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BOARD # 383: Investigating the development and manifestation of engineering students' conceptualizations of well-being in engineering programs and careers

Dr. Justin Charles Major, Rowan University

Dr. Justin C. Major (they/them) is an Assistant Professor of Experiential Engineering Education at Rowan University where they leads ASPIRE Lab (Advancing Student Pathways through Inequality Research in Engineering). Justin's research focuses on low-income students, engineering belonging and marginalization mechanisms, adverse childhood experiences, and feminist approaches to EER, and connects these topics to broader understandings of student success in engineering. Justin completed their Ph.D. in Engineering Education ('22) and M.S. in Aeronautics and Astronautics ('21) at Purdue University, and two B.S. in Mechanical Engineering and Secondary Mathematics Education at the University of Nevada, Reno ('17). Atop their education, Justin is a previous NSF Graduate Research Fellow and has won over a dozen awards for research, service, and activism related to marginalized communities, including the 2020 ASEE ERM Division Best Diversity Paper for their work on test anxiety. As a previous homeless and food-insecure student, Justin is eager to challenge and change engineering engineering education to be a pathway for socioeconomic mobility and broader systemic improvement rather than an additional barrier.

Dr. Karin Jensen, University of Michigan

Karin Jensen, Ph.D. (she/her) is an assistant professor in biomedical engineering and engineering education research at the University of Michigan. Her research interests include mental health and wellness, engineering student career pathways, and engagement of engineering faculty in engineering education research.

Kailey Nicole Head, University of Michigan
Sowmya Panuganti, Purdue Engineering Education

Sowmya Panuganti is a graduate student at Purdue University in the Engineering Education department. She is passionate about understanding engineering culture and the effects it has on engineers' mental health and well-being.

Ash Quadd, Rowan University

Investigating the development and manifestation of engineering students' conceptualizations of well-being in engineering programs and careers

Abstract
This paper describes a multi-institutional research project funded by the National Science Foundation Directorate for STEM Education under Awards #24000607/2400608. Our five-year project explores how undergraduate engineering students (UES) conceptualize well-being in their programs and careers. With over 75% of college students experiencing moderate to severe psychological distress and 60% meeting criteria for mental health diagnoses, addressing mental health in engineering is critical. UES often describe stress as a "necessity," reflecting harmful cultural narratives that discourage well-being and help-seeking behaviors. Launched in 2024, our project examines how UES' perceptions of well-being influence their career decisions.

Project Introduction & Background

Worsening student mental health and well-being is a crisis that needs urgent attention to support student wellness and the growth of the engineering workforce. Recent studies have identified that more than 75% of college students experience moderate to severe psychological distress and that more than 60% meet the criteria for one or more mental health diagnoses [1]. Academically, un- or under-treated mental health problems are linked to diminished performance [2], stress is a top reason students cite for "stopping out," or leaving, degree programs [3]. Even more concerning, studies have shown that suicide is the second leading cause of death of college students (~1.1k lives/year). Issues are well-presented in engineering. UES have suggested that stress is a "necessity," demonstrating how harmful engineering cultures create pervasive narratives against well-being [4]. Culture has also been shown to have a repeated effect on UES help-seeking behaviors and faculty support of mental health [5]. We believe that novel mental health investigations are needed to support UES development. We wonder whether UES' thinking regarding mental health and well-being is connected to the choices they make about their careers.

Engineering educators want, and need, to develop graduates with the knowledge, skills, and abilities necessary to take on Grand Challenges [6]. This development is instrumental to ongoing efforts to develop an adequately sized and prepared STEM workforce [7]. To support these goals, graduates must be prepared to significantly impact their local and national communities [8]. To develop intellectually prepared graduates properly, engineering education must understand how UES experience engineering physically and emotionally [9], how UES see themselves in the future [10], and finally, how their future perceptions are linked to their present perceptions.

Previous research with UES has quantitatively measured mental health dimensions along with engineering identity and perceptions of inclusion in undergraduate engineering programs [9], [11], differences in prevalence of mental health conditions between disciplines [12], help-seeking behaviors [13], the influence of the COVID-19 pandemic on stress and coping [14], and stigma associated with mental health help-seeking. In a recent study, Beddoes and Danowitz [14] described high-stress cultures as leading to the "normalization and trivialization of mental health challenges" [pp. 4] in which the widespread prevalence of stress effects results in the perception of mental health issues as "unimportant." This scholarship has contributed to our understanding of UES mental health and help-seeking behaviors, however, we find that an understudied topic that remains is 1) how UES conceptualize well-being and 2) how these conceptualizations impact their career decision-making processes. We posit that both facets of UES well-being are critical in developing the workforce and proactively addressing the mental health crisis.

