Likert scale. Table 2 displays the subscales comprising the LAESE survey. “Engineering self-efficacy 1” indicates a student’s perception of their ability to earn an A or B in physics, math, and engineering courses and succeed in an engineering curriculum while not giving up participation in their outside interests. The student’s perception of their ability to complete engineering requirements such as math, physics, chemistry and also their general ability to succeed in any engineering major is indicated by “engineering self-efficacy 2.”

The MSLQ was designed and developed by a team of researchers from the National Center for Research to Improve Postsecondary Teaching and Learning (NCRIPTAL) and the School of Education at the University of Michigan [24]. Consisting of 81 items, the 1991 version of the MSLQ has 15 subscales in two main categories: motivational beliefs and learning strategies. These subscales are designed to be modular and can be used together or singly to reach the researcher’s goals. In a 1990 study by Pintrich, a member of NCRIPTAL, and De Groot that laid the foundation for the development of the full 1991 version of MSLQ, the researchers developed a "short version" (44 item, 5 subscales) which combines questions from several of the 15 subscales in the 1991 version which were shown to be correlated. This study utilizes the short MSLQ with the 44 questions which are 7-point Likert scale (1 = not at all true of me to 7 = very true of me). The intrinsic value, self-efficacy and test anxiety subscales are referred to as motivational beliefs, while the strategy use and self-regulation subscales are considered learning strategies. The self-regulation and strategy use subscales are constructed from combinations of questions from related subscales in the 1991 version [24, 29]. Subscales of the surveys are shown in Table 2.

Table 2: Survey Details

Survey	Number of Questions Used	Likert Scale	Measures (subscales)	
GRIT	12	5 point scale	Grittiness	
LAESE	31	7 point scale	1) Engineering self-efficacy 1	4) Feelings of inclusion
			2) Engineering career expectations	5) Efficacy in coping with difficulties
			3) Engineering self-efficacy 2	6) Math outcomes efficacy
MSLQ	44	7 point scale	1) Intrinsic value	4) Strategy use
			2) Self-efficacy	5) Self-regulation
			3) Test anxiety	

All students who voluntarily left the engineering college prior to matriculating into an engineering discipline were required to complete an exit survey which asked students to report the last math class they took in high school, their previous semester GPA, their previous semester math course, their current math course, and the grade earned or expected in each of the math courses. Students were also asked to check all of the reasons may motivate their desire to transfer out of engineering. The options on the form include: (1) I am having academic difficulty, (2) My classes are too large, (3) My high school education did not prepare me for college courses, (4) I think I can make more money in another discipline, (5) Too much effort required when I am not certain this is what I want to do, (6) Engineering majors offered do not match my interests, (7) I have other obligations and the curriculum is too intensive, (8) Courses I want to take are not offered enough, (9) Engineering is not challenging enough for me, and (10) I had problems with advising in engineering. Students were also given the option to provide a specific reason not listed above on the form.

3.0 Results and Discussion

Results from the GRIT, LAESE, and MSLQ surveys are presented and discussed. Reasons for leaving engineering are compiled from the exit surveys administered to students who voluntarily leave engineering. These results are combined to gain an understanding into why students leave engineering. Due to the nature of the AcES program, the sample size of each year's cohorts are relatively small, making statistically significant findings unlikely. The authors hope to share their findings and use these findings as the groundwork to expand research efforts into linking why students are leaving engineering to results from the GRIT, LAESE, and MSLQ surveys.

3.1 Survey Results

Program students completed the GRIT, LAESE, and MSLQ surveys in fall 2017 and fall 2018, before taking their first class on campus. The results, presented below, give interesting insight to the initial mindsets of these students.

3.1.1 GRIT Survey Results

Figure 1, below, shows that AcES students have a baseline GRIT score approximately equal to the average baseline GRIT score of the entire incoming freshmen engineering class and that score was relatively consistent for each incoming class. The 2017 AcES cohort consisted of 20 students, with seven identifying with an URG. The 2018 AcES cohort was made up of 22 students, with five identifying with an URG. The 2017 and 2018 FEP cohorts consisted of 607 and 713 students who completed the surveys, respectively. From the 2017 FEP cohort, 221 of the students identified with an URG and from the 2018 FEP cohort, 226 students identified with an URG.

