A Mixed-Methods Investigation of Thriving in Engineering Undergraduate Students: Exploring Why Students Report Low Thriving Scores

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Introduction

This empirical research brief explores factors that may contribute to engineering undergraduate students reporting lower perceptions of thriving in their degree programs. Engineering education has emphasized academic performance as the primary indicator for student success. However, there is an increasing concern surrounding mental health among university students worldwide. This growing concern has led to calls for a broader understanding of well-being and achievement [1]. Engineering programs are structured with rigorous course expectations that develop analytical and innovative thinking skills but contribute to intense workload and stress levels, which are a significant negative contributor to students' mental health [2-6]. The persistent challenges in engineering programs such as low satisfaction, lack of belonging, and inadequate institutional support have led to high rates of attrition among undergraduate students [7]. Mental health and well-being are recognized as key elements in engineering students that influence retention and success [8-9]. Employing a mixed method approach, this study explores factors that contribute to lower perceptions of thriving among engineering undergraduate students. Specifically, we investigate the research questions:

1. What quantitative patterns emerge in learning and vitality for students with low thriving scores?
2. What are factors that contribute to the perception of low-thriving for engineering students?

Background and Conceptual Framework

Thriving Scale. The thriving scale, introduced by Porath et al. [10], is used to measure the thriving of a person through vitality, which refers to feeling energy and aliveness, and learning, which refers to gaining and applying knowledge. This scale has been primarily applied in the context of adult workplace [10-11]. In these spaces, thriving has been positively related to mental health [12]. Kleine et al. [11] measured thriving in the workplace and found that stress, along with other social and institutional factors, was negatively associated with employees' thriving scores. We acknowledge that there are environmental and individual differences between an adult in a professional workplace and an engineering student in an undergraduate program. Despite these nuances, the thriving scale has been used to study undergraduate engineering experiences [13-14].

Thriving Framework. Using Norrish's [15] representation of Positive Education and Maslow's [16] Hierarchy of Needs, Ge and Berger [17] developed a conceptual framework to examine

thriving in engineering students. In this framework, thriving is used to describe how engineers develop and refine competencies that contribute to their success in the engineering field. This framework demonstrates how engineering thriving is not one goal or standard, but an evolving and continuous process. Ge and Berger [17] adopt Seligman's [18] interpretation of how flourishing takes place; mediations that foster thriving are not the same as interventions that diminish problems. Thus, investigating reasons for high and low thriving creates an opportunity to assess ways to increase thriving in engineering students. This framework guides our qualitative analysis of student interviews on their engineering education experience and contributes to further adapting the concept of thriving in engineering education environments.

Quantifying Student Success. Much of the existing research on engineering student success is defined through numerical scores [2,19]. For instance, Hewagallage [20] used ACT and SAT test scores to predict course grades. While the study was designed to explore the preparation of engineering students, success was nevertheless based on grades assigned by the professor [7, 20-21]. Academic success indicators are also associated with undergraduate student mental health. A decline in mental health predicts poorer academic performance [9]. However, grades alone may overlook students' mental well-being and fail to capture holistic success in undergraduate engineering programs. D'Entremont [22] demonstrated that undergraduate student mental health decreased as students started their program because they began attributing their self-worth to their grade point averages. Incorporating the thriving scale and framework into evaluations of student success can provide a more holistic assessment of how students are progressing in their engineering education in addition to more quantitative measures such as their grades.

Methods

For this mixed-methods study, quantitative data was collected through a survey followed by qualitative interviews [23]. The survey, which collected descriptive data on undergraduate engineering students' experience, attitude, and perception of thriving, was distributed via email to all undergraduate engineering students at one research-intensive public university. A total of 188 students responded to the survey, and 112 students indicated willingness to participate in the interview. Maximum variation sampling was used to select participants to interview that represented a range of engineering majors, year of study, gender, and racial identity. Of 40 students invited to the interview, 18 students participated. The National Science Foundation (NSF) project funding for the data collection was cancelled at the start of the interview period, which was a barrier to interviewing more participants. Participants received a $20 Visa E-gift card as compensation, which was funded from an alternative, non-NSF source.

Porath et al.'s [10] instrument was used to collect self-reported thriving scores, which comprise the quantitative data in this paper. The purpose of the quantitative data was to identify patterns of thriving among undergraduate engineering students. The thriving scale used Likert-scale items to

measure students' self-reported ratings of learning and vitality and was comprised of 10 items producing total scores ranging from 10 to 50. Each students' thriving score is a composite of the learning and vitality sub-scales. Based on these results, we selected the five interview participants with the lowest thriving scores for deeper analysis in this research brief.

