Teaching Undergraduate Engineering Students Gratitude, Meaning, and Mindfulness

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WIP: Teaching Undergraduate Engineering Students Gratitude, Meaning, and Mindfulness

Introduction
In this work-in-progress research paper, we evaluate the impact of a novel interdisciplinary course in which we taught undergraduate engineering students about gratitude, meaning, mindfulness, and other topics relevant to thriving. In this paper, we define thriving as the process in which students develop and refine asset-based competencies that allow them to achieve optimal functioning in engineering. The one-credit elective course was developed at a large midwestern university as the first step to investigate whether non-cognitive competencies relevant to thriving and wellbeing could be taught. Currently, thriving remains an underexplored area in engineering contexts [1]. We hypothesize that interventions to promote thriving may be an important step in broadening what it means to succeed in engineering. This course serves as an intervention to introduce the concept and language of thriving to undergraduate engineering students so that they can better articulate their conceptions of thriving. By analyzing course documents and survey data, we seek to understand whether a course on thriving can change undergraduate engineering students' perceptions of gratitude, meaning, and mindfulness. And if so, whether these changes persist six months beyond course completion.

Summary of Measured Competencies and Associated Class Activities
In this paper, we focused on students' changes in three competencies—gratitude, meaning, and mindfulness—using evidence-based class activities found in the scholarly literature. These practices were grounded in experiential and cooperative learning such as visits from experts, round-table discussions, reflections, but still included traditional learning activities such as assigned readings and lectures. Outside the classroom, students actively worked with community partners to improve thriving in the community.

Gratitude - Gratitude consists of feelings of appreciation for someone in response to receiving intentional benefits, especially at some cost to the benefactor [2], [3]. There are both interpersonal and intrapersonal benefits of gratitude. Gratitude is one of the strongest correlates to emotional wellbeing [4], life satisfaction, optimism, and reduced anxiety [5]. In education, gratitude improves teamwork, enjoyment and other positive emotions in learning, wellbeing, and the likelihood of giving back (such as through alumni donations) [6], [7], [8]. In class, students learned about gratitude (both personal and interpersonal benefits) by viewing videos and reading scholarly research papers [5], [9]–[11]. Then, they cultivated gratitude by journaling about moments in which they felt grateful, moments in which others were kind to them, and moments that seem negative at first but could be positively reframed. We provided open-ended question prompts so that the students could write about gratitude in their engineering education experience or in other dimensions of their lives.

Meaning - We define "meaning" in the broad context of meaning and purpose in life. Meaning is a multidimensional phenomenon that can be conceptualized as a set of values, actions, and goals that interact to create a sustained life purpose [12]. A sense of meaning has been associated with academic achievement, creativity, learning, motivation, character growth, and life satisfaction [13]–[16]. Previous studies indicated that meaning could be taught in schools [17]. In our course, students explored meaning by reflecting on their own lives using quotes about meaning and

purpose, serving others in ways they could benefit their communities, and using their strength without expectation of return.

Mindfulness - Mindfulness is defined as intentional, purposeful, focused, and nonjudgmental awareness [18], [19]. Although often associated with Buddhism, mindfulness is conceptualized as a universally applicable practice and an innate human capacity [19], with a focus on finding the novelty and opportunity engage in every moment [20]. Neuroscience studies claim that mindfulness cultivates attention, creativity, and increased cognitive performance [21], [22]. Additionally, mindfulness has been added to traditional pedagogical practice to help K-12 students improve focus, sleep, emotional self-regulation, self-control, relationships, executive functioning, and resilience [23]–[25]. In our course, students practiced mindfulness through guided meditation by experts and online resources such as Headspace, Sattva, and iMindfulness; and through day-to-day practice and reflection doing normal activities such as eating, moving, and journaling.

Methods
Our participants in this study were undergraduate engineering students—mostly first- and second-year and from various demographic backgrounds—who took the course on engineering thriving during 2018. We examined changes in students' scores on gratitude, meaning, and mindfulness at three time-intervals: a pretest the first day of class ($n = 12$), a post-test the last day of class ($n = 12$), and a follow-up six months later ($n = 5$). Part of a larger project (NSF #1626287), we measured these competencies using a previously validated survey [26] that examined the impact of various non-cognitive and affective factors on engineering student success. For gratitude, students responded to six statements such as "I am grateful for the people who have helped me succeed in college." For meaning, students were given three statements, such as "My life has a clear sense of purpose." Finally, for mindfulness, students were given four statements such as "I find myself doing things without paying attention." On the survey, students rated their level of agreement on a 7-point Likert scale with higher scores indicating stronger agreement. We calculated each students' final score on each competency based on the average of their responses for each question. To better understand the observed changes in students' survey data, we reviewed written assignments from students including weekly course reflections, notes from class discussions, and course feedback from students. We also reviewed documents from community partners who collaborated with students. These written documents were analyzed using thematic analysis [27].