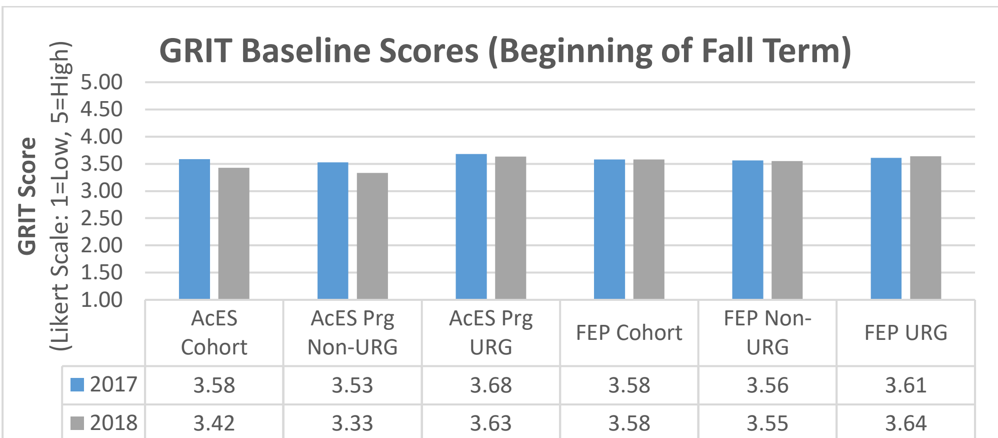
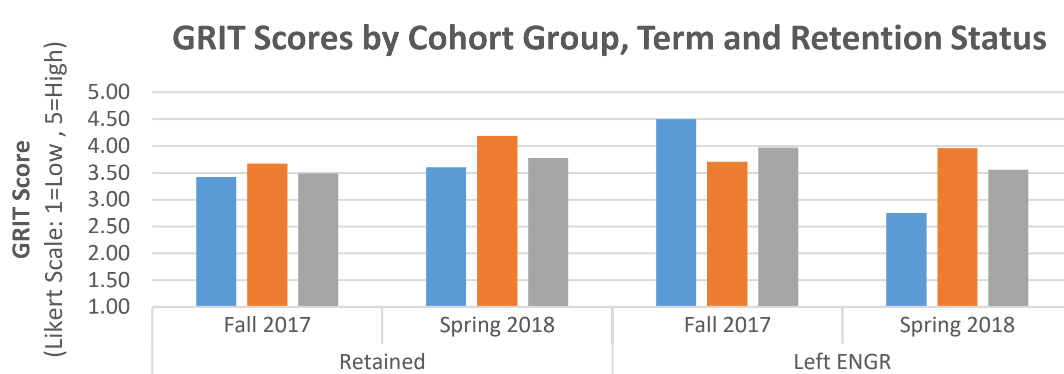


Figure 1: Baseline GRIT score comparison of 2017 and 2018 AcES and overall FEP cohorts.

The FEP cohort and its subpopulations (URG, non-URG) have consistent average baseline GRIT scores for both 2017 and 2018. Likely because of the much smaller number of students in the AcES program, the average baseline GRIT scores for the AcES program cohort appear to be more variable and are slightly lower in 2018.

Grit theory purports that the "grittier" a student is, the more likely the student will be retained [28]. The 20 students in the 2017 AcES cohort, however, appear to counter that theory since the average baseline GRIT score for the AcES students who left in the engineering college beyond their first-year (3.97) was higher than the average GRIT score of the AcES students who remained in the engineering college (3.49). This result, shown in Figure 2, may indicate that students may have had a false sense of their own perseverance skills before they met the challenges of their first year in college. Not surprisingly, however, the GRIT scores of students who remained in engineering increased from the beginning of fall 2017 (3.49) to the end of spring 2018 (3.78), while the GRIT scores of those who left engineering decreased from fall 2017 (3.97) to the end of spring 2018

(3.56). At the end of the first year, GRIT scores for students who retained in engineering (3.78) were higher than those who left engineering (3.56).



