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WIP: Motivation and Identity: The Impact of Identity on Recovering from Failure

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Introduction

This work-in-progress research paper presents the theory and preliminary data analysis in our effort to determine if academic motivation and engineering identity are related to the extent that one can predict the other. Engineering students consistently face challenges that can result in failure while working towards their degrees. Failure is an essential part of education and can provoke strong reactions. Studying the steps an individual takes towards motivation after failure simultaneously with engineering identity can provide insight into any relationship between the two constructs. We hypothesize that students' with stronger engineering identity will also demonstrate greater motivation to complete academic goals and recover from academic failure. A relationship between academic motivation and engineering identity, if it exists, could allow educators and researchers to quantitatively measure engineering identity and gain further insight into motivational patterns.

Theoretical Framework

This work-in-progress focuses on uncovering patterns between engineering identity and academic motivation. Both constructs involve student self-perception. This study closely examines how students perceive themselves as engineers, how they perceive success, and how they respond to failure. Our work is grounded in several theories that report on these perceptions.

Identity

Identity is defined in this study as how a student perceives themselves to fit in a group [1]. This study focuses specifically on engineering identity, which can simply be defined as how a student perceives themselves to fit into engineering. It is a subset of greater student identity, which also includes personal, social, and professional aspects. [1]. Engineering identity can also be categorized as a type of role identity. Role identity consists of the social and cultural constructs an individual associates with a specific role [2].

This work-in-progress utilizes the Engineering Identity Instrument, as developed by Dr. Alison Godwin [2]. Her work breaks down engineering identity into three dimensions: recognition, interest, and performance/competence. Recognition refers to a student's perception of how others view himself or herself, which influences how they then perceive themselves [2].Recognition is important early on in a student's engineering education. Interest is defined as "the state of wanting to know or learn about something or someone." The desire to learn something, such as engineering, has been previously linked to motivation [2]. Performance/competence refers to how students perceive their own abilities in performing and understanding engineering. Thus, it influences whether the student can practically see himself or herself putting their abilities to practice in the workplace [2]. These three dimensions are analyzed independently in this work (as described in Methods).

Motivation

Motivation is defined in this study as the reasons one has for acting or behaving in a particular way [3]. Theories encompassing motivation such as achievement goal theory, self-efficacy, and attribution theory play key roles in interpreting student motivational patterns and are particularly relevant to this study.

Achievement goal theory shows that academic motivation can be understood as attempts to achieve goals [4]. Behaviors are thus driven by the extent to which the student wants to achieve a particular goal. [4] This theory describes the ultimate "mastery pattern" or the way the most successful students behave. Students who accomplish mastery goals have been found to be self-regulating, self-determining, and believe that effort is the source of success or failure. [4] Mastery pattern itself is influenced by a strong sense of self and control. Thus, we believe that mastery patterns may correlate with high engineering identity in the performance/competence dimension and offer a lens through which to view the intersection of motivation and identity.

Self-efficacy theory is prevalent in examining why students approach or avoid experiences. The theory encompasses the confidence of a person in their ability to perform a specific task [4]. Achievement related behaviors have been correlated to this confidence, which provides a broader sense of an individual's underlying motivation [4] For example, if a student believes they will not have success at a certain task, they will generally avoid the task. Not attempting a task eliminates the chance of failure and the negative consequences associated with it. How students approach situations, in particular if they have previously failed in that area, can reflect their self-efficacy and may correlate to performance/competence with respect to their engineering identity.

Attribution theory describes student perception of the cause of an outcome [4]. Attributions in academia may include effort, knowledge, or ability and are strongly connected to emotions [4]. Emotions generally influence daily choices. The way an individual reacts to the outcome of these choices may influence future behaviors. However, it is the student's perception of attributions which emotionally influence motivation. Two students may attribute an outcome to the same cause, but view the characteristics of the cause very differently. We are particularly interested in how these attributions may vary with strength of engineering identity (overall and by dimension).