Semi-structured interviews (30-90 minutes) were conducted to allow flexibility in exploring the experience of the participants. The interview protocol focused on seven themes: major choice and persistence, policies and advising, interactions with peers, academic preparation, career readiness and personal growth, well-being, and institutional improvements. Thematic analysis on interviews from the low thriving group was guided by the engineering thriving conceptual framework to identify common themes from students reporting low thriving scores within the engineering undergraduate environment [17,24]. Our thematic analysis paid special attention to both academic competency and broader support systems to contribute to a holistic approach [17,24]. Open coding was employed to develop unique themes along with the constant comparative method to ensure consistent code usage [25-26]. Initial coding for the paper was completed by the first author and codes were reviewed and adjusted by the second author. For analysis and discussion, pseudonyms were assigned to participants.

Results

Thriving scale. Thriving scale levels were categorized using percentage bands of the total possible score: scores from 10-29 indicate low thriving, 30-39 indicate moderate thriving and 40-50 represent high thriving. The boundaries were applied to group mean to characterize the quantitative profile of the sample. Table 1 (Appendix A) shows descriptive statistics from the thriving scale response across the full dataset (N = 173), interviewed participants (n = 18), and the low-thriving group (n= 5). The full sample shows a moderate level of thriving, learning, and vitality, capturing sufficient variability of participant experience. The interviewed sample demonstrates slightly lower mean values, indicating that these participants experienced somewhat reduced well-being relative to broader populations.

The low thriving participants show lower scores on all three constructs, with vitality scores lower than that of learning scores for all but one participant. Of those four, there was little change in vitality, a two-point difference, whereas the change in learning was six points. Notably different from the rest of the group, Marcos' (P05) learning score was nine points lower than the next lowest learning score; however, his vitality score was still in the low-mid range for the full interview group. These patterns illustrated in Appendix B provide context for the qualitative analysis on how the low-thriving cases fit within the broader set of student experience.

Qualitative interviews. Three themes emerged from analysis of interviews from the five low-thriving participants: difficulties with coursework, variability in academic or career preparation

support systems, and negative impacts on well-being. While the first two themes impact learning and the third vitality, interactions between themes may result in unequal distribution of impact.

Difficulties with coursework was a persistent concern seen amongst participants with low perceptions of thriving. This theme included concerns about not passing or doing well in courses, difficulties around learning styles, and difficulties with teaching decisions made by instructional faculty. Almost all participants had some form of negative interaction with at least one instructor where participants discussed instructors using teaching practices that were unengaged, upsetting, or unlikely to encourage student questions or exploration. For example, Taylor (P08) said, "I've had friends who get good grades out of the class in spite [of] the instructor, and I just can't do the same that often. And I guess it makes me think that I'm not cut out for this stuff sometimes." Although students continued to learn and progress, the emotional cost of doing so was high and often negatively impacted the students' sense of belonging in engineering. Participants reported feelings of frustration, anxiety, and discouragement while navigating difficult courses. However, participants often normalized these experiences as unavoidable aspects of being an engineering student. This pattern reflected that engineering requires endurance and sacrifice for success which may contribute to negative impacts surrounding well-being.

Variability in Academic or Career Preparation Support Systems. Despite negative interactions with some faculty, all participants had at least one positive experience with a university-related support system. In some cases, these were tied to academics and ability to learn concepts, but they were also tied to more complex topics such as course advising, mentorship, or career advising and exploration. Despite having these positive support systems, variability in presence or continuity were prohibitive to these students long-term, impacting their ability to succeed in foundational coursework or influencing their course of study. David (P13) describes this variability along with a lack of control over their education: "It's hit or miss, whether or not you get a good teacher that prepares you for things and [where the] goal is your success." Marwa (P12) touches on academic support in foundational coursework, saying "a lot of professors are mainly focused on research and not really the education. So, that was a major struggle, especially in those early years of engineering where you're taking all the foundational engineering courses." In some cases where faculty and advising support systems started to fail, students relied on peers to help them survive and navigate that system. However, conditions were often not greatly improved, resulting in the student needing to retake a course or alter other plans.