	Retained		Left ENGR	
	Fall 2017	Spring 2018	Fall 2017	Spring 2018
Non-URG	3.42	3.6	4.50	2.75
URG	3.67	4.19	3.71	3.96
Cohort	3.49	3.78	3.97	3.56

Figure 2: GRIT score data for the 2017 cohort group and subgroups presented by term and cohort sub-group, based on whether or not they retained in engineering.

Of the seven 2017 URG AcES students, four were retained in engineering. Two of the 13 non-URG 2017 AcES students left engineering, and the other 11 were retained in engineering beyond their first year. The AcES URG students who left engineering had a slightly higher average baseline GRIT score (3.71) than the average baseline GRIT score of AcES URG students who were retained (3.67). GRIT scores increased for URG students who retained in engineering, but also increased for URG students who left engineering. Interestingly, it appears that URG students who participated in the AcES program became "grittier" regardless of their retention in engineering.

Surprisingly, the average baseline GRIT scores of non-URG students who retained in engineering (3.42) were lower than the average baseline GRIT scores of non-URG students who left engineering (4.50). The average GRIT score of non-URG students who retained in engineering increased from 3.42 to 3.6 while the average GRIT score of non-URG students who left engineering decreased, significantly, from 4.50 to 2.75. For these students, apparently, persisting in engineering developed their grittiness, while leaving engineering made them less gritty.

3.1.2 LAESE Survey Results

AcES students completed the LAESE survey during the first week of their first semester in college. The LAESE survey baseline data for the 20 student 2017 AcES cohort, presented in Figure 3 below, identifies student's perceptions of their engineering career expectations, engineering self-efficacy, feelings of inclusion, coping self-efficacy, and math outcomes efficacy for the 15 students who retained and the five students who left engineering prior to their second year.

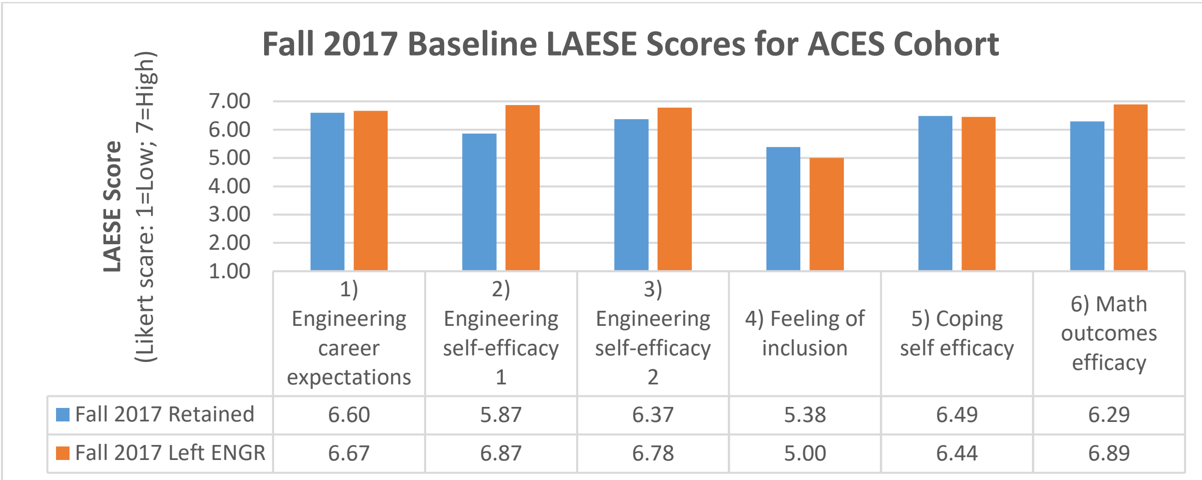


Figure 3: Fall 2017 AcES Cohort LAESE baseline comparison of students who retained in engineering with those who did not retain in engineering.

Baseline LAESE survey results indicate that the five 2017 AcES students who left engineering reported higher scores in engineering career expectations, engineering self-efficacy (1 and 2), and math outcome efficacy than the 15 AcES students who were retained. AcES students retained into the second year in engineering reported higher feelings of inclusion and coping self-efficacy than the AcES students who left. Since this survey was given at the beginning of the fall term when students were still acclimating to the campus, it is not surprising that the lowest average score, overall, was related to feelings of inclusion.

