Engineering Doctoral Students' Motivations and Identities: Understandings and Implications

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Engineering Doctoral Students' Motivations and Identities: Findings and Implications

Project Overview

The goal of this project is to improve the understanding of how graduate student experiences influence engineering identity formation and goal setting processes. Engineering identity and motivational goal setting processes have been shown to be important factors for undergraduate student participation in engineering communities of practice [1]–[6] but have not been applied to engineering graduate communities. Through a mixed methods approach, this study will investigate graduate student motivational goal setting and identity formation to answer the following research questions:

RQ1: What are the identity and motivation profiles of engineering doctoral students, which are based on previous academic and research experiences in STEM?

RQ2: How does the STEM community influence identity formation and motivational goal setting processes of engineering doctoral students?

RQ3: How do goal setting processes related to identity formation and motivation influence engineering graduate student retention, productivity, and pursuit of doctoral level engineering careers?

Results of this study will inform programmatic decisions in engineering graduate programs and facilitate targeted interventions that promote motivation and identity development of students. This work also aims to shape graduate education best practices for recruitment, retention, and training in engineering disciplines.

Project Motivation

The significant, positive impact of federal funding mechanisms on engineering doctoral research training programs is clear on the development of graduate students. On the contrary, engineering doctoral degree granting institutions and departments have been slow to make programmatic decisions informed by evidence derived from rigorous engineering education research. Additionally, engineering is one of the least studied fields in the realm of graduate education, and if studied, is often combined with other STEM disciplines, in spite of unique disciplinary cultures [7], [8]. This lack of research-driven innovation has potential to marginalize students who do not thrive in more traditionally established engineering graduate communities and has created a community with reported attrition rates as high as 50% [9], [10]. As the demand for creative engineering solutions increases, there is a pressing need to promote doctoral training environments that foster a desire to achieve metrics of success in academics and research, persist to graduation, and ultimately seek a permanent position as an engineer. To address this issue, we seek to understand the influence of past and present student experiences on their engineering identity formation and motivation-based goal setting processes, which have been shown to be

important factors for undergraduate student participation in engineering communities of practice [2], [4]–[6], [11], [12], but have not yet been applied to engineering doctoral communities.

Overview of Results

Qualitative Exploration of Engineering Doctoral Experiences

The initial, qualitative phase (Phase 1) of the project, was completed during the Fall 2016 semester. During Year 1, we recruited Ph.D. students (n=46) in engineering programs to participate in focus groups and interviews about their graduate-level academic and research experiences. To complete Phase 1, interview transcripts were analyzed during Year 2 using an Interpretative Phenomenological Analysis (IPA) approach [13], [14]. The goal of the analysis was to understand the lived engineering experiences of the students and the meaning found in these experiences within the context of the project's focus on identity and motivation. An IPA approach allows connections between graduate experiences and student affective domain traits that are complex and may not be readily visible to students. The results of this work have also begun to address RQ3 through student discussions about experiences within graduate programs and with faculty and about concerns of balancing multiple identities. The results of Phase 1 of the project have been previously described in [15]–[17]. In brief, results indicated that engineering graduate students draw on a higher number of identities when navigating their doctoral experiences when compared with undergraduates [17], leverage the past and the future when making decisions for the present [16], and seek ways to integrate their identities into their research projects and graduate experiences [15].

Quantitative Instrument Development and Deployment

In addition to describing the experiences of students and identifying key themes and features of these experiences, results from IPA analysis informed item development for a quantitative instrument. We developed novel Likert-type survey measures of graduate student future time perspectives, identities, identity based motivations, and experiences to begin establishing items that reflect graduate student experiences. Specifically, items incorporated novel elements of students' future time perspectives including student conceptualizations of near and far futures, additional identities including researcher identity, and student-advisor experiences. Consultation with field experts in each of these areas led to further refinement of newly developed items. Additional items were pulled from existing instruments [3], [6], [18]–[20] to supplement newly generated items. Three separate pilot instruments were developed in Qualtrics with questions framed by Identity, Future Time Perspective, and Identity-Based Motivation frameworks and findings.

