Creating a Psychological Profile of Successful First-Year Engineering Students

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Introduction

This Complete Evidence-Based Research paper considers the effect of the characteristics of first-year engineering students and their persistence and retention.

Although the number of students earning bachelor's degrees in science and engineering has risen steadily in the past decade, institutions of higher education are facing shifts in enrollment patterns, with an increasing number of students pursuing on-line education [1]. As revenues for many four-year colleges and universities become increasingly dependent on student tuition, there has been growing concern with attracting and retaining students to traditional programs. This is especially true in engineering, which requires students to have an arsenal of advanced mathematical and analytical skills and a broad background in science and technology [1]. Unfortunately, many of the students who enroll in engineering programs may find themselves significantly unprepared for the academic rigors and personal challenges of collegiate life. In response, educators have sought to identify key factors that aid not only in the retention of students, but also maximize the resources necessary to guide those students to successful degree completion.

One area of investigation has focused on the characteristics of the student learner. While students entering engineering programs tend to have higher SAT math scores [2] and a broader array of previous STEM education courses compared to other students in different majors, many students are still ill-prepared for the academic rigors of engineering programs, suggesting that other factors beyond broadly conceptualized intelligence make contributions to what comprises a "successful student." One such factor is metacognition, broadly defined as one's knowledge of the learning process, learning preferences, and conditions under which particular learning strategies are best employed [3]. This knowledge component is combined with other factors, such as a student's intrinsic interest and motivation to pursue academic interests, the ability to monitor progress towards self-generated goals, and the ability to reflect on performance and make adjustments and manage time effectively, to comprise the overarching construct of self-regulation in learning [4].

Students who are better at self-regulation often outperform those who have not developed these skills [5]. Although the literature on this topic heavily focuses on students' use of strategies or performance, there is a growing body of research focused on students' backgrounds and underlying beliefs regarding learning. These individual difference variables may globally influence a student's disposition, use of strategy, and thus, performance [4, 6]. Although there are several potential lines of inquiry available, the present study was limited to three: need for cognition, locus of control, and academic attributions.

The need for cognition, broadly defined as one's proclivity to engage in and enjoy complex cognitive activity [7], is a relatively stable and enduring trait that characterizes the extent to which people approach or withdraw from cognitive tasks. Those who regularly seek out and reflect on information and attempt to find patterns and relationships between stimuli and world events are called *cognizers*; their minds are active and continuously try to make sense of the environment. In contrast, those who shy away from opportunities to engage in cognition and instead prefer to rely on cognitive shortcuts, heuristics, or let others (e.g., experts or celebrities) engage in complex cognition are termed *cognitive misers.* The Need for Cognition Scale was developed to identify those who score high on this trait (i.e., the cognizers) or low on this trait (i.e., the misers) [7]. In a large review of the literature, Cacioppo and colleagues found that need for cognition was positively related to ACT scores, Grade Point Average, and engagement in effortful information-processing activities [8]. Thus, higher scores reflect a general propensity to engage in mental activities that are related to success in an academic setting.

A second individual difference factor of interest is that of locus of control, which broadly refers to the agent to whom one ascribes causal influences on outcomes. Those who possess an internal locus of control believe that outcomes are due to factors unique to oneself (e.g., ability or intelligence), whereas those who have an external locus of control tend to expect that outcomes are due to the influence of powerful others (e.g., teachers, coaches) or random events (e.g., luck, fate) [9]. This orientation has implications for future behavior, as those who believe that an outcome is largely determined by their own actions will be more likely to employ different strategies when given feedback, compared to those who believe that external forces are responsible for outcomes? To examine this control orientation in the context of academics, Curtis and Trice created the Revised Academic Locus of Control Scale for College Students [10]. In general, higher scores reflect a more external locus of control; in a review, the scale authors indicate that several studies have found that higher scores tend to be negatively related to academic achievement and attendance, and positively related to procrastination [10].

Although closely related to the construct of locus of control, attributional style augments the discussion of self-regulation by adding two dimensions that are thought to influence motivation: controllability (i.e., whether the cause of an outcome was under one's personal control or beyond it) and stability (i.e., whether the cause of an outcome was due to relatively permanent, long-lasting circumstances or relatively transient factors) [9]. Individuals can adopt a functional attribution style, in which negative outcomes are attributed to internal, controllable, and unstable factors (e.g., lack of effort). This suggests that individuals have the ability to change a behavior to yield a different outcome in the future. In contrast, those who adopt a dysfunctional attribution style tend to ascribe positive outcomes to factors that are internal, uncontrollable, and stable (e.g., one's innate ability or intelligence) and thus express little hope that a similar future event will elicit a different outcome. The Academic Attribution Style Questionnaire (AASQ) was developed to identify students who espoused a dysfunctional attribution style [11]. Researchers using this scale found that a dysfunctional attribution style predicted lower success expectations and less persistence among students when faced with a failure. Combined, these data suggest that this scale is useful as a means to identify causal attributions and their ability to predict student academic behavior.