At the beginning of their college experience, students who would leave engineering eventually scored higher than those who would stay in engineering on four of the six measures of self-efficacy that are linked to academic performance, with the notable exceptions of “feeling of inclusion” and “coping self-efficacy.” This result raises the question of whether or not “feelings of inclusion” and “coping self-efficacy” are more influential than the other measures on a student’s decision to remain in or leave engineering. Additionally, are these results similar for URG students?

The latter question was investigated and the LAESE baseline results for the seven 2017 URG AcES students are presented in Figure 4, below. Four of the seven students were retained in engineering and three of them left prior to the start of their second year.

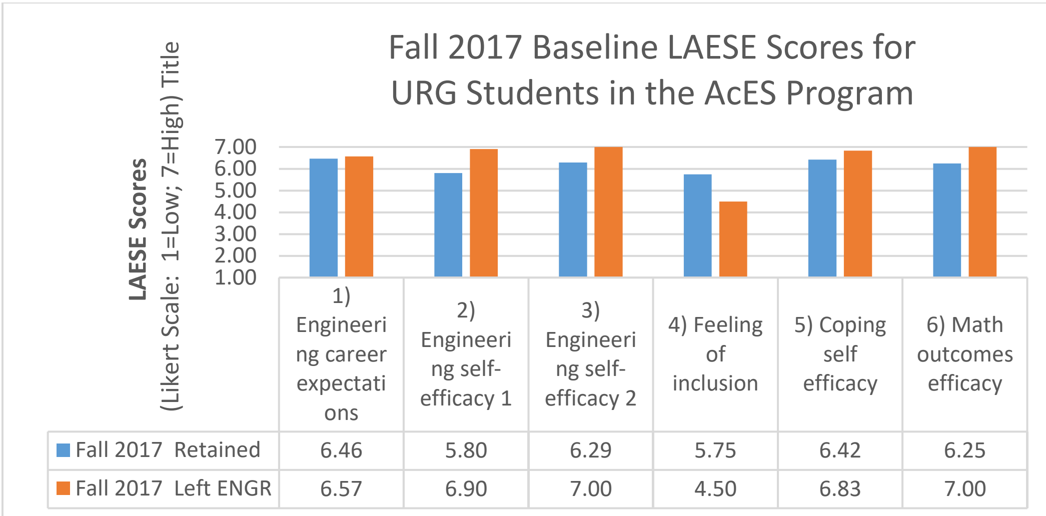


Figure 4: Fall 2017 URG LAESE baseline comparison of students who left engineering and those who retained.

The most noteworthy difference between the URG students who retained in or left engineering was their reported feelings of inclusion. URG students who left engineering had a significantly lower feeling of inclusion average score (4.50) than the URG students who were retained (5.75). The retained URG students' feeling of inclusion average score (5.75) was higher than the retained non-URG students' score (5.50). In fact, feeling of inclusion was the only measure in which the URG students who left engineering scored lower than those who retained. At the beginning of the fall 2017 semester, the URG students who would eventually leave engineering before their second year scored higher on six of the seven measured categories, including: engineering career expectations, engineering self-efficacy (1 & 2), coping self-efficacy, and math outcomes efficacy.

3.1.3 MSLQ Survey Results

The MSLQ provides a measure of motivational belief (intrinsic value, self-efficacy, and test anxiety) and of learning strategies (self-regulation and strategy use). Intrinsic value, part of the motivational belief measure, refers to a student's perception of the reasons for engaging in a learning task. Intrinsic value based reasons for engaging in a task include: curiosity, mastery, or for the challenge of it. Self-regulation and strategy use comprise the learning strategies measure. Self-regulation refers to a combination of cognitive regulation; the use of planning and comprehension monitoring, and effort regulation which consists of measuring a student's ability and willingness to persist at tasks. Strategic use indicates one's ability to strategically implement practices such as rehearsal, elaboration, and organization learning strategies [24, 29].

The 20 students in the 2017 AcES cohort took the MSLQ survey at the end of the spring 2018. The results for all five measures of motivational beliefs and learning strategies are presented in Figure 5 below by categories of students who were retained in or who left engineering.