Results and Discussion
Analysis of students' survey data revealed varying changes in students' gratitude, meaning, and mindfulness throughout the course. Figures 1 and 2 display these changes over three time intervals. Figure 1 shows that students generally improved in gratitude and meaning throughout the course, while their mindfulness scores generally declined. We believe the observed decline in students' mindfulness scores might be related to the response shift bias, in which students become more mindful of their state of mind and thus notice their (lack of) mindfulness [28], [29]. Alternately, the observed decline in students' mindfulness scores may be explained by the Dunning–Kruger effect, in which novice students mistakenly over-rate their own abilities [30]. Hence, students might rate their posttest mindfulness level lower than their pretest level despite becoming more mindful. Figure 2 shows that these competencies generally improved in the six-month follow-up survey. However, examining gratitude, meaning, and mindfulness separately also reveals inconsistencies in individual students' gains and declines for these competencies. A potential explanation for these inconsistencies, especially large for mindfulness, could be due to context.

Since students' scores on the non-cognitive variables depend on context, other factors outside of the course may be influencing these changes in students' scores over time. Future research is needed to explore these contextual factors.
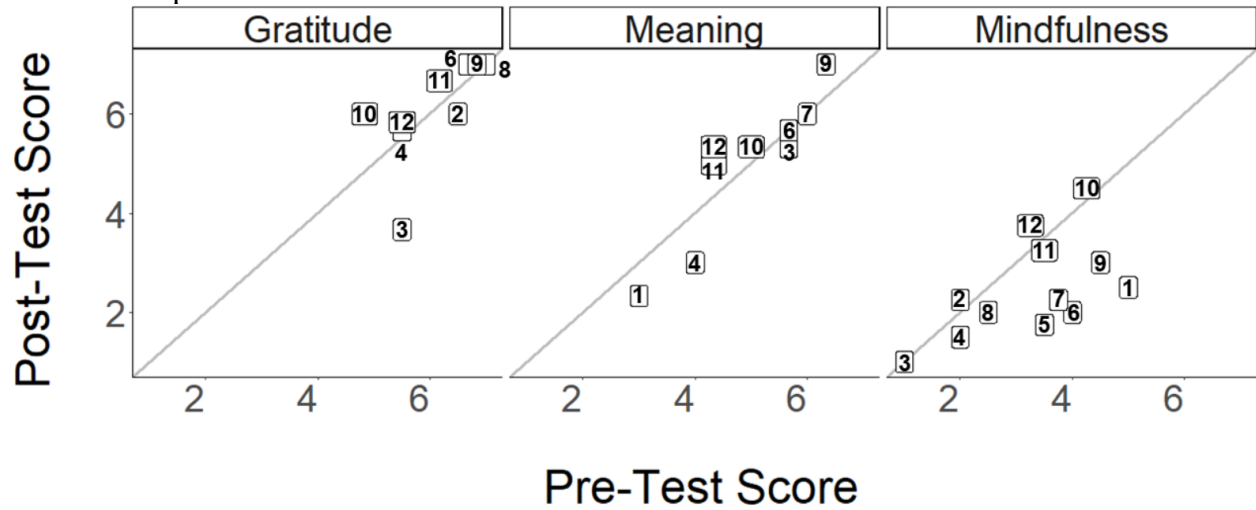

