

Assessing Happiness in Undergraduate Engineering Students

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Abstract—This research Work in Progress explores establishing a baseline for a measure of ‘happiness’ as a noncognitive construct, and how it might change over the school year for engineering students, and begins to explore how it may relate to other noncognitive attributes.

Affective characteristics of engineering students have been studied in different contexts. Studies have attempted to assess the effect of affective and cognitive characteristics on retention, success, motivation, etc. Little if any research has been done on happiness of engineering students as an affective construct, or a trajectory of happiness within engineering cohorts.

This work-in-progress builds upon prior research at a large, mid-Atlantic university. As the COVID pandemic began, multidisciplinary engineering students were given an open-ended prompt to submit an artifact that illustrated how the pandemic was affecting them. There were no restrictions, other than the assignment had to be capable of being submitted in the existing learning management system. Students submitted a wide variety of creative artifacts, from poems to movies to paintings. These submissions were analyzed based on the type of submission and emotion mentioned or conveyed in the assignments. Submissions were coded to glean characteristics such as happiness, sadness, and other emotions from the students’ submissions.

This was created in a snapshot in time, within the first few weeks of COVID and before the effects of COVID on students or society was evident. The COVID-19 pandemic had undoubtedly impacted any measure of happiness among engineering undergraduates (which was the impetus of the project). From this initial study, two research questions emerged: a) what is the happiness level of engineering students as they begin the academic year, and b) what is the trajectory over the course of the year? For further consideration, does a quantitative measure of happiness correlate to fixed vs. growth mindset? The Subjective Happiness Scale (SHS) was administered at the beginning of the academic year, at the end of the first semester, and at the end of the year at a small, private, Midwest university. This study hopes to establish a baseline to understand how interventions might be designed to positively affect happiness within students. This paper will discuss the initial results of administering the SHS to undergraduate engineering students, with a comparison to results from a similar instrument measuring fixed vs. growth mindset.

Keywords—*Noncognitive Characteristics, Happiness, Fixed vs Growth Mindset, Retention*

I. BACKGROUND

Multiple studies of cognitive and affective characteristics and their effect on student success exist, with many of these focused on engineering undergraduate students [1-6].

The COVID-19 pandemic introduced a fundamental change in every aspect of education. The first few weeks of the COVID-19 pandemic saw students sent home from campus without warning for an indeterminate amount of time and a radical shift to online courses with no preparation. Courses that were heavily experiential faced difficult transitions, including many first-year engineering programs.

The authors theorized that the change in student engagement and integration into a cohort or into a community were among the most significant changes that may affect student success. Results of this open-ended assignment created to explore and rebuild the student-instructor relationship gave rise to new research questions: were students happy? Taking this a step further, were students happy in general as they start the academic year, and, if so, was there a trajectory over the year? Further (and the goal of this work-in-progress), how can we measure a trajectory of happiness over the course of a year?

Some relevant studies have examined happiness in software engineers. These suggest a variety of internal and external consequences of subjects' happiness states, notably including impacts on cognitive performance, flow, and motivation [7, 8]. Sources of unhappiness were predominantly controllable by leaders, technical in nature, and related to time pressure. Engineering courses are analogous to these systems, and so understanding happiness in engineering students could lead to improvements in course and curriculum design. Studies that have examined student success within engineering programs rely on a standard framework and consistency in undergraduate engineering, consisting of largely in-person programs with hands-on laboratories, with different student support resources in place.

II. INITIAL STUDY

The first-year program at a large, mid-Atlantic university was designed to be an in-class, hands-on learning experience, with the second semester structured around a team design project. The project had students building attachments to remote controlled (RC) cars to accomplish a set of goals. This project-based pedagogy had been a long-standing course design prior to the COVID pandemic. When the COVID pandemic hit, Spring Break was extended, then students were told not to return to campus. The fact that students had to abandon their teams and their physical cars, first for a presumed few weeks, then for the rest of the academic year, made this more challenging. Instructors were faced with converting this project to a new individual and autonomous paradigm for the transition to online learning. Beyond the pedagogical challenges was the challenge of maintaining a connection with these first-year students.

The instructors designed an open-ended assignment to reach out to students to encourage them to communicate how the interruption and transition was affecting them using a creative medium of their choice. The assignment specifically mentioned “Your feelings may be positive, neutral, negative, or all of the above. This assignment is an expression of your feelings, and any and all of them are valid (but please be classroom appropriate).” The only requirement was that their work had to be shareable through the course’s LMS [9].

Purpose

Self-reflection and creative expression can be useful tools, particularly in times of uncertainty. This assignment will give you the opportunity to practice these tools in the context of our course transition.

Task

Moving a course from in-person to online in the middle of the semester is disruptive, to say the least. It is probably also causing you to have a wide variety of thoughts and feelings.