The need for cognition, locus of control, and attribution style metrics all represent individual differences that influence students' academic experiences and interact with students' ability to self-regulate, and create diversity among first-year students entering college. Moreover, adaptive and success-oriented regulatory behaviors are not usually taught in K-12 education [4], tend to be less present among first-generation college students [12, 13], tend to be less valued by college students [14], and in some cases, may vary by ethnic differences and academic background [15]. Given that the incoming college populations are becoming more diverse [1], these factors may contribute to the growing rift between student performance and faculty expectations of performance. The present study informs this growing body of literature by examining the relationship between these variables and retention of first-year students in engineering programs.

In this project, we investigated some of the individual differences in academic self-regulation, to address the hypothesis that a profile or identifying factors would allow faculty and administrators to distinguish engineering students most likely to return for the second year from those who are most likely to withdraw or transfer away from the program. We expected that successful engineering students (i.e., those who remained in the program) would exhibit a high need for cognition, an internal locus of control, and reveal a functional attribution style for academically difficult outcomes. In addition, we considered factors such as integration into college life and employment demands. If we can detect "at-risk" students early on, we may be able to support those who would otherwise leave the engineering program, which would bolster overall university retention.

Method

The present study represents data from an ongoing investigation to establish a profile of a generally successful undergraduate engineering student. In this quasi-experimental design, we investigated relatively stable individual differences (i.e., need for cognition, academic locus of control, and attribution style) and student retention, broadly defined as those who had continued to the second year in good standing. Data from two academic year cohorts were collected, allowing analysis of student profiles in the context of those who remained engineers, dropped from the engineering program, or who transferred internally.

Participants

Similar to methodology used by others [6], undergraduate engineering students participated in our study in partial fulfillment of the course requirements for their first-year seminar, which is a zero credit-hour course graded on a pass/fail basis and mandatory for all engineering students. Because all sections of the first-year seminar were taught by the same experienced instructor, collecting data from the seminar, rather than a different course in the major, made it less likely there would be confounds due to differences between instructors across sections. In addition, no other first-year course is mandatory for *all* first-year engineers (e.g., students with appropriate Advanced Placement scores do not enroll in Calculus I). Each survey was one of several assignments that could be completed for credit, and so not every student was required to participate. In alignment with the ethical standards required to protect participants in research in psychology, students were given the option to complete the survey for points toward their grade, but elect to exclude their data from analyses from our research without penalty. Aside from the number of students who opted out, reported for each cohort below, no further information will be provided for those students. All of the survey responses were confidential (i.e., the instructor of the course did not see their survey answers), and students earned full credit for the assignment even if they left some items blank or opted out of the research. As noted previously, data were collected from two cohorts of students. Cohort One's sample represented students who matriculated in Fall 2014; Cohort Two sampled from students entering engineering in Fall 2015.

Cohort One

There were a total of 146 students enrolled in the first-year seminar in Fall 2014. Of that total, 141 students were enrolled in an engineering program and were designated Cohort One. In December, 16 students left, but 8 transferred in, yielding 133 in Spring 2015. The survey was administered to students during the spring semester seminar. Of the total enrollment, 17 students (9.9%) completed the survey, but opted to have their data withdrawn from the study's analysis. Out of the 129 students remaining, 34 (27.9%) did not choose to complete the survey, and two students' surveys were excluded from the sample because they responded to fewer than 7% of the items on the survey. Thus, the final analyses of Cohort One are based on 93 surveys.

The average age for students from this cohort was 18.6 years (*SD* = 0.64). Of those answering this question, 79.5% identified as men, 18.2% identified as women, and 2.3% preferred not to identify their gender; 5 did not answer the question. Of those that reported engineering as their major, the largest proportion of students identified themselves as mechanical engineering majors (46.1%), with the remainder split among renewable energy (7.9%), ceramic (12.4%), materials science (7.9%), biomaterials (12.4%), glass (3.4%), and undecided students (10.1%). Four participants did not report their major. The vast majority reported only majoring in engineering (only 5.6% were double majors), and only 22.5% of had declared a minor.