Theoretical Frameworks

Our framing combines well-being, social cognitive career theory (SCCT), and engineering culture to robustly investigate our RQs. We hypothesize that UES make career decisions with their present and future well-being conceptualizations in mind, specifically, that decisions about one's career and well-being happen together. We further hypothesize that culture mediates these decisions, which may be the root cause for why UES feel they must consider both together at all. We consider the following theoretical underpinnings to guide our thinking:

- *Engineering Thriving* is the process by which UES develop a state of "optimal functioning" in engineering [pp. 20, 2], what we refer to as UES' state of feeling good and doing good [15].
- *Social Cognitive Career Theory (SCCT)* describes how various inputs, contextual factors, and behaviors drive individuals' career decision-making processes [16]. We hypothesize that development happens in tandem with one's development thriving.
- *Engineering Culture, d*eveloped from Schein's [17] cultural framework by Godfrey & Parker [18], describes six dimensions of culture specific to engineering. It describes understandings, values, and assumptions shared by engineering faculty, staff, and UES.

Project Goals, Purpose, and Research Questions

We posit that understanding how culture, well-being, and career decision-making manifest and develop together could help us develop pedagogical, cultural, or structural changes that support developing engineers long-term as it refers to the creation of a culture of thriving. We believe that an enhanced understanding of well-being in engineering will support UES's recruitment, retention, and success, leading to a broadened workforce prepared to take on existent and emerging challenges [6], [7]. Our project seeks to understand how UES' well-being perceptions influence personal and professional formation over time. We seek to meet the following aims:

- *Aim 1*: Identify how UES form their conceptualizations of well-being.
- *Aim 2*: Connect UES' well-being conceptualizations to their personal and professional goals.
- *Aim 3*: Identify how UES' well-being conceptualizations & career trajectories change.

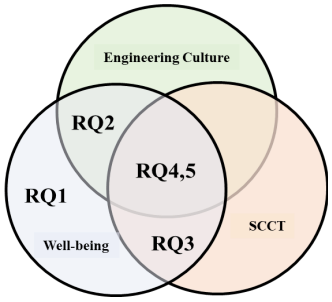

Figure 1: Theoretical framework combining underpinnings of well-being, SCCT, and engineering culture.

Overall RQ: How do UES' understandings of well-being influence their personal and professional formation?

RQ1: How do UES' conceptualize well-being as it relates to engineering learning and professional practice?

RQ2: How do UES come to form their conceptions of well-being as they relate to engineering learning and professional practice? What are important factors and experiences that influence the development of these conceptualizations for UES?

RQ3: How do UES see their conceptualizations of well-being being a part of their future personal and professional goals, if at all?

RQ4: How do UES conceptualizations of well-being impact their career decision-making process?

RQ5: How do UES' conceptualizations of well-being and their personal and professional trajectory change over time?

Methods

Our project contains a five-year sequential exploratory mixed-methods project (Figure 2). The project is made up of a large qualitative, and a small exploratory quantitative, component.

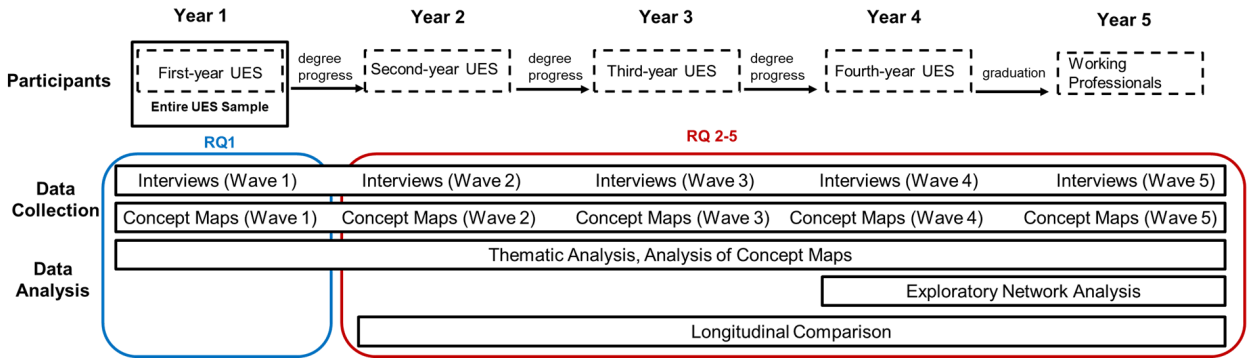

Figure 2. A representation of our five-year longitudinal research project.

Recruitment - Our qualitative component comprises five years. Amongst this component, we are first video interviewing 55 UES ages 18+ across levels and two institutions to identify what UES' conceptualizations of well-being and their future career are, and how they developed those beliefs. To recruit an initial pool of UES large enough to choose from, we are distributing a recruitment message across both institutions. Prospective UES are asked to complete a short interest survey containing nuanced demographic questions. We are using a stratified sampling approach to choose a diverse sample from that pool. Of the total 55 planned interviews, 25 UES are first-year (supporting attrition), the remaining 30 will be split across the second through fourth years. Participants are being offered a $25 gift card for each interview ($10 additional for member-checking), an extra $100 will be provided to participants who complete all five phases.

