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WIP: Assessing the impacts of engineering educators' self-determination on student learning experiences and outcomes

Dr. Shaylin N Williams, University of Virginia

Shaylin Williams is invested in identifying ways to improve the engineering education experience for future generations of engineers. She is a native of Natchez, Mississippi. As a McNair Scholar at the University of Mississippi, she worked on various chemical engineering projects. Additionally, she completed an REU in healthcare engineering at the University of Wisconsin- Madison. Shaylin earned a master's degree in industrial and systems Engineering and Ph.D. in Engineering Education at Mississippi State University. Her research used Self Determination Theory to analyze Summer Bridge students' experiences and senior engineering students' graduation plans. She also researched how different first-year structures affect students' engineering identities and involvement in communities of practice over time. Shaylin joined the University of Virginia in July 2023 and serves as an assistant professor and academic advisor in the First Year Engineering Center. She maintains interests in learning more about what contributes to engineering students' success, how they can get the most out of their undergraduate programs, and how programs can be better designed to cater to students' needs.

WIP: Assessing the impacts of engineering educators' self-determination on student learning experiences and outcomes

Overview

This study is geared toward gathering information regarding the self-determination levels of engineering educators. Using Self-Determination Theory (SDT) as a guide and lens, two surveys were developed and distributed to engineering educators and their students to determine whether the educators' SDT scores and backgrounds significantly impacted students' classroom experiences.

Research Questions

1. To what extent are engineering educators' basic psychological needs met within the workplace at an R1 institution?
    a. Does an educator's self-determination and teaching background impact students' learning experiences and outcomes?

Purpose Statement

The current study intends to examine the potential intersection between engineering educators' reported levels of needs satisfaction in higher education and students' reported outcomes and formal learning experiences in engineering summer courses. This research will fill a gap uncovered by a literature survey that mainly consisted of a student-focused research approach—rather than also focusing on faculty self-determination—as well as a previous, extensive review conducted by engineering education researchers.

Situating the Study

<u>Non-STEM Lenses: Blurring Disciplinary Boundaries</u>

Engineering is a long-standing field with persistent problems that can be better informed by the conceptual lenses of non-STEM frameworks. While engineering professors are often deemed experts in their niche areas of technical research, understanding and devoting attention to the intricacies of effectively working with students at institutions of higher learning is a distinct feat.

The guiding framework used in this study, Self-Determination Theory (SDT), was developed by psychologists, Ryan and Deci [1]. It emerged to challenge the widely accepted belief that the best way to encourage people to perform tasks was through reinforcing their behavior with rewards. The broad framework posits that humans are motivated based on the degree to which three primary psychological needs are fulfilled: autonomy, competence, and relatedness [2]. It is important to note that self-determination for a single person can vary across contexts. For instance, a high school student may feel that the extent to which each of these needs are met in a trigonometry class differs from how they are met in the context of their track and field team practice. SDT, along with its many validated metrics and extensive body of scholarly work, will serve as a valuable lens for viewing and assessing engineering education-focused research questions.

In practice, SDT has provided evidence of how to effectively assess and improve the motivation of teachers, students, employees, athletes, and parents, among other groups of people [3], [4], [5]. Specific scales were developed for various contexts, and evidence-based practices such as "goal-striving" in coaching, psychotherapy interventions, and motivational interviewing have been adopted across fields [6], [7].

Systemic Issues Impacting Engineering Education

Engineering started as a discipline exclusive to military personnel [8]. Unsurprisingly, the field has been primarily dominated by White males since its beginnings. In contemporary higher education, the student population has become, and continues to grow, increasingly diverse [9], [10]. Many engineering programs still have trouble recruiting and retaining diverse students. Furthermore, once students are recruited, the engineering faculty makeup they encounter is often not representative of the student body [11].

This problem is not one-sided. The recruitment and retention of a diverse faculty body within engineering schools is as important as the student-centered crisis [12], [13]. Due to these long-standing issues, engineering schools are always in search of ways to continue to diversify both their faculty and student populations. However, faculty experiences are not as widely researched and discussed as the experiences of the students they work with. Further inquiry into the perceptions, experiences, and satisfaction of faculty can provide insight on how to better support and attract them. In turn, this will help engineering leaders better strategize for the recruitment and retention of the type of faculty makeup they envision as being representative of their schools and students. When more attention is given to faculty and their experiences, engineering schools will better understand how to foster the best environment for them, allowing them to show up as their best selves for students.

SDT in Engineering Education: Progression Through Combining Concepts

Self-Determination Theory can help us gauge and better understand whether engineering educators' basic psychological needs are being met in the workplace. Engineering education researchers have previously investigated how SDT may inform ways to promote students' intrinsic motivation to learn in formal engineering courses [14]. Additionally, educators have undergone professional training related to SDT and aimed to connect the theory's principles to the traditional ways of teaching design thinking [15]. The overall landscape of the literature pertaining to SDT's adoption in engineering is useful for providing evidence of increasing engineering students' motivation to learn and engage in educational settings [16], [17]. A systematic review by Brown and colleagues posed helpful suggestions for increasing the understanding of motivation in engineering disciples [18]. In alignment with prior suggestions and building upon the work of previous engineering education researchers who used SDT as a lens, the current study will employ SDT with a focus on engineering educators. More specifically, this paper details how focusing on educators' need satisfaction levels may provide insight into students' experiences and outcomes which can affect student retention and motivation.