Cohort Two

There were a total of 125 students enrolled in the engineering program in Cohort Two. After excluding four non-degree seeking students, there were 121 students enrolled in First-Year Seminar in Fall 2015, which was when the survey was administered. In December, 9 students left, but 5 transferred in, yielding 117 in Spring 2016. From the fall seminar enrollment, 10 students (8.0%) opted to have their data withdrawn upon completion of the survey, and 13 students (11.3%) chose not to complete the survey. Thus, the final analyses of Cohort Two are based on 102 surveys.

The average age for students from this cohort was 18.1 years (*SD* = 0.48). The majority identified as men (77.7%), 21.3% identified as women, 1.1% identified their gender as "other," and 2.3% preferred not to identify their gender. Eight students did not answer the question. Of those who reported their major, one-third of students identified themselves as mechanical engineering majors (34.0%), with the remainder split among renewable energy (11.7%), ceramic (18.1%), materials science (10.6%), biomaterials (9.6%), glass (3.2%), and undecided students (12.8%). Eight participants did not report their major. The vast majority reported only majoring in engineering (only 3.3% were double majors), and 22.1% of the sample had declared a minor.

Materials and Procedure

First-year engineering students had the option to complete the survey in partial fulfillment of the requirements for their first-year seminar. The instructor announced the online survey's six-week availability in class and provided the URL via a link posted on the course's learning management system portal. All components of the survey were managed through the eSurveysPro.com website, which is a secure, subscription-based surveying tool.

The first page of the survey provided general information, including the broad purpose of the survey, use and care of results, and instructions for completion. Students who consented to continue were instructed to provide their full name in order to receive course credit, and informed that further responses would be confidential. This was followed by three validated psychological measures and a demographics questionnaire which collected information and details about the students' major interests, co-curricular responsibilities, and extra-curricular commitments.

The first measure was the Revised Need for Cognition Scale [7]. For this 18-item scale, students responded to questions concerning preferences for complexity of thought and enjoyment of cognitive activities (e.g., "I like to have the responsibility of handling a situation that requires a lot of thinking" and "I only think as hard as I have to") using a 9-point Likert scale ranging from +4 (Very Strong Agreement) to -4 (Very Strong Disagreement). All negatively worded items were reverse-scored; using the 9-point scale, the highest possible score on the Need for

Cognition Scale is +72 (18 items multiplied by 4 points each), and the lowest possible score is -72. Higher, positive scores indicate a higher need for cognition. This scale has been found to have a strong internal consistency, validity, and test-retest reliability among college students [8].

The second component of the survey was the Revised Academic Locus of Control Scale for College Students [10]. In this instrument, locus of control refers to the extent to which students believe that their academic successes or failures are due to factors within their own control or beyond their control. Those who believe that they have agency over their own actions and believe that their academic outcomes are due to their ability or effort are typically considered to have an *internal* locus of control. Those who believe that academic outcomes are due to factors such as the disposition of professor, the ease or difficulty of the material, wording of questions, or luck are considered to exhibit characteristics of an external locus on control. Students responded "True" or "False" to 21 items such as, "I sometimes feel that there is nothing I can do to improve my situation" and "I came to college because it was expected of me." Negatively worded items were reverse scored, and the total score was computed by summing the items rated as "True." The scores can range from 0 to 21, with higher scores indicating a more external locus of control [10].

The third measure of the of the survey was the Academic Attributional Style Questionnaire [11], which measures the explanatory style students generally adopt when faced with negative academic outcomes. Previous research suggests that students tend to rationalize outcomes as a combination of locus (i.e., internal or externally based factors), controllability (i.e., able to be affected by personal action or not), and stability (i.e., temporary or long-lasting) [9]. In general, a student would be considered to have a functional attributional styles if a negative event (e.g., failing an exam) is viewed as personally controllable and temporary, as it suggests that future outcomes are subject to change. In contrast, a dysfunctional attributional style is characterized as personally uncontrollable and stable, as it suggests that there is nothing the student can do to effect changes [11]. In order to measure attributional style, participants were asked to consider six hypothetical negative scenarios, such as, "You fail an examination," and "You cannot get started writing a paper." After reading each instance, students provided a free-response rationale for the scenario. Students were then presented with twelve nine-point semantic differential scales, with four dimensions (Internal locus of control, Personal controllability, Stability, or External locus of control) measured by three items each. For each item, students were asked to mark where on a line the cause of the negative outcome fell between two conceptual endpoints, such as "This reflects an aspect of the situation --- This reflects an aspect of you," and "Over which you have no power --- Over which you have power." Twelve responses are generated for each of the six scenarios, and in the context of an online survey, the response options in between the endpoints were given numeric values from 1 to 9. To determine students' scores on each dimension, the ratings for each item were averaged across the six scenarios, and then condensed across the four dimensions. Higher averages indicate students have a more internal locus of control, they see the cause of the negative outcomes as personally controllable, unstable, and externally controlled. High scorers might believe that their behavior is their own to control, but because they put in low effort (which is personally controllable and a temporary situation), and perhaps the teacher is not helpful (an external influence controlling their behavior), the negative outcome is either not their fault or not fixable.