Data Collection - Our project relies on a 60-120 minute semi-structured video interview approach that we repeat each wave. Following Year 1, we will follow a subset of 25 the 55 first-year UES longitudinally for another four years (Years/Waves 2-5), into their first work position, clarifying initial findings, and identifying how their conceptualizations grow and change in regard to engineering culture. In each interview, we will ask UES about the following features: (1) their goals, (2) their mental health in and out of engineering, (3) their attitudes as they relate to their goals and mental health, and (5) their experiences and beliefs surrounding engineering culture and context and the ways in which both has shaped their goal orientations and their (un)embedded beliefs about well-being. All interviews will be video recorded and their audio transcribed. Transcripts of the audio will be further checked for accuracy by the research team, and member-checked by participants. We are also engaging UES in the development of a concept map as part of the interview process, supporting their thinking and our analysis. Concept maps are a visual representation of one's thought process, typically including words and phrases in a hierarchy of connecting lines and words [19]. As UES describe their definitions and experiences amongst interviews, we will have them map their thoughts.

Data Analysis and Mixing - Qualitative data will be analyzed using thematic analysis [20]. We will listen/watch audio/video, review concept maps, and read transcripts. Guided by Saldaña [21] we will search for codes that describe features related to our theoretical framing, and additional emergent ones. During the coding process, we will search for themes across codes, adjust them iteratively, and define them, allowing us to share a thick, rich analysis of findings. As a final step, we will explore our data using network analysis to study UES-generated concept maps and changes over time. We will mix this quantitative analysis with our qualitative analyses. This component of our analysis will be developed further throughout our five-year project.

Preliminary Year 1 Results

As of January 2025, we have completed all recruiting surveys and conducted 13 semi-structured interviews with first-year UES. Some example concept maps from two participants are shown below in Figure 3. While formal thematic analysis has not commenced, we have identified, and present, two interesting trends: 1) people and past experiences play an important role in UES conceptualizations of mental health in and out of engineering, and 2) forward thinking regarding mental health varies across students and reflects the depth to which they have thought about their future career. Further interviewing and analysis is needed to develop more formalized themes.

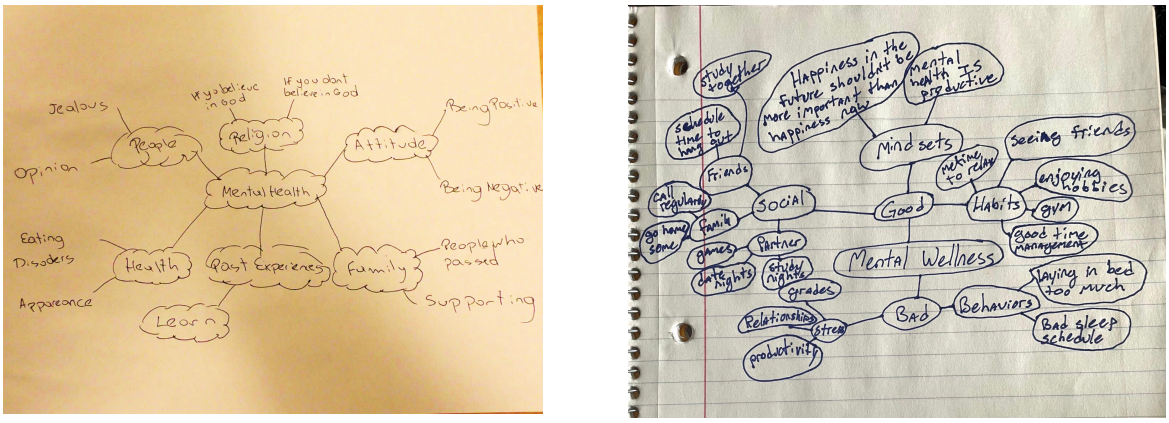

Figure 3. Example concept maps from two of 25 first-year UES (Andreas [left], Lucy [right]).

Conclusions & Implications

Ongoing work for the project team includes longitudinal interviews in Years 1-5 (Figure 2) and continued data analysis of transcripts and concept maps. The longitudinal design will provide opportunities for comparisons over time, both of interview themes and concept maps.

Our work supports broader salutogenic conversations surrounding human development and thriving amongst the many areas of human life. When people thrive, they are more likely to be successful in other avenues of everyday life (e.g., education) leading to broader potential to contribute to the economic and social well-being of their fellow humans. We imagine that our findings will contribute to understanding of UES mental health alone and in relation to career development through the sharing of research and pedagogical outcomes, leading to better UES thriving. We expect that UES who are better able to thrive amidst their engineering trajectory are more likely to continue into engineering careers and will be more likely to contribute to the solution of Grand Challenges of Engineering. Ultimately, improving UES well-being, including through engineering faculty awareness, will support well-being initiatives in higher education more broadly, including for graduate students, postdoctoral scholars, staff, and faculty. Changing the narrative from a necessity of high stress in engineering to one of well-being will create an inclusive academic environment where all can thrive. Challenging engineering's culture of hardship may also help recruit and retain UES and change public opinions of engineering.

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