Smart Enough to Succeed: The Case for Supporting Students' Non-Cognitive and Affective Factors

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Abstract

[This is a presentation-only submission and thus only a summary of the presentation is included below.] Oftentimes, and perhaps more commonly in STEM disciplines, students who are struggling academically are provided additional academic support through tutoring, encouragement to attend office hours or forming study groups. Each discipline similarly seeks to improve students' performance through improved instruction, such as providing faculty with workshops or lessons on pedagogy and teaching methodologies, tools to facilitate student learning, or curricular improvements to, for example, improve the flow of topics within and between courses. Such efforts at helping students through cognitive improvements are worthy but a substantial portion of STEM students continue to struggle. Our research has focused on studying a collection of non-cognitive and affective (NCA) factors and how these factors work in concert to support students in their studies. NCA factors, defined as psychological traits, beliefs or behaviors that are unrelated to talent or intelligence, are known to be important to the academic success and thriving of college undergraduates. These factors include Grit, Engineering Identity, Mindset, Mindfulness, Meaning and Purpose, Belongingness, Gratitude, Future Time Perspectives of Motivation, Test Anxiety, Time and Study Environment, Perceptions of Faculty Caring, Self-Control and Stress. These NCA factors have been studied individually or, in some cases, in small groups and were found to have an impact on academic performance. Our approach is to study them as a larger collection to determine how perhaps certain groupings of these factors are impactful on student performance.

Summary of Presentation

Studying engineering is hard. The subjects are difficult, the workload is heavy and the competition is intense. Making this demanding environment even more so is a sometimes unwelcoming environment for some students [1], perhaps an unkind culture that includes a perceived "weed-out" system and expectations of lower GPAs than students in other programs [2]. Given this learning environment, it's not surprising that some students struggle to succeed. *We argue, however, that success is not enough*. The true measure of an excellent program is having students and graduates that thrive, meaning that they are 'doing well' and 'feeling good' [3, p. 838]. Thriving students take steps to improve in the areas that bolster the 'feeling good' part of learning engineering by making thriving competencies – skills, behaviors and beliefs – an integral part of who they are.

Thriving competencies are linked to noncognitive and affective (NCA) factors, which we hypothesize are also linked to the academic success of engineering and computing students. Our research team developed a survey instrument to measure 28 NCA factors derived from 14 constructs. The constructs include personality, grit, meaning and purpose, mindset, motivation, gratitude, mindfulness, self-control, engineering identity, sense of belonging, perceptions of faculty caring, test anxiety, time and study environment and stress.

The instrument, called the SUCCESS (Studying Underlying Characteristics of Computing and Engineering Student Success) survey, has been given to over 5,300 U.S. undergraduate engineering and computing students at 20 institutions. Using clustering with data collected in 2017-18 from 2339

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undergraduates from 20 U.S. colleges, we found that over 74% of the students fall into one of four distinct clusters [4, 5, 6, 7]. The clusters can be described as:

- Cluster 1: The Normative Cluster (n = 832, or 35.6% of sample). Members of this cluster had factor means that were all similar to the overall sample mean.
- Cluster 2: High Positive NCA Factors but with a Fixed Mindset (n = 500; 21.4%). The members in Cluster 2 were generally high in many of the factors that are associated with positive academic outcomes, with many statistically different from all other clusters. These factors include support for stress, time and study environment, gratitude, belongingness, meaning and purpose, engineering identity, and facets of motivation.
- Cluster 3: Unconnected and Closed Off (n = 311; 13.3%). Members of this cluster displayed several factors that correlate to lower student success, including significantly lower means for engineering identity (interest), belongingness, expectancy, instrumentality, and connectedness.
- Cluster 4: Without Feeling of Support from Faculty and Peers (n = 94; 4.0%). Cluster 4 displayed strongly negative values for several NCA factors associated with lower student success, including significantly lower scores than all other clusters for engineering identity, instrumentality, perceptions of the future, expectancy, belongingness, and perceptions of faculty support.

From the original sample of 2339 students on which the clustering was based, 388 were first-year students who hailed from a single institution for which we had access to complete transcripts since they took the survey in 2017-18. This sub-sample's computed GPAs, by cluster, clearly demonstrated the impact of a student's NCA profile: Students in Cluster 2, as expected based on previous single-factor studies, outperformed students in Cluster 3 by a statistically significant margin, and this difference appeared early and persisted through four years of studies. The GPA of Cluster 1 students fell between those of Clusters 2 and 3. Note that Cluster 4, because of the extremely small sample size (n=15), did not provide meaningful results.

We next use this sub-sample of students from one institution to examine the longitudinal changes in NCA profiles. Forty-eight (48) of the 388 survey respondents, when they were all first-year engineering undergraduates, took the survey for three consecutive years, allowing us a view of how noncognitive factors evolve. Five of the 28 factors changed significantly over time. These were: stress due to changes, reactions to stress, belongingness, engineering identity (interest), and motivation by expectancy. All five factors changed in the direction that prior research found to be negatively associated with academic success and, interestingly, all factors changed between the first and second years of college. We emphasize that all students in this sample are "succeeding" academically – their average cumulative GPA was 3.38 out of 4.0. This collection of findings points to the possibility for timely, directed interventions to support students' needs beyond curricular content and speaks to the role that the university should take to help students go beyond success and toward thriving. We note that we found little difference between race or ethnicity or gender in our findings, suggesting that all students need to develop thriving competencies, much as they need to develop engineering skills and knowledge during their undergraduate studies.

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