2023 Annual Conference & Exposition
Baltimore Convention Center, MD | June 25 - 28, 2023
The Harbor of Engineering
Education for 130 Years
ASEE
Paper ID #37437

Work in Progress: Impacts of Engineering-Adjacent Participation On Identity and Motivation in Engineering

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WIP: Impacts of engineering-adjacent participation on student motivation in engineering

This work-in-progress research paper describes emerging work exploring connections between students' participation in "engineering-adjacent" activities outside of class and their motivation to pursue goals. In this study, we define engineering-adjacent activities as those activities that are not typically seen as "engineering" by engineering culture and curriculum (in opposition to accepted activities such as engineering club participation, engineering service, etc.), but that students identify as connected to their goals in engineering. Examples of these activities could include students' participation in competitive or recreational sports, artistic hobbies, and other leisure-based activities, though nearly any activity could be identified in this way by a student.

Literature shows that students' participation in on- and off-campus activities influence their sense of belonging and conceptions of themselves as engineers [1], [2]. Amongst these activities, students are exposed and integrated into cultures of engineering that inform and develop their perceptions of who engineers are and what engineers do, which may shape their own process of "engineering becoming" [3]. While many of the activities students engage in are directly connected to engineering, some activities may be seen as outside or even "engineering-adjacent" [4]. The impact of engineering-adjacent activities on students' motivations are less explored, making them important to study. We are exploring students' participation in these activities and their perceptions of the role these activities have in their motivations towards engineering.

Background

Engineering student motivation is a key attitudinal construct that informs how and why students pursue specific tasks [5]. Motivation includes students' drive or desire in the present to pursue specific outcomes in the future. In the context of engineering, motivation includes students' vision of themselves in future roles that include engineering and considers the roles they hold in the present. Researchers and practitioners can and should support the attitudinal development of students to encourage these connections by improving their engineering curriculum design or developing out-of-class programming, as students who make connections between their present and future goals are more likely to achieve success in engineering [1], [5], [6].

There are many theories that explore motivation. In this work, we focus on Future Time Perspective (FTP) [7]–[9], a motivation framework that provides a lens to understand how students might make connections between their current activities, motivations, and goals. The following section provides a summary of how FTP was used to inform our work.

Future Time Perspective (FTP) – FTP [7] describes students' perceptions of the future and accounts for their goals, present actions and their perceived usefulness, and the connectedness of the two. The theory posits that students' ability to make connections between their present actions and future goals, particularly their ability to identify and pursue steps that will lead them to successful goal attainment, leads to stronger motivation for success. Within engineering, researchers have found that students' FTPs differ and that those differences can be linked to varying levels of academic success [10]. Current FTP research in engineering suggests that students who have more defined FTPs are more likely to see the steps they need to be successful and to find relevance between what they are doing now with their future. FTP was selected as a theoretical lens for our study because the theory allows us to connect students' future goals to the engineering and engineering-adjacent activities they participate in at present.

Study Design

Our institutional review board (IRB) approved study leverages semi-structured interviews and qualitative data analysis to explore nuances among undergraduate engineering students' motivations and their actions. Particulars of our study and our study design are described further.

Study Context – The participants of focus in our study are undergraduate engineering students at a mid-Atlantic R2 Carnegie Classification university enrolled in one of six available engineering majors at the institution (mechanical, civil and environmental, chemical, biomedical, electrical and computer, or engineering entrepreneurship). The population of the institution's engineering program is approximately 34% non-White and 22% non-Male. Across the institution itself, a third of students are first-generation while nearly 44% are identified as "food insecure."

Interview Protocol Development – Our semi-structured interview protocol was developed by adapting our colleagues', Kirn and Benson [5], past work with FTP and engineering student problem-solving behaviors to our own, engineering adjacent activities context. Kirn & Benson found that students' choices in the present, including how they solved engineering problems, were connected to how they thought about their futures. In our study, we wonder whether students' engineering-adjacent participation may also be connected to their FTP development. We anticipate that a majority of Kirn & Benson's interview questions [5], some of which we adapted to our current context while others were added or removed, will help us explore connections between students' current actions and their future goals. To better capture students' actions, we have developed interview questions to guide participants to reflect on their future goals, share their present actions related to involvement in engineering, non-engineering, and engineering adjacent activities, and finally, elicit their understanding of how their goals are connected (or not connected) to the activities they participate in.

Data Collection Plans – We are presently recruiting engineering students to participate in 45-60 minute semi-structured interviews. These students are being recruited through institutional listservs. After a saturation recruitment of 15-20 students, we will purposefully sample a subset of 8-12 students that capture as many academic years and engineering disciplines as possible. Participants will be interviewed by the research team using our protocol. These interviews will be transcribed using the Otter AI platform. Our sample size is appropriate for deductive thematic analysis [11], the qualitative method we describe in the coming section; there are no plans to convert participants' qualitative data to a quantitative format to be used for statistical analysis.