Pilot surveys were distributed to students at a southeastern and western university with a goal of approximately 100 responses per survey to run exploratory factor analysis to determine the factor structure for each instrument. Across the three surveys, 477 responses were collected. Of these responses, 167 were from the Future Time Perspective survey, 144 from the Identity Survey, and 166 from the Identity-Based Motivation survey. Following pilot data collection, we conducted initial exploratory and confirmatory factor analyses to assist with survey validation as well as the item cutting/streamlining process. In brief, results indicated similar factor structures for the identity constructs for engineering graduate students as have been documented with undergraduate students [3]. For the domain general constructs of FTP, distance and speed loaded

similarly to the structures provided in [6] and [18] while clarity of the future loaded similar to [20]. As the context specific questions related to a graduate context rather than undergraduate contexts in past studies, the constructs loaded in the EFA reflected the findings from our qualitative study [16]. Additionally, we found that the engineering graduate students differentiated between endogenous and exogenous task usefulness constructs, but exogenous task usefulness constructs split further into two categories. Identity-Based Motivation results indicated that scientist, researcher, and engineer identities were salient for students across a variety of graduate-level tasks, with a few 'student' items (e.g., attending class, completing homework) clustering together and suggesting a salient student identity that was separate from the others.

Results of exploratory factor analyses led to a further reduction of survey items through items that either did not load or were cross-loaded with other items. The remaining items were then further discussed amongst the research team for importance in addressing the research questions, and those of reduced importance were cut. The final survey was then compiled into a singular instrument and deployed to a national sample of engineering graduate students [21]. The sample consisted of 253 engineering doctoral degree granting programs that were selected to create a nationally representative sample. To date (February 2018), 859 engineering graduate students have taken the survey, and programs are continuing to be recruited along with participants.

Contributions of this Work

This work is beginning to:

- further researchers' understanding in a new domain – specifically, how graduate engineering students develop engineering identities and motivations for continued participation in STEM.
- open the conversation about how we teach and train graduate engineers and how we develop engineering faculty to work with graduate engineering students.
- employ innovative research methods including analytic approaches to quantitative analysis and advanced qualitative techniques to analyze interviews and focus groups.
- shape the interpretation and understanding of motivation and identity theories in graduate education. The blending of theoretical perspectives has generated new understanding within the educational psychology and engineering education research communities.

One long-term benefit of this research project will be an improved understanding of how engineering graduate students navigate their development of engineering identities and motivational goals. Thus, the results can be used to improve the effectiveness of training students and faculty on how to work in and be successful in engineering graduate programs. Results of this work can inform what to teach and how to teach these topics to improve student attitudes and pedagogical practices within engineering. Such efforts may, therefore, improve the development, inclusion, and production of the next generation of engineering practitioners.

Future Work

Responses from the national survey data will be used to build a topological data analysis [22] of student attitudinal profiles based on past and present STEM-related experiences, motivations, and identities. It will also highlight doctoral-level experiences that are related positively and

negatively to attitudinal profile development. In Phase 3 (qualitative), a small sample of doctoral students from various attitudinal profiles identified in Phase 2 will be recruited for follow-up interviews.

In addition to these phase-specific deliverables, results from this project suggest a need to better explore and understand how faculty advisors influence and direct student identity development. Preliminary results indicate that students differentiate between researcher, scientist, and engineer identities qualitatively and quantitatively, but that these identities are separate from the salient identity activated when completing student-type tasks. As such, items developed in this work can be used to craft a framework for understanding graduate student experiences, but future refinement may be necessary to fully capture students' transitions from undergraduate to graduate education. While the results of this study speak to graduate students holistically, further work is needed to understand how the different sub-populations (e.g., underrepresented minorities, international students) that exist within engineering graduate programs experience graduate education.

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