For this assignment, I’d like you to spend some time reflecting on your feelings about the transition of ENGE1216 to an online format. Then, express your thoughts or feelings through some creative medium. A few of you mentioned drawing and dance in your intro slides - feel free to be creative!)

Your creative medium can be whatever you like, depending on your preferences and available resources. Some of you may want to write stories or poems, some may want to draw, paint, or sculpt, some of you may want to create songs or videos. Some of you may have other ideas entirely. Any medium you choose is valid, and you do not have to explain this choice. All we ask is that you submit some way for us to see, hear, or experience your creation. We expect that will be through images, text, or links to audio or video for most of you.

Your feelings may be positive, neutral, negative, or all of the above. This assignment is an expression of your feelings, and any and all of them are valid (but please be classroom appropriate).

The types of submissions varied widely, including graphics (memes, paintings), to written (poems, song lyrics), to performance (videos, dance). Submissions were coded in an attempt to assess the prevailing sentiments and emotions expressed (Table 1). Note these codes are preliminary, and thus far have only been applied by one researcher. Additional rounds and comparisons are planned.

The expectation is that the opportunity to creatively collaborate in such an activity helped mitigate the loss of a sense of belonging [10]. While there was not a specific effort to document or assess happiness as a construct, satisfaction and happiness began to emerge through the coding process, and questions emerged regarding different affective characteristics, sense of belonging, and student success.

TABLE I. ASSIGNMENT SUBMISSIONS CODED FOR EMOTION

Positive	Generally positive. Good feelings 75%+	10.30%	74
Negative	Generally negative. Feeling not so good 75%+	40.20%	290
Mixed	Mix of positive and negative expression or thoughts	25.70%	185
None	Mood is unclear or unexpressed	23.70%	171
Humor	Levity, attempts at humor or silliness	5.10%	37
Seriousness	Not intended to amuse	1.50%	11
Uncertainty	Confusion, not knowing what is happening	7.10%	51
Confidence	May be confidence in others, or selves	0.60%	4
Optimism	Hopeful for the future	7.80%	56
Pessimism	Expecting more trouble	1.80%	13
Disappointment	Bummed things have gone the way they have	11.80%	85
Appreciation	Glad certain things have already happened	5.50%	40

Fig. 1. Original creativity assignment

This analysis led to further questions and served as the motivation for further study. Since students showed a significant number of responses that could be classified as positive or optimistic, was there an underlying level of happiness within this cohort? In other words, were these students happy regardless of circumstances? Was there a way to assess a level and a trajectory of happiness as a construct? Some responses also alluded to a sense of growth mindset, where students expressed that they thought they could grow from this experience. Further questions to a relation between happiness and fixed-vs.-growth mindset emerged.

III. THE SUBJECTIVE HAPPINESS SCALE

The Subjective Happiness Scale (SHS) is a 4-item scale measuring happiness which has been shown to have high internal consistency and excellent reliability. Two of the four items describe characteristics of happiness and unhappiness, and ask students to consider their happiness according to these descriptions, representing absolute happiness. The other two items ask students to consider their happiness relative to others, or a measure of relative happiness [11].

The items in the SHS include:

Absolute questions:

- In general, I consider myself to be a happy person
- I consider myself to be more happy than most of my peers

Relative questions:

- Some people are generally very happy. They enjoy life regardless of what's going on, getting the most out of everything. This describes me.
- Some people are generally not very happy. Although they are not depressed, they never seem as happy as they might be. This describes me.

The goal was to include these quantitative measures in a standard survey to establish a baseline of a measurement of undergraduate engineering student happiness [12-14]. These questions were included in an instrument designed to assess multiple noncognitive attributes (including mindset), to be administered to all engineering students in a small, private institution in the Midwest.

IV. SETTING

The setting for the quantitative study is a private teaching institution in the Midwest with an overall student population of approximately 5,000. The school of engineering was established about five years prior and has around 200 students - all of whom participate in design activities each year. The School of Engineering also has computer science students, who participate in their first and final years. All design courses in the sophomore, junior, and senior years have either external clients or mentors, and are focused on a design process model involving client interviews, research, more traditional project development, fabrication and testing. The survey was administered to all students through the school's LMS and was not tied to any course or instructor.