The last section of the survey collected demographic information from the participants, including their gender, age, ethnicity, major engineering program (e.g., mechanical engineering, materials science, etc.), minor (if applicable), and the number of overall credit hours in which they were enrolled during the semester in which they completed the survey. Students also indicated participation in co-curricular and extracurricular activities (e.g., clubs, sports) and employment, either on- or off-campus. The final page of the survey reiterated the students' rights as research participants and asked them to elect to allow their data to be used for the research or removed from the analysis for the study. Students who opted out still received credit in the class for completing the assignment. The first-year seminar instructor never saw individual students' answers to survey items, but was instead provided with a roster of who had completed the survey by the due date.

Results and Discussion

To test the hypothesis that a successful first-year engineering student will exhibit a different pattern or profile from those who were not retained in the program, we first examined scores for each of the cohorts to ensure that they were not statistically different from each other. Overall, the cohorts did not differ with respect to their scores on the three psychological measures. Both cohorts scored similarly on the Need for Cognition Scale. The results of a one-way between subjects Analysis of Variance (ANOVA) revealed that, although the difference was not significant; the scores for Cohort 1 were slightly more negative than those for Cohort 2. Given that scores can range from -72 to +72, the fact that both groups averaged slightly lower than midpoint was unexpected, as it suggests that neither of these groups of students are particularly motivated by the need to engage in cognitive tasks for enjoyment. Typically, participants who score high in need for cognition report enjoying complex cognitive tasks and choose to engage in such tasks, whereas those whose scores are low on the Need for Cognition Scale report preferences for repetitive, monotonous, and low cognitive engagement tasks [7].

A one-way between-subjects ANOVA also revealed no significant difference between the two cohorts' scores on the Academic Locus of Control Scale. As seen in Table I, although the cohorts did not differ significantly, the ranges were above the 10.5 midpoint, and suggested more of an external orientation. Previous research has found that higher scores have been found to be negatively correlated with GPA, meaning that students with a more external locus of control tend to have a lower GPA [8]. In addition, external scores have also been associated with students who completed homework assignments towards the end of the semester (versus the beginning) and began homework days later than their internally-oriented counterparts [8].

And finally, one-way between-subjects ANOVAs showed no significant differences between the two cohorts on any of the four subscales of the Academic Attributional Style Questionnaire (AASQ) [11] (see Table I), with all $F(1, 191) < 1.00$, *ns*. Both cohorts of students reacted similarly to the negative scenarios with responses that reflected an internal locus of control, high levels of personal controllability, and mostly unstable or temporary circumstances. In other words, students' scores indicated a belief that academic outcomes were within their ability to affect, were not permanent, and that they were not subject to external forces such as luck or Powerful Others. This suggests that students are aware that personal actions have academic consequences, and their successes or failures are mostly their own doing.

Table I. Descriptive Results for Psychological Questionnaires

	Cohort 1		Cohort 2		F-Values
	M (SD)	Range	*M (SD)*	Range	
Need for Cognition	- 9.16 (9.64)		-6.89 (9.07)		$F(1,195) = 2.91$
Academic Locus of Control	12.10 (2.25)	6-18	11.78 (2.04)	5-16	$F(1,190) = 1.06$
Academic Attributional Style Questionnaire					
Locus	6.49 (1.25)	3.44–9.00	6.51 (1.29)	2.56–9.00	$F(1, 191) = 0.03$
Personal Controllability	6.67 (1.28)	3.28– 9.00	6.68 (1.38)	1.94–9.00	$F(1, 191) = 0.00$
Stability	3.38 (1.24)	1.11– 7.67	3.35 (1.19)	1.00–7.72	$F(1, 191) = 0.05$
Externally Controlled	3.85 (1.48)	1.00– 7.67	3.78 (1.39)	1.00–7.24	$F(1,191) = 0.10$