The pressing and increasingly complex needs that persist in engineering education cannot be solved by using tunnel vision. Engineering education research with aims similar to the ones in this study allows us to gather invaluable information regarding the experiences of educators and students and assess how they play a role in improving teaching and learning for all. Frameworks

like SDT can provide rich data about motivation and the dynamics of teaching and learning in STEM.

Engineering research must continue to move further from deficit-based approaches and theories, which tend to frame students as lacking some necessity to perform well in higher education, and in engineering more specifically [19], [20]. In doing so, researchers will be able to discover actual root causes of discrepancies in teaching and learning and work collaboratively to develop action plans for improvement.

The present study's focus on assessing faculty experiences and motivation will allow the research to organically tell a story about how teaching and learning can improve for all involved parties. Starting on a small scale and analyzing whether engineering educators at the host institution feel their needs are met in the context of their teaching roles will serve as a critical point for better understanding teaching motivation, impacts on students, and the teaching and learning environments that will either attract or deter future students and faculty.

Method

The protocol for this study was reviewed and approved by the Institutional Review Board (IRB). The protocol included pre-written email prompts used to recruit participants. After a support letter was received from the engineering dean's office, educator emails were extracted from an online database. The research team prepared 2 Qualtrics surveys- one for engineering educators and one for engineering students. The educators and students were all involved in various engineering courses at an R1 institution during the summer of 2024.

The SDT instruments used within the Qualtrics survey designed to assess educator self-determination were the Work Climate Questionnaire (WCQ) and the Basic Psychological Need Satisfaction at Work Scale (BSNSS-Work). The educators' survey consisted of the following: 1 informed consent question, 3 general eligibility questions, 3 demographic questions, 7 teaching background questions, 15 Likert-scale questions from the WCQ (ranging from strongly disagree to strongly agree), 21 Likert-scale questions from the BSNSS-Work, and 1 optional open-ended feedback question. The survey took approximately 10 minutes to complete, and participants were able to withdraw at any time, without penalty. The survey for the engineering educators was distributed via Qualtrics email on July 8, 2024, and closed on July 15, 2024. Reminder emails were sent on July 10, 2024, and July 12, 2024.

Students who took the educators' courses were asked to complete a survey including general questions about their performance range, their experiences in the learning environment, and the overall educator-student relationship dynamics. They were also provided space to leave any additional qualitative feedback. The students' survey consisted of the following: 1 informed consent question, 4 general eligibility questions, 1 question about grades, 6 Likert-scale questions focused on general outcomes, 15 Likert-scale questions from the SDT Learning Climate Questionnaire (LCQ), 1 student experience question, and 1 optional open-ended feedback question. The survey took approximately 8 minutes to complete, and participants were able to withdraw at any time, without penalty. The survey for the students was distributed via Qualtrics email on August 8, 2024, and closed on August 16, 2024. a. Reminder emails were sent on August 12, 2024, and August 14, 2024.

Preliminary Data

The engineering educator survey was sent to a total of 32 faculty members, and 8 surveys were fully completed, resulting in a 25% response rate. The engineering student survey was distributed to 310 students who were registered for summer courses in the School of Engineering and Applied Sciences. Of the 310, 58 students began the survey, and 44 finished it. This resulted in an overall response rate of 19% and a completion rate of about 76 percent.

Preliminary analyses of the educators' responses serve as a basis to understand the general makeup of the relatively small sample. Among the 8 educators who completed the survey, 5 were White, and 3 were Asian. The reported gender profile was 3 males and 5 females. Five of the 8 educators were first-generation college students. All the respondents except one reported gaining teaching experience while they were either an undergraduate or graduate student. Of the seven who had teaching experience, 4 served as the primary instructor of record, 2 assisted the primary instructor, and 1 served in both primary and supporting roles.

Likewise, preliminary analyses of the engineering students' responses allow for a clearer understanding of the sample that will soon be connected to the educators' responses. Of the 44 students who completed the survey in its entirety, 23 were White (52%), 15 were Asian (34%), 6 were African American or Black (14%), 3 were Hispanic or Latino (7%), 3 reported being two or more of the ethnicities listed (7%), and 1 reported being an ethnicity that was not listed – North African/Middle Eastern (2%). Twenty-six students were male (59%), 17 were female (39%), and 1 was non-binary (2%). Within the student sample, 17 were first-generation college students (39%) and 27 were not (61%).

Next Steps: Analyses

Initially, the research team planned to complete statistical analyses such as chi-squared to determine if significant differences in self-determination levels existed for specific sub-groups of educators. Due to the small sample size resulting from the engineering educators' surveys, quantitative methods.

1. Next, students' survey responses will be linked and compared to the responses of the educators whose summer engineering course(s) they took.
2. Descriptive statistics and qualitative findings will be aggregated to determine if trends and/or correlations are present between educators' self-determination in the context of teaching and their work environments and students' performance and learning experiences within the educator's class.
3. The data analyses will be followed by a deeper dive toward interpreting and discussing how the results, along with the guiding framework, may serve as a foundation for creating intentional strategies and suggestions for increasing the recruitment and retention of diverse faculty and student populations in engineering.

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