Negative Impacts on Well-Being. All participants discussed some level of negative impacts to their general well-being, including physical and mental health. Stress, burnout, and academic pressure were common concerns discussed by students tied to their mental health, often related to discussion on topics related to support. For example, David (P13) said:

> I'm only 23, but this is...by far going to engineering has been the hardest thing I've ever done. Many facets, being first generation, having to work through it, trying to balance everything else

> that I find important in my life with doing this, and not letting me just take over everything is very exhausting. I'm definitely feeling that burnout creeping in, and ultimately … I feel like I'm not getting enough support in what I'm doing.

Complex responsibilities outside of their education can add to these concerns, as David discusses, or exacerbate other mental health issues present prior to entering college. Increasing pressure without adequate support often resulted in further loss in support systems such as classmates and friends. While there was a general focus on impacts to mental health, one participant attributed the increase in stress from engineering education to a diabetes diagnosis and another described mental fatigue and gradual withdrawal from social interactions, indicating that social isolation was developing in parallel to academic challenges. While the engineering thriving framework [17] does not directly mention well-being or mental health, they are present in contributing frameworks and highlight the importance of the addition of vitality from the thriving scale [10].

Discussion

Despite vitality scores being consistently lower than learning scores, aspects of how students feel and their well-being were less directly discussed during interviews; often being overlooked compared to how they performed. This focus on gaining competency over well-being likely allowed students to continue to progress in their degree while negatively impacting perception of thriving. Alignment with personal and career goals encouraged resiliency when support systems were variable and significant positive growth when support systems were functioning. However, this unequal or inconsistent presence of support systems were a notable area of variability in student experiences. Many of the students with low perceptions of thriving had both positive and negative interactions with university-based support systems. However, students perceived that negative experiences damaged their progression in their degree or preparation for career or future coursework. As the engineering thriving framework [17] discusses, the culture promoted within engineering can undermine the acquisition of engineering competencies and impact engineering thriving. Faculty and other academic support systems play a part in directing this culture. These interviews showed that a few experiences misaligned in encouraging these engineering competencies could have significant impacts on skill acquisition and student perceptions of thriving.

While the engineering thriving framework [17] groups competencies into three categories – academic, intrapersonal, and interpersonal – aspects of this paper's themes are present in multiple of these categories. This overlap reflects Ge and Berger's [17] argument that engineering competencies are complementary and interconnected. For example, difficulties with coursework affected academic competencies but also influenced intrapersonal constructs like motivation and self-efficacy. These challenges did not always affect students' learning, but they made learning feel more draining, leading to lower vitality scores.

Intersection of thriving scale and thriving framework. While the thriving scale provides a succinct quantitative measurement for exploring perceptions of thriving at a specific point for students, the qualitative analysis and the engineering thriving framework contribute context and depth of perception to student responses. This depth highlights the importance of consistent student support and consideration for student well-being in order to create engineering education programs that support competencies that contribute to thriving in these programs.

Special case. Of the five participants in this study, the lowest reporting score (Marcos, P05) reported higher vitality and lower learning values; the opposite of the other four participants. When looking at this specific case, the participant has several unique characteristics which reinforce that student background and larger environment can influence perception of thriving, learning, and vitality within the engineering environment. Marcos was a non-traditional student who was older and had an established life before entering his engineering education. This prior experience, in the form of other post-secondary education and experience in construction and agriculture related fields, along with a willingness to seek support for mental health concerns, may be what contributed to the reversal in the pattern seen in other participants. Across the five interviews, it became clearer that low thriving does not look the same for all individuals. Marcos appeared to be in a different stage of life than the other participants and had already navigated many challenges the others were facing for the first time. As a result, challenges that affected younger students had less emotional impact on Marcos. However, Marcos' lower learning score and reduced thriving were due to misalignment in academics rather than diminished vitality. Although the interpretation is made cautiously due to small sample size, the opposite cases indicate that thriving is shaped by individual context and experiences.

Limitations. It is important to note that GPA and length to completion, common forms of assessing success in engineering courses of study, were not collected or assessed for this study. Additionally, the thriving scale and interviews were collected near the end of the Spring 2024 semester. The timing of data collection could alter the current mindset of students and impact student responses and perception of thriving. Longitudinal data would be needed to assess fluctuation in perceptions of thriving over the semester or at different points in academic career.

Conclusion

The preliminary results across three themes show intersection in how low-thriving students experience learning and vitality, showing insights into lower ends of the larger study of thriving distribution. This study highlights the inconsistent instructional and institutional support system experienced by the lower thriving group, leading to destabilized student progress. Future work could examine these support systems in more depth and include faculty and institutional perspectives to explore how engineering programs can create consistent and equitable space for student thriving.