Based on the analyses confirming that there were no significant differences between the two cohorts on any of the variables of interest, the data were collapsed across cohorts to test the hypothesis. We separated the students based on records indicating those who stayed in the program as engineers, those who left the institution, and those who transferred from engineering to another unit within the institution (e.g., from the School of Engineering to a mathematics major within the College of Liberal Arts and Sciences). Of the 244 students in the sample, 77.9% of the students remained in engineering. A chi-square test of independence determined that the retention rate was not significantly different between the cohorts, even though there was a significant difference between the numbers of those retained versus lost (X^2 (2, N=244) = 71.71, p <.001). Enrollment records from the year following the students' matriculation revealed that of the 190 students who stayed in engineering, 97.4% were in good standing. Of the 38 students (15.6%) who left the university, 52.6% were in good standing. Of the 16 students (6.6%) who transferred to another college within the university, 93.8% were in good standing. Out of the entire sample, 24 (9.8%) of the students had grades that warranted placement on academic probation, suspension, or dismissal.

Using one-way, between-subjects ANOVAs, we compared the scores on the three main scales for each of the three groups (see Table II). Although there appeared to be some mean differences between the groups, none of the ANOVAs revealed significant differences between their scores (all p > .10). While we expected to see some meaningful differences between the students who persevered and those who left, based on the well-established diagnosticity of the individual difference measurement scales we used [8, 10, 11], the small differences that emerged were not enough to identify the students likely to succeed.

Table II. Comparison of Students Who Remained Engineers, Left the Program, or Transferred Internally.

	Remained Engineers N = 164	Internally Transferred N = 9	Left the University N = 24	
	M (*SD*)	*M* (*SD*)	*M* (*SD*)	ANOVA Results
Need for Cognition	-7.89 (9.43)	-4.56 (6.82)	-10.04 (9.83)	F (2, 194) = 1.19
Locus of Control	11.93 (2.18)	13.00 (1.87)	11.52 (1.95)	F (2,189) = 1.54
AASQ Locus	6.46 (1.27)	7.17 (1.17)	6.50 (1.30)	F (2, 190) = 1.31
AASQ Personal Controllability	6.69 (1.30)	5.82 (2.17)	6.90 (1.05)	F (2, 190) = 2.23
AASQ Stability	3.34 (1.22)	3.09 (1.17)	3.60 (1.18)	F (2, 190) < 1.00
AASQ Externally Controlled	3.83 (1.42)	3.49 (1.25)	3.85 (1.57)	F (2, 290) < 1.00

Because the measures that we expected to identify students who would not persevere in engineering did not do so, we returned to the wealth of data we collected on the students' academic, co-curricular, and extra-curricular lives to investigate alternative indicators.

Overall, there were no significant differences between the groups in terms of student engagement. We examined student engagement in extra-curricular activity, in terms of varsity athletics, performing arts, student organizations, and other uncategorized activities using a chi square test of independence. Students who left the university or transferred internally were not more likely to be involved in extra-curricular activities than students who remained in engineering, X^2 (N=183, 12) = 8.49, *ns*. Taken together, 27.46% were involved in varsity athletics, 10.66% participated in performing arts (theater or music), 35.25% were active in established student clubs or organizations, and 87.30% regularly engaged in extracurricular activities (e.g., weight-lifting, Chemistry Club, intramural sports). Students who left the university or transferred were not more likely to be employed off campus than those who stayed in engineering, X^2 (N = 181, 8) = 6.09, *ns*, and there were no differences for students who worked on campus in work-study either, X^2 (N = 182, 4) = 6.30, *ns*. In terms of employment, 22.13% of students reported working 1 to 10 hours per week, and 4.10% worked between 10 and 20 hours per week. A small number of students, 2.46% reported working 20 to 40 hours per week.

We looked to the grades students earned in the first-year seminar. We also compared the three groups on based on whether the students passed both semesters of the first-year seminar, failed either the Fall or the Spring semesters, or failed both semesters (see Table III). "Remained 2nd Year" designates those students still enrolled in an engineering major on the census date of their second year; "Internal Transfer" designates those who transferred internally to another unit within the institution (e.g., mathematics within the College of Liberal Arts and Sciences); "Departed" designates both voluntary and involuntary separations from the University.