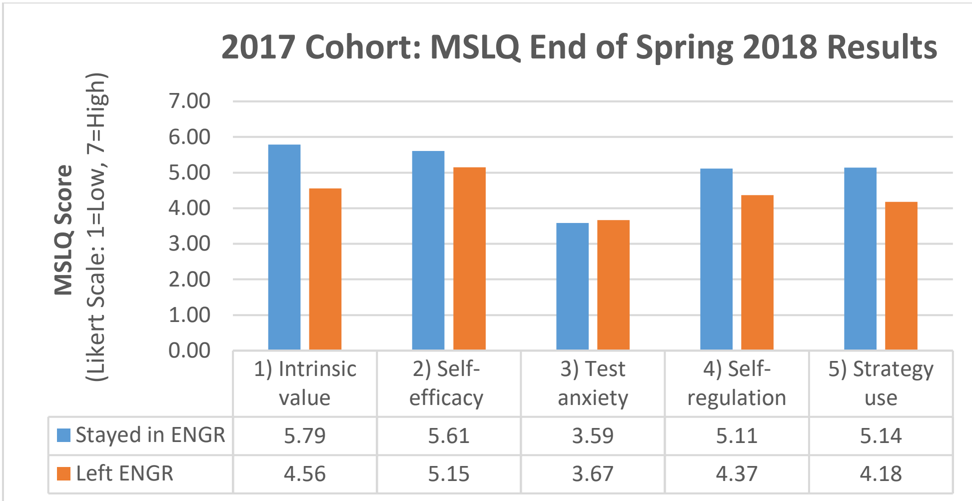


Figure 5: Comparison of the spring 2018 MSLQ Survey results of the 2017 cohort students who retained in ENGR with those who left engineering before the second year.

On measures of intrinsic value, self-efficacy, self-regulation, and strategy use, the 15 students in the 2017 cohort who retained in engineering scored higher than the five students who left engineering. Those who left engineering scored slightly higher on test anxiety.

These results were also divided into two groups, URG students and non-URG students, to see if there was any difference in the average response in each category. Here, seven of the 20 students represented URGs. That data is presented in Figure 6 below.

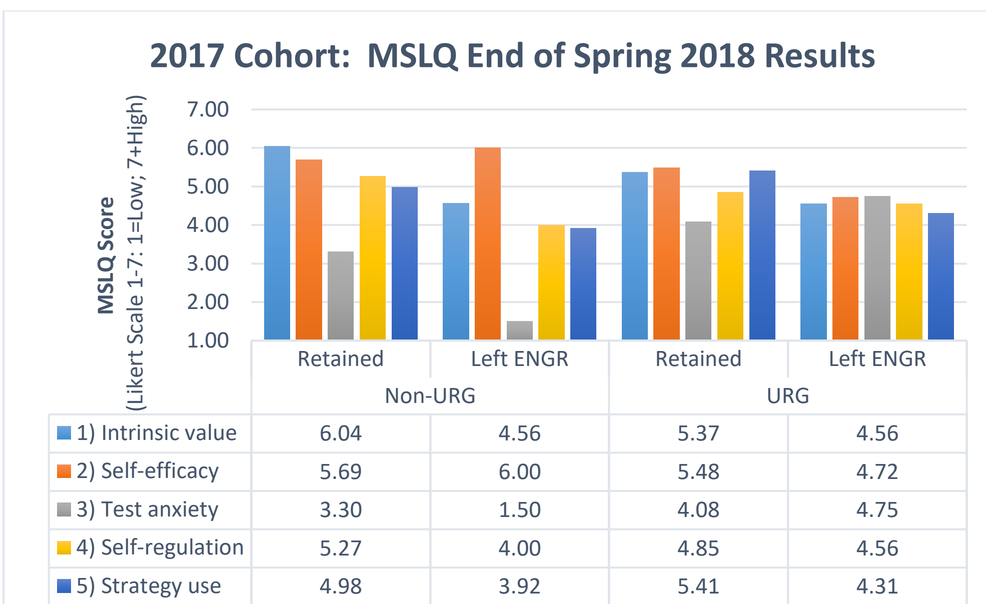


Figure 6: Comparison of the End of Spring 2018 MSLQ survey results of non-URG students and URG students in the 2017 program cohort.

Of the 2017 AcES program cohort, URG students who retained in engineering scored lower than their non-URG peers who also retained in engineering in areas of intrinsic value, self-efficacy, and self-regulation, but higher than their non-URG peers in test anxiety and strategy use.