Data Analysis Plans – After transcription, we will conduct thematic analyses using deductive coding [11]. Thematic analysis is a process of coding data and finding themes across codes; deductive coding relies on *a priori* codes. Our initial codebook includes contextually-appropriate *a priori* codes from Kirn & Benson's [5] past work (refer to Table 1). Amongst coding not only will we code our data using *a priori* codes, but we will also allow for the emergence of other codes. Our planned unit of analysis will focus on the student rather than the department or academic year, to ensure that our sample size is sufficient for our study purpose.

Informal Pilot Work & Discussions

At the present time, we have developed the interview protocol that explores students' engineering and engineering-adjacent out-of-class engagement in relation to their future goals. We are currently recruiting undergraduate engineering students for the interview process.

During our Fall 2022 semester study development, six undergraduate students (one senior-level Middle Eastern woman in Civil Engineering; four junior-level and one senior-level White men in Mechanical Engineering; refer to the acknowledgements) at our institution engaged with us as part of a collaborative research experience that is required for their degrees. These students assisted us in the adaptation of our protocol, practiced interviewing each other with the adapted protocol, transcribed those practice interviews, and conducted a preliminary analysis of this practice data for their research experience. From practice interview sessions and discussions with the students, we were able to obtain feedback from the students and further refine the protocol to its present state. Amongst refinement, students developed potential analytical codes (Table 2), adding to those originally developed by Kirn and Benson [5] (refer to Table 1).

Table 1. Preliminary codebook adapted from Kirn and Benson [5].

Codename	**Description**
Future Career	describes attributes or characteristics of their future career
Outcomes of Future Career	describes outcomes of their future career
Steps to Reach Future Goals	describes a series of steps or paths needed to reach a distant future goal. This is also known as "contingent path"
Desired Future	describes what they want to be in the future
Relevance of Future on Goals	describes how their future goals are influencing what they do in the present
Realistic Future	describes what they can realistically do in the future
Ideal Future	describes what they ideally want to do in the future
Past/Present Actions Influence on Future	describes how what they want to do in the present or what they have done in the past influences their goals for the future
Past Experience and Perceptions	describes an experience that occurred in the past or a perception of the present or future that was formed in the past

Emergent codes, which we refer to as *Who Influences* and *Escape/Break*, were prevalent in many of the students practice interviews, prompting their addition to our preliminary codebook (refer to Table 2). *Who Influences* refers to someone who helped our students shape their future goals in and out of engineering, or who encouraged the student to get involved in a particular activity. *Escape/Break* is much more interesting, however. Particularly, amongst our students' discussions, we found that students discussed in detail the stresses and pressures they experienced in engineering, and how those non-engineering or engineering-adjacent activities that they engaged in allowed them to "take a break from engineering" or "think about something besides engineering," as if the activity was a welcome opportunity to escape engineering without necessarily leaving the discipline altogether. We see some initial connections between these codes and other, parallel identity and motivation theories that literature has connected to FTP (see below). We expect to consider these additional codes amongst the actual interviews we will conduct soon. In the meantime, the potential of these theories to this work is described further.

Potential Theoretical Connection: Situated Expectancy Value Theory (SEVT) – SEVT is a motivational theory that describes how academic performance, persistence, and choice are connected to an individual's expectancies and values [12]. According to Eccles and Wigfield [12], there are two key elements to SEVT: expectancies and subjective task values. Expectancies relate to how an individual perceives their competence at being able to complete tasks in either the near or long-term future. This sense of competence can be influenced by a number of factors *including* *feedback the student receives from others*, the student's affective memories, and finally, how the student evaluates their prior performance on tasks. Subjective task values describe the positive or negative value that students associate with meeting or not meeting goals. And are categorized into four main types: (1) attainment (e.g., perceived personal importance of attaining current or future goals), (2) intrinsic (e.g., personal enjoyment or interest in the current or future goals), (3) utility (e.g., perceived usefulness of tasks to current and future goals), and (4) cost (e.g., efforts, opportunities, and emotions at risk amongst one's trajectory towards their future goals). SEVT has prior use within engineering [13]–[18] including through understanding students' desired future engineering careers [13]. The modern model now includes a situated component to reflect that the motivational constructs being measured are impacted by situational "in-the-moment" elements encountered that change and that do not stay stagnant over time [19].

Table 2. Emergent codes developed through informal pilot testing.