Scope of work

Our interest in the intersection of identity and motivation leads us to a mixed-methods approach in which we couple a quantitative measure of engineering identity (Engineering Identity Instrument) with a qualitative investigation of motivation. Specifically, we interpret motivation through the lens of student responses to failure, and frame our results in the context of achievement goal, self-efficacy, and attribution theories. Students who are motivated by achievement attribute effort as the cause of success or failure. When faced with failure, students of this mindset put forth more effort to overcome the situation. However, students are also motivated by their own perception of success and failure. This perception can lead them to avoid situations where they believe failure will occur. Students who approach these high-risk situations having previously failed may show high self-efficacy.

In this work-in-progress paper, we report results from engineering identity analysis of a pilot study and describe the development of the qualitative research methods for future work.

Methods

Methods used in this in this work-in-progress are based upon our previous work and refined accordingly to prior results [5]. Data is collected in two parts: (1) a survey using the validated Engineering Identity Instrument [2] and (2) interviews using Critical Incident Technique [6].

Sample

The sample population for this work-in-progress consists of 41 students enrolled in an upper-level aerospace engineering class at a private university. Most students in the class were juniors or seniors. Upper-level students were chosen because they have had more time to develop their engineering identity and are closer to joining the workforce as practicing engineers.

Part 1: Engineering Identity Instrument

All participants were first presented with the Engineering Identity Instrument, distributed electronically via a Google Form Survey. The Engineering Identity Instrument is composed of thirteen statements, each on a 7-point Likert scale (0 – "strongly disagree", 6- "strongly agree"), prompting students to reflect upon these statements within themselves as engineers [2]. Scores are averaged within each dimension of recognition, interest, and performance/competence respectively. We consider students with average scores of four or above on the Engineering Identity scale (after correcting for reverse coding) to have a "confident identity" (strongly considers themselves an engineer) within a dimension, while students with average scores of three or less are considered to have a "not confident identity" (do not strongly consider themselves an engineer). Data was analyzed and students were sorted by level of confidence to identify potential interview participants. Statistical analysis, using Fisher's Exact test to account for small sample sizes (subsamples < 5), was used to assess correlations between identity dimensions and demographics to better understand the population.

Part 2: Critical Incident Interviews (Ongoing Spring 2020)

In our previous work, motivation was captured through a Critical Incident (CIT) based, electronically distributed, short answer questionnaire. To facilitate a greater depth of response, this has been transformed into a 30-minute video interview. In an interview, the interviewer can gather a better sense of the individual and gain additional information through follow-up questioning, which the previous study did not allow.

A sub-sample of approximately eight students were chosen based on Engineering Identity– specifically four overall "confident identity" and four overall "not confident identity." Here, we define overall "confident identity" as a score of 4 and above across the three dimensions, whereas overall "not confident identity" is characterized by scores of 3 or less. These eight individuals were invited to participate in a 30-minute video-based interview hosted on Zoom. Interviews are recorded and subsequently auto-transcribed by the Zoom software.

Critical Incident Technique collects qualitative observations of human behavior in correlation to a critical incident [6]. A critical incident is an important situation with clear intent and observable outcomes. We ask students to recall two events, one where they believe they successfully recovered from failure and one where they believe they unsuccessfully recovered from failure. Failure does not have to be engineering specific. This allows us to understand what the student perceives failure and success to mean. Students are asked a set of seven questions twice – once for successful recovery and once for unsuccessful recovery [5].

Qualitative analysis of the responses will include coding for aspects of motivational theory and emergent themes from prior work [5]. In future work, we aim to see how closely emergent themes from interviews align with motivational theory.

This study seeks to uncover any relationship between self-perceived engineering identity and academic motivation despite failure. We will use the most prevalent themes established from the interview portion and confidence trends from the Engineering Identity Instrument in a comparative analysis in ongoing work. We hypothesize that engineering identity and academic motivation are related, and specifically that identity may offer predictive insight into motivational responses.

Limitations

As a work-in-progress, the research described here represents preliminary and ongoing work that will inform future study design. Our results have two prevalent limitations: 1) the sample size and 2) the nature of the institution where the study took place. With respect to sample size, many of sub-sample populations were less than five, and while we have used Fisher's Exact Test in statistical analysis to account for these small subsamples, this does limit any conclusions that can be drawn. The analysis presented, however, is still valuable to note for future work. In the next round of our study, we will be able to reference these findings to look for consistency. Larger sample sizes will allow for higher confidence in correlations. With respect to the second limitation, the sample population attends a STEM-oriented university, and may not represent the larger population of engineering students.