Both URG and non-URG students who retained in engineering had higher average intrinsic value, self-regulation, and strategy use scores than their peers who left engineering. The non-URG students who left engineering had the highest self-efficacy average score (6.00), while their URG peers who also left engineering had the lowest self-efficacy average score (4.72).

Interestingly, the non-URG students who retained in engineering had a higher average test anxiety score than the non-URG students who left engineering, while the URG students who retained in engineering had a lower average test anxiety score than the URG students who left engineering. Test anxiety appears to have a different effect on the URG students then on their non-URG peers.

3.1.4 Survey Summary

Results of the GRIT, LAESE, and MSLQ surveys presented are summarized in Table 3 below.

Table 3: Summary of Results from GRIT, LAESE, and MSLQ surveys

Fall 2017 Program Cohort	**Retained**	**Left ENGR**
GRIT (*Likert scale: 1 low – 5 high*)	3.49	3.97
LAESE (*Likert Scale: 1 low – 7 high*)		
Engineering Career Expectations	6.6	6.67
Engineering Self-Efficacy 1	5.87	6.87
Engineering Self-Efficacy 2	6.37	6.78
Feeling of Inclusion	5.38	5
Coping Self Efficacy	6.49	6.44
Math Outcomes Efficacy	6.29	6.89
MSLQ (*Likert Scale: 1 low – 7 high*)		
Intrinsic Value	5.79	4.56
Self-Efficacy	5.61	5.15
Test Anxiety	3.59	3.67
Self-Regulation	5.11	4.37
Strategy Use	5.14	4.18

Students who retain in engineering past their first year entered their engineering studies with higher feeling of inclusion and coping self-efficacy, and through the year develop motivational beliefs of the intrinsic value of studying engineering and self-efficacy as well as the learning strategies of self-regulation and strategy use. In contrast, students who leave engineering during their first year appear to have entered their engineering studies with more grit, higher engineering career expectations, engineering self-efficacy, and math outcomes self-efficacy than their peers who retain in engineering. At the end of their first year, they score higher in test anxiety.

While these surveys investigate student characteristics associated with academic performance, they do not address academic performance directly or indicate other circumstances that may cause students to withdraw from engineering before their second year. Additional research into why students leave engineering during their first year is needed. To address that need, students who leave engineering during their first year are asked to complete an exit survey. The results of that survey are presented in the following section.

3.2 Reasons for Leaving Engineering

While some students leave engineering voluntarily for a variety of reasons, others are forced to leave because of their failure to meet college or university academic performance standards. Of the 12 students in the 2016 AcES program cohort, five received S-STEM scholarships and none of those scholarship recipients had left engineering at the end of their first year. Of the 20 students in the 2017 program cohort, seven received S-STEM scholarships; one scholarship recipient was dismissed from the engineering college due to lack of math progression and another left the institution to join the military after the first year. While their financial pressures were reduced by the scholarships, these students still had academic difficulty which caused them to leave engineering and the university. Other first-year students, with or without scholarships, also have academic difficulty and leave engineering or the university.

3.2.1 Leaving Engineering Involuntarily

Failure to meet academic performance standards results in removal from the engineering college or the university and definitely affects first-to-second year retention. Table 4 displays the total number of FTFT freshman that were eligible for suspension at the end of their first year.

Table 4: FTFT Freshman Suspension Data for First-Year Engineering Program

	Eligible For Suspension at End of Academic Year			
	ENGR Track 1	**ENGR Track 2**	**ENGR Track 3**	**Total**
FTFT Freshman Fall 2016	11	19	8	38
FTFT Freshman Fall 2017	11	25	22	58

Of the 32 students in two cohorts of the program (2016-2017 and 2017-2018), none were forced to leave the university (or engineering) through suspension. Additionally, the number of students eligible for suspension at the end of the academic year for FTFT freshmen entering fall 2017 is significantly higher, especially among Track 2 and Track 3 students, because the university raised the minimum GPA requirement for suspension, effective May 2018. Previous to May 2018, the minimum GPA required for a freshman student to remain at the university (not be suspended) was 1.4 and in May 2018 that minimum GPA was raised to 2.0 for all students at the university. The engineering Track 2 and Track 3 students are not calculus-ready when they enter the engineering college and often struggle in math and science courses during their first year in college.