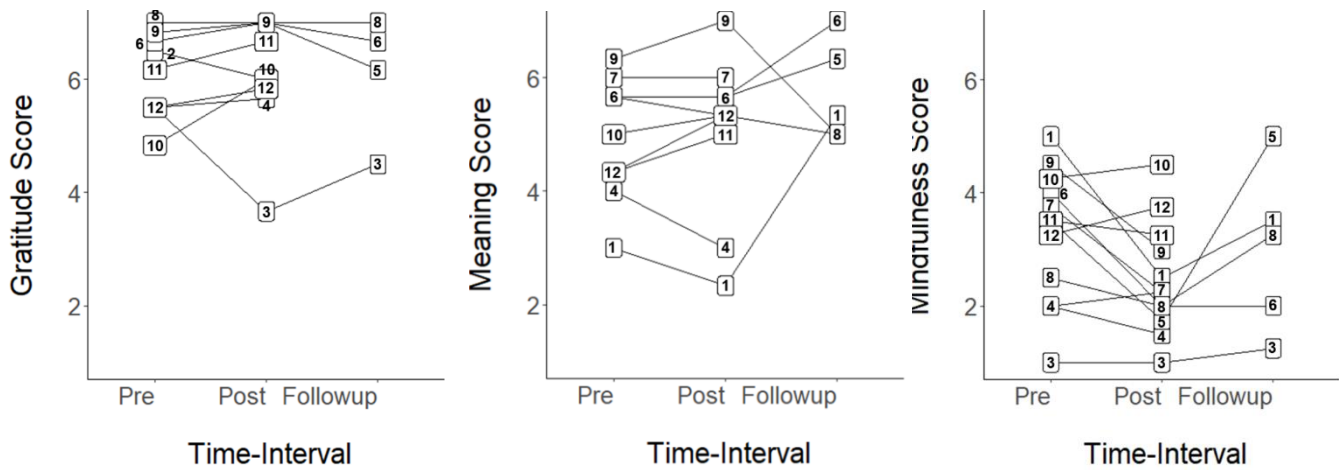**Figure 1:** Students' pre-post scores in gratitude, meaning, and mindfulness.

Figure 2: Changes in students' gratitude, meaning, and mindfulness scores over time.

Further thematic analysis of student's written documents offers some explanation to complement the survey data and also presents a strong argument not to research individual competencies without considering their impact on other competencies that, together, influence the students' experiences. Although the survey data showed fluctuations in students' gains and declines for the competencies, their written reflections indicate a clear growth in their understanding of gratitude, meaning, and mindfulness. During the first day of class, nearly every student defined thriving through academic or financial achievements, devoid of any mention of gratitude, meaning, and mindfulness. However, by the last day of class, nearly all students commented on the importance of gratitude, meaning, and mindfulness. For example, the same student who wrote on the first day of class "thriving is achieving all my goals," reflected on the last day of class:

> I always thought that thriving meant having a lot of success in my career and life as a student. [Now, I know] it is awareness of how I am doing in the present... and

> knowing how to change or transform based on the things thrown at me in life, good or bad.

This quote shows how this student's definition of thriving evolved over the course. As the students engaged with the course content, the students articulated other competencies relevant to thriving. Several students' reflections exemplified the interrelated nature of non-cognitive competencies. For example, two students commented on the interrelatedness between mindfulness, gratitude, and other competencies:

> When I am mindful of whatever I am presently involved in, may that be working on my homework or all the sights as I walk to class, I see others being kind and caring for me in places where I would have looked over in the past.

> Being mindful helps you make decisions based on your health, which increases your ability to accomplish the recommended sleep, exercise, diet, and mindfulness goals for each week. It also makes you more aware of, and more appreciative of, each interaction with someone else and this helps you be more in the moment and form more genuine relationships with people. This strategy makes you viscerally aware of your reality and allows you to see it from an objective view, and having this ability is so important in making good decisions when weighing different factors and being aware of biases.

Together, findings from survey data and written documents suggest that engineering students' non-cognitive competencies are malleable over time; they can be taught and learned. However, individual non-cognitive competencies should not be researched in isolation because they may be interconnected and may function synergistically.

Conclusions, Limitations, and Future Work
This paper details the effects of a new course on undergraduate engineering students' gratitude, meaning, and mindfulness. Preliminary findings indicate that a course on thriving might change undergraduate engineering students' non-cognitive competencies and that some changes might endure six months after the course. Furthermore, our results show that the distinct non-cognitive competencies we measured changed in similar patterns over time.

Our future work on this project will address several limitations. First, students in class do not have reference points for their data findings. To address this limitation in future work, we will recruit a comparison group of undergraduate engineering students who did not take the course to determine the extent to which changes in students' non-cognitive profile simply occurred due to natural maturation over time. Second, our sample size is limited by enrollment, which prevents us from using meaningful statistical inferences. This limitation can be addressed in future iterations of this course. Finally, our future work will also involve analyzing more non-cognitive competencies that were measured in the survey shown as beneficial to student success in the literature, such as engineering identity, motivation, and grit. Potential future interventions developed from this study are meant to complement, rather than replace, the traditional practices in engineering education. In addition to developing a strong technical foundation, engineers of the future will need to understand and appreciate the value of non-cognitive competencies in order to create more thriving engineers to serve a thriving society.

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