Table III. Destination/Persistence of Students and Their First-Year Seminar Grades (Pass or Fail). Comparison of Students Who Remained Engineers, Internally Transferred, or Departed

	Passed both semesters (%)	Failed 1 of 2 semesters (%)	Failed both semesters (%)
Remained 2nd Year	90.54	6.84	2.63
Internal Transfer	81.25	12.5	6.25
Departed	55.26	23.68	21.05

Of those who remained in the engineering program their second year, approximately 90% passed both semesters. In contrast, approximately 80% of those who internally transferred passed both semesters of seminar. Of those that departed from the university, only a little over half passed both semesters of seminar. A chi-square test of independence revealed that the difference in rates of passing for each of the groups was significant, (X^2 (6, N = 244) = 33.92, $p < .001$), meaning that the frequency of students transferring, leaving the institution, or remaining in engineering is related to their grades in the first-year seminar, though causality is impossible to determine. Unsurprisingly, students who failed one or both semesters of the seminar were significantly more likely to leave engineering than students who passed.

Implications and Future Directions

This study represented an unusual collaboration across disciplines (Psychology and Engineering) to create a profile that characterized a successful engineering student. After collecting information from two cohorts, the study did not find evidence to support the hypothesis that the individual differences associated with academic success in general would predict success or failure in engineering. Furthermore, the data did not provide clear indicators that readily distinguished students who returned from those who left the program, although grades in first year seminar did provide some indication. There are several potential interpretations of these results.

The first possible explanation is that the study's methodology obscured the actual individual differences among students who succeed or fail on the three psychological constructs we chose. As this was one assignment of many available to fulfill the requirements of the course, it was not mandatory for students to complete these surveys, and therefore compliance was not complete. Moreover, once students completed the surveys, they had the opportunity to withdraw their data from the analyses. It is possible that there was some factor that was fundamentally different between the groups who elected to do, or not do, the survey. Because we could not analyze the data from the people who withdrew or never participated, we might be missing the explanatory data. It is tempting to recommend that future research consider making the survey assignment a required course component and not allowing students to opt out once they have consented. However, because this research takes place in a course the students are required to take, there is increased risk of coercion, which is both bad for the integrity of the data that would be collected, as well as a violation of human-subjects research ethics as enforced in the professional standards of the American Psychological Association. Students are classified as a vulnerable population and given extra protection for precisely this reason.

The second methodological confound might come from the fact that the survey was given in the context of a "low-stakes" first-year seminar, wherein anything above a ~60% is considered a passing grade. It is possible that students did not allocate effort into answering the questions carefully. The survey was relatively long, and because of the time required to complete over 100 questions, the point value of the assignment was larger than the other optional assignments; the additional points were meant to incentivize students to invest appropriate effort. Nonetheless, the knowledge that their answers to the survey questions were confidential (i.e., their instructor would not see how they answered) and the potentially fatiguing nature of a lengthy survey could have decreased the conscientiousness with which they responded to the items. If their answers were lackadaisical or represented a response bias (e.g., answering all the questions the same way because they were not actually reading and considering the questions thoughtfully), we would lose resolution in the measurement of the targeted characteristics. However, point values were increased for the second Cohort and the data remained collapsible.

Finally, it is possible that the measures used in the present investigation are not actually predictive of persistence in an engineering program, and therefore the null result we found depicts the true state of reality. There are myriad components to self-regulation beyond the subset chosen for this study. For example, self-efficacy, or the personal belief that one can or cannot accomplish particular tasks in particular domains, has been linked to academic outcomes [16], as have implicit theories regarding the source of one’s intelligence in subsequent implications for outcomes [17, 18]. Nelson and colleagues incorporated knowledge building and class goal orientation as measures in their study of self-regulation and retention of computer science engineering students [6]. Other researchers suggest that students’ academic preparedness, engagement, and overall satisfaction with the program and institution may also play a role in whether they choose to stay or leave [19]. Zimmerman [4] suggests that individuals who perceive threats to self-satisfaction may exhibit defensive reactions, such as withdrawing or avoiding opportunities to learn, dropping courses, being absent from an exam, or withdrawing from a program. It is possible that these factors would be better predictors of persistence.

In conclusion, this study employed three individual difference measures to investigate whether a profile of a successful engineering student could be created. Overall, the current data suggest that further research is necessary to determine what other individual differences might be more effective predictors of success and retention. As we continue this line of research, we will continue investigating additional factors from which persistence in engineering can be predicted. What remains uncontested is the conclusion that better insight into students’ ability to succeed and choice to remain would help educators address the lowering retention rates in engineering programs.

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