3.2.2 Leaving Engineering Voluntarily

Students who left engineering voluntarily were given a survey asking them why they chose to leave and why they originally selected engineering as their major. Results from 85 students who completed the exit survey are presented in Figure 7 below.

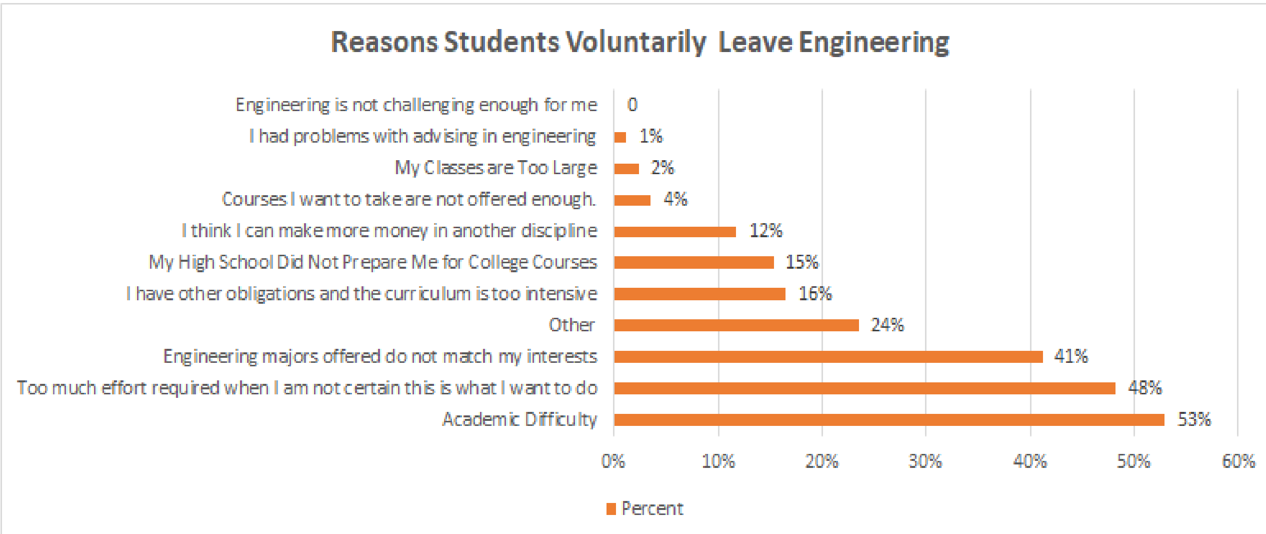


Figure 7: Reasons for leaving engineering given by students who were leaving engineering for a different major at the university.

The data clearly indicates the top three reasons students voluntarily leave are: (1) academic difficulty (53%), (2) Too much effort when they are not sure that engineering is really what they want to do (48%), and (3) Engineering majors do not match their interest (41%). Since the first-year engineering program is designed to help students learn about the engineering profession while they also take foundational math and science courses, these results are not surprising. Of the five students in the 2017 cohort of the AcES program who left engineering, 40% left engineering because of academic difficulty and 60% left due to changed interests; they were no longer interested in engineering. No students in the 2017 cohort of the AcES program left because they believed that engineering required too much work when they are uncertain what they want to do.

3.2.2.1 Academic Difficulty

Students who indicated that they were leaving engineering because they were in academic difficulty were asked to indicate if their academic difficulty was "general" (difficulty in several subjects leading to a low GPA) or if it was specifically related to difficulty in math, chemistry, or in both math and chemistry. Twenty-five of the 39 students (65%) who responded to that question indicated having difficulty with both math and chemistry. Seventeen (68%) of these students indicated that they had difficulty in Calculus 1; the remaining students either did not indicate a math class or indicated College Algebra, College Trigonometry, or Calculus 2 or 3. Interestingly, 22 of the 25 students who indicated having academic difficulty in both math and chemistry gave 27 reasons why they started in engineering, but predominantly believed that engineering matched their interests (41%) or that they were either good at or interested in math, science, computer science, or problem-solving (30%). Eighteen of these 25 students also responded to the question "If your interests have changed, what did you learn about engineering that changed your mind?" Eleven students (61%) indicated that the work was more difficult than expected and seven students (39%) indicated that they discovered engineering is not what they thought it was and is not the career for them. Additionally, 14 of the 25 students who indicated having academic difficulty in both math and chemistry (56%) also indicated that they were leaving engineering because there was "too much effort required when I am not sure this is what I want to do." Only five of the 25 students indicated that "I have other obligations and the curriculum is too intensive;" five indicated that "engineering majors offered do not match my interests;" and four indicated that "My high school education did not prepare me for college courses."