Acknowledgements

This material is based upon work supported by the National Science Foundation under Grant Number 2408749. Any opinions, findings, and conclusions or recommendations expressed in this material are those of the authors and do not necessarily reflect the views of the National Science Foundation.

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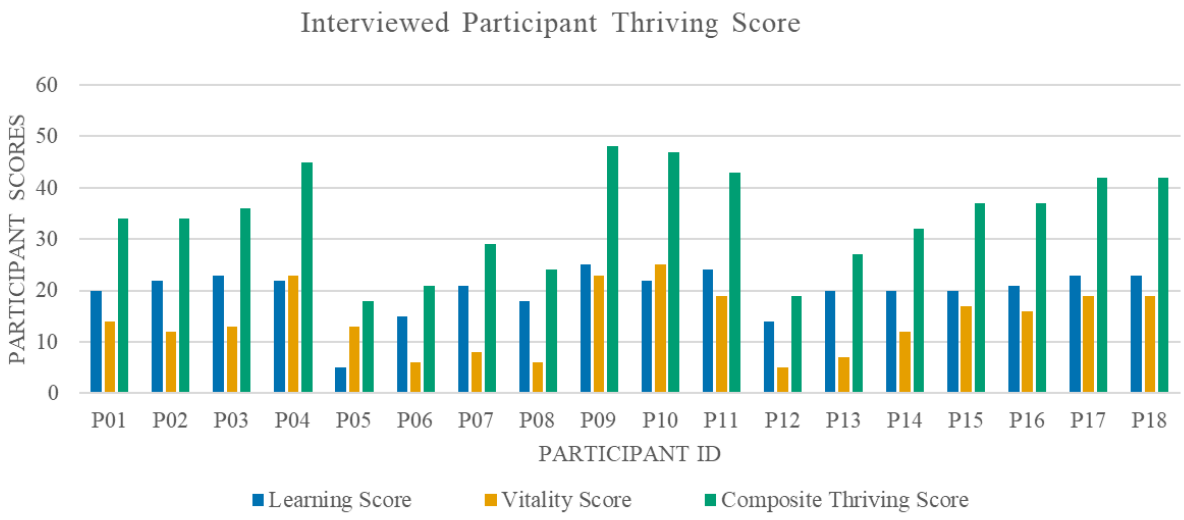
Appendix A:

Table 1. Summary of Thriving(T), Learning(L) and Vitality(V) Scores for all Participants

	Full Sample			Interview Sample			Low Thriving Sample		
	T	L	V	T	L	V	T	L	V
Mean	37.2	21.3	15.8	34.1	19.88	14.27	21.8	14.4	7.4
Median	37	21	16	35	21	13.5	21	15	6
Minimum	18	5	5	18	5	5	18	5	5
Maximum	50	25	25	48	25	25	27	20	13
Sample Number	173			18			5		

Appendix B:



Appendix C:

Table 2. Summary of Participant Demographics for the Interview Sample and the Low Thriving Sample

	Interview Sample	Low Thriving Sample
Gender	% (n)	% (n)
Female	38.9 (7)	20.0 (1)
Male	38.9 (7)	60.0 (3)
Nonbinary/Nonconforming	11.1 (2)	0 (0)
Transgender	5.6 (1)	20.0 (1)
Prefer not to say	5.6 (1)	0 (0)
Race		
White or European American	27.8 (5)	20.0 (1)
Asian or Asian American	16.7 (3)	0 (0)
Hispanic or Latino/a/x/e	16.7 (3)	20.0 (1)
Middle Eastern or North African	5.6 (1)	20.0 (1)
Native Hawaiian or Pacific Islander	0 (0)	20.0 (1)
Black or African American	5.6 (1)	0 (0)
Biracial or Multiracial	11.1 (2)	0 (0)
Multiple	16.7 (3)	20.0 (1)
Degree Program		
Civil Engineering	16.7 (3)	20.0 (1)
Computer Science	16.7 (3)	0 (0)
Mechanical Engineering	27.8 (5)	40.0 (2)
Software Engineering	5.6 (1)	0 (0)
Biological Systems Engineering	11.1 (2)	20.0 (1)
Environmental Engineering	5.6 (1)	20.0 (1)
Electrical Engineering	5.6 (1)	0 (0)
Computer Engineering	5.6 (1)	0 (0)
Other	5.6 (1)	0 (0)