V. SURVEY: INCLUDING SUBJECTIVE HAPPINESS & GROWTH MINDSET

A survey was designed to assess a number of affective characteristics among engineering students. It is a combination of multiple protocols, including a fixed vs. growth mindset survey [15-17], the Subjective Happiness Scale, and the Big Five scale [18, 19]. The mindset survey, colloquially referred to as the Dweck instrument, originally consisted of a 24-question instrument, and has been over the past decade reduced down to a 16-question instrument. All questions were on a Likert scale, where Strongly Agree was 1, Strongly disagree was 6. Note that 'neutral' was not a choice. The quadrants of the instrument include positive- and negative-framed questions on the plasticity (or rigidity) of talent and intelligence from the student's perspective. The Big Five Inventory scale is described by Goldberg's seminal work [20] and adapted by John [21]. This instrument contains 44 questions on a 5-point Likert scale with a neutral option, with sections related to the Big Five personality traits: extraversion; agreeableness; conscientiousness; neuroticism; and openness. The analysis focused on scales to assess happiness and mindset (as specified by the research questions).

The survey was administered within the first week of classes (pre), at the end of the first semester (mid) and at the end of the year during the week prior to final exams (post). The survey and administration of the survey were IRB approved.

VI. RESULTS

The survey was issued to all undergraduate engineering students at a small, private, urban university early in the first semester of the 2021-2022 academic year (pre), at the end of the first semester (mid), and at the end of the academic year (post).

The pre survey had 43 respondents (n=43, 72% male, 30% female, 4% other), while the mid survey had 24 responses (n=24, 63% male, 33% female, 4% other). The pre-survey featured the bulk of responses from students in their first and fourth years of study (44% and 27% respectfully). The number in the first year decreased in the mid with a majority of responses coming from seniors (58%). The post survey only had 7 respondents who completed the survey, perhaps due to timing and survey fatigue (as the post-survey was released at the same time as end-of-semester course evaluations).

Given the large body of work documenting the propensity for decreases in affective characteristics of engineering students through the academic year, we hypothesized that we would see a decrease in happiness over the semester, then over the year.

A. Happiness Results

The change in means from the pre to the mid are shown in Table 2. Note that a positive difference indicates a shift toward 'strongly disagree'. Overall, we saw little to no change at all in the items asking students if they consider themselves to be a happy person.

TABLE 2: DIFFERENCES IN SHS, PRE- TO MID- YEAR
(POSITIVE NUMBERS INDICATE A SHIFT TOWARD “STRONGLY DISAGREE”)

SHS item (question)	Diff <i>mid-pre</i>
In general, I consider myself to be a happy person	0.00
I consider myself to be more happy than most of my peers	-0.15
Some people are generally very happy. They enjoy life regardless of what's going on, getting the most out of everything. This describes me.	-0.42
Some people are generally not very happy. Although they are not depressed, they never seem as happy as they might be. This describes me.	0.43

The largest changes between the pre and mid implementations were contained in questions that involved *comparing* themselves to their peers, or the items assessing *relative happiness*. There was essentially no change over the first semester of study (in the means) of questions on absolute happiness.

The authors are also interested in a comparison between any change in happiness level and fixed vs. growth mindset. We saw a very similar pattern in questions on mindset, with little to no change in the overall constructs (Fixed mindset: a change of 0.00. Growth mindset: change of 0.02). However, when looking at specific questions, we saw a change toward disagreement in:

- You can learn new things, but you can't really change your basic intelligence (magnitude of change = 0.5)
- You have a certain amount of intelligence, and you really can't do much to change it. (0.38)

And toward agreement in:

- You have a certain amount of talent, and you can't really do much to change it. (0.33)
- Your talent in an area is something about you that you can't change very much. (0.37)
- To be honest, you can't really change how much talent you have. (0.36)

The authors hypothesize that this may indicate a move toward a belief that you can't change your level of intelligence or talent, but still with a propensity toward a growth mindset, as shown in the literature. The data in this case was insufficient to draw any further conclusions.

The lack of responses in the end-of-year survey did not allow a comparison to the prior data and is not included in the analysis.

It does bring up potential biases which must be acknowledged. This initial implementation of the survey obviously faced participant attrition as the numbers of responses decreased. Further, the nature of the questions leads to issues of participation bias, where those taking the survey anticipate the answers they believe the researchers would like to see. We included statements that the responses were anonymous and that

negative and positive responses were all equally valid to attempt to overcome participation bias.

VII. CONCLUSIONS AND FUTURE WORK

The original qualitative assignment, based on assessing student engagement and general feelings at the beginning of the COVID pandemic led us to questions on student happiness in general. This work was an initial attempt to measure happiness using a validated scale, and an initial investigation on whether happiness was related to a fixed vs growth mindset.

Overall, students appeared to self-assess themselves as happy to start the academic year, with a slight indication that happiness, relative to happiness of others, may be decreasing in the first semester. Post data was inconclusive (due to a small number of responses) to determine if this shift persists throughout the year.

As this area of study is relatively new to engineering students, the authors believe this should establish a baseline by which further investigation into student happiness may be investigated.

Further work remains in a complete picture of the trajectory of student happiness over the course of the year, and whether there is a relation between happiness and fixed/growth mindset, or other noncognitive attributes.

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