3.2.2.2 Too Much Effort

Of the 41 students who indicated they were leaving engineering because "too much effort required when I am not certain this is what I want to do," 15 (36.6%) also indicated that that "Engineering majors offered do not match my interests" and 10 (24.4%) also indicated that "I have other obligations and the curriculum is too intense." These students started in engineering primarily because they believed they were good at or interested in math, science, computer science, or problem-solving (32%) or they thought this major matched their interests (28%). Additionally, 12% of these students originally selected engineering as their major because they were not sure what they wanted to do and 12% selected the major because of high school influence. When asked what they learned about engineering that changed their interest in continuing to pursue it as a career, nine students (22.0%) indicated they learned that engineering was more difficult than they expected, and eight students (19.5%) learned that the jobs they would do or classes they would need to take did not match their interests.

3.2.2.3 Lack of Interest

Of the 35 students who indicated they were leaving engineering because "Engineering majors offered do not match my interests," 15 students (42.8%) also indicated that "Too much effort required when I am not certain this is what I want to do and eight students (22.9%) indicated they "have other obligations and the curriculum is too intensive. Additionally, nine students (25.7%) commented about the academic challenge of engineering curriculum, five students (14.3%) believed they could "make more money in another discipline" and 13 students (37.1%) learned that engineering was not a good fit for them. One student commented that s/he learned that "I wouldn't be happy in a career field I am not passionate about."

These students originally chose to pursue engineering as their major and career choice predominantly because they believed that engineering matched their interests (30%) and they believed they were good at or strongly interested in math, science, computer science, or problem-solving (22%). Several students (13%) were not sure what they wanted to do and several students cited a high school influence (11%) or a family or parental influence (9%) as a factor in their decision. Only 7% of these students indicated that salary expectations influenced their decision.

4.0 Conclusions

AcES program participants are exposed to deliberate experiences, developed based on best practices established in literature. These students participate in a summer bridge experience, student success seminars, two common courses; experience quality academic advising; and are provided with faculty, student, and industry mentors and financial aid. Despite participating in a program aimed at retention, several students still do not matriculate into their second year in engineering or in college. Of the program scholarship recipients who have not been retained, all of them left due to poor academic performance. While some non-program participants at the institution were also not retained due to poor academic performance, many others cited reasons such as too much effort required when they are uncertain engineering is for them, the engineering curriculum being too intense with their other obligations, and engineering not matching their interests.

Program cohort students who left engineering consistently scored lower in areas of feeling of inclusion and coping self-efficacy. By the end of the first year, these students also scored lower in measures of self-efficacy and the motivational belief of the intrinsic value of their engineering education and scored higher in measures of test anxiety than their peers in the cohort that were retained. Interestingly, scores for URGs, including underrepresented minorities, women, and first-generation students, were differentiated from their mainstream peers in the areas of test anxiety and self-efficacy. URG students who left engineering had the lowest average self-efficacy scores and the highest average test anxiety scores while the non-URG students who also left engineering had the highest average self-efficacy scores and the lowest average test anxiety scores.

Program cohort students who were dismissed from the engineering college or who left voluntarily due to academic difficulties had higher average scores related to grit, engineering career expectation, engineering self-efficacy, and math outcome self-efficacy than the students in the cohort who were retained. Even at the end of the year, the cohort students who left engineering had higher self-efficacy scores than their peers who retained. While the sample size was small, this result appears to support the Kruger-Dunning Effect [27]. Kruger and Dunning found that people who are most unskilled routinely overestimate their abilities [27]. Future work will include further examination of the relationship between self-efficacy scores and retention in engineering.

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