Codename	Description
Who Influences	describes a person or persons who impacted or influenced their future plans and/or goals
Escape/Break	describes an activity or something they do that is considered unrelated to engineering that provides them with an escape or a break from engineering coursework and activities

Amongst our emergent codes, we see connections between SEVT and our code *Who Influences*. Particularly, expectancies can be influenced by feedback students receive from others who are involved in their plans and goals [12]. Students who receive feedback from others are more likely to develop stronger goals and connections to those goals, leading to stronger perceptions of expectancy for success. We expect to explore *Who Influences* students in our primary interviews to see how external people play a role in students' motivations (non)inclusive of their engineering-adjacent participation. We believe outside individuals may play a substantial role in students decision-making process regarding engineering and engineering-adjacent participation.

Potential Theoretical Connection: Multiple Identity Theory (MIT) or Identity-Based Motivation (IBM) – We also saw connections between FTP, IBM, and MIT as students navigate and negotiate the different motivating selves they hold simultaneously. We find connections unsurprising given known connections between FTP, SEVT, and Engineering Identity in prior work on IBM by Godwin & Kirn [1]. Engineering identity refers to whether students see themselves as the "kinds of people" that can do engineering informing overall belonging as an engineer, and typically includes their perceived competence to complete engineering tasks, their interests and enjoyment in engineering, and external recognition [6]. That is, when students feel like they can competently complete engineering tasks, and further, are either interested in engineering or feel recognized as engineers by others, they are likely to hold an engineering identity. MIT, however, acknowledges that students may hold many different identities at any given time and that they may sometimes be in conflict for a variety of reasons [20]. For our students, these identities may include personal goals or hobbies (e.g., artist, "sports person").

Relatedly, IBM is a theory first described by Oyserman and Destin [21] which suggests that one's present identity can influence their motivation to complete tasks, or vis-a-versa. Specifically, one's identity in context (e.g., do they see themselves as a specific "kind of person" in the moment) given the specific intrinsic and attainment values of their goals may drive them to enact their own identities as motivational outputs. Similarly, one's sense of motivation may impact whether they see themselves as a person who can do those tasks. Given connections between FTP, SEVT, and identity above, we find value in exploring connections to IBM.

The pertinence of each of the above theories will only be known once we get to our true analysis stage this coming summer, but evidence thus far suggests that each theory could be highly informative. We see identity theories as highly pertinent to this work given our students' discussions of *Escapes/Breaks* from engineering. To our students, escaping or taking a break from engineering includes engaging in personally fulfilling or meaningful engineering-adjacent activities that allow them to avoid the stress and pressure they feel in the moment so they can come back to engineering refreshed and motivated later. The fulfilling nature of engineering- adjacent activities and their negotiation with students' identities as engineers seems to align with MIT and IBM helping us to better articulate students' pursuit of future goals. *We wonder whether students' different identities are negotiated and, within that negotiation, if each identity enacts seemingly conflicting motivations towards future personal and professional goals that must be reconciled.* We believe the process we see students engaging in is that process of reconciliation. We anticipate additional emergent codes to be informed by these theories giving us additional insights into how engaging in engineering-adjacent activities supports students' motivations.

Concluding Thoughts

Our work seeks to identify connections between students' engineering-adjacent participation activities and their motivations towards engineering. We have found initial evidence that students' expectancies and identities, in part, play a role in students' activity selection processes. Research in engineering identity continues to suggest that students with a greater sense of belonging tend to identify as engineers, and have greater motivation to persist [22], [23]. Students' sense of belonging has also been linked to their involvement in activities, inferring that students who participate in extra- and co-curricular activities identify more as engineers, increasing their motivation to become future engineers [4], [24].

Typically, engineering-related experiences such as internships, engineering clubs, and other co-curricular experiences have been linked to students' aforementioned increase in motivation [24] which may also influence their goals. We expect that non-engineering related experiences will have a similar effect since many students consider non-engineering activities as vital to their undergraduate experience [4]. Our preliminary results along with previous research suggest that besides engineering-related, extra- and co-curricular activities, students also value participating in activities that are not considered to be traditionally related to engineering [4]. These activities may build students' confidence, teamwork, and leadership skills [4], and may be a way for them to cope with the high amounts of stress associated with the engineering major [25].

Simultaneously however, students' need to "escape" from the stresses of engineering also raises questions in our minds about the cultures of engineering. We wonder whether it is seemingly "right" that students are forced to "leave" and be something else separate from being engineers rather than being able to bring their holistic selves into engineering. Our work will explore and address the above claims and concerns amongst our broader participant pool. We hope to create a hypothesis about engineering undergraduate students' involvement in engineering-adjacent activities, furthering our understanding of how these activities affect their motivations.

Acknowledgements

The authors would like to acknowledge the contributions of undergraduate students Nicholas Insinga, David Lentz, Dylan Letcher, Alfred Marchev, and Ryan Petzitillo who assisted in the development of the interview protocol and identification of the initial emergent codes.

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