Results and Discussion

The sample population of undergraduate engineering students was confident overall. Figure 1 shows the number of confident and not confident students for each engineering identity dimension. At this stage of our work–in-progress, we are not yet able to answer our research question, however, we have conducted analysis of our population's identity characteristics and correlations with demographics. We find significant correlations ($\alpha = 0.05$) between factors within dimensions of engineering identity. Demographic analysis also showed significant relationships ($\alpha = 0.05$), as well as trending relationships ($\alpha = 0.10$) as summarized in Table 1 (following page).

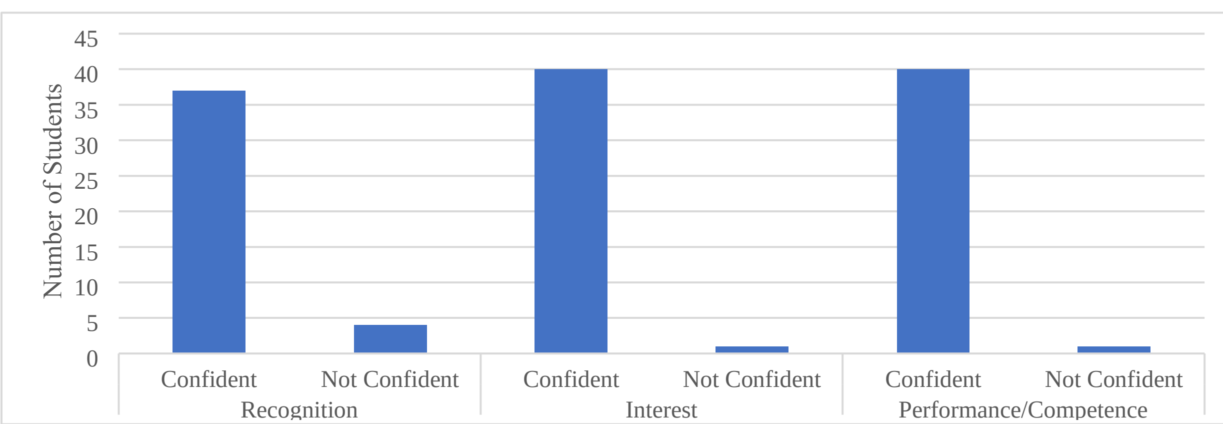

Figure 1: Number of Students per Engineering Identity Dimension by Strength of Identification (n = 41)

Table 1. Summary of Significant and Trending Relationships (n=41)

Relationship	P-value (Fisher's Exact Test)
Dimension vs Dimension	
Interest vs Performance/Competence	0.018
Demographic vs Engineering Identity Statement	
Gender vs Others ask me for help in engineering subjects	0.027
Ethnicity vs My parents see me as an engineer	0.0203
Ethnicity vs I am confident I can understand engineering in class	0.0134
Demographic vs Dimension	
Type of Tuition Payment vs Recognition	0.074
Type of Tuition Payment vs Interest	0.017
Ethnicity vs Recognition	0.0241
Gender vs Performance/Competence	0.069

Dimension vs Dimension

We took a closer look at how the three dimensions of identity – recognition, interest, and performance/competence – related to one another. Interest and performance/competence have a statistically significant correlation in our sample population, with a direct relationship ($p = 0.018$). Thus, higher interest scores predict higher performance/competence score. This result may suggest that engineering student's ability to perform and understand academic tasks is based upon how interested they are in the content of the course.

Demographic vs Engineering Identity Statement

Gender, ethnicity, and military status were found to be correlated to the majority of identity statements. In particular, gender had a significant impact on whether individuals felt that others ask them for help in engineering subjects ($p = 0.027$). Three-quarters of female students answered four or less as compared to the 34% of male students. Females (n=8), in this sample, do not feel as though others ask them for help in engineering. Ethnicity had significant correlations spread out amongst all three dimensions of identity. In particular, ethnicity impacts whether the student believes their parents see them as engineers (recognition, $p = 0.0203$), and their confidence in understanding engineering inside the classroom (performance/competence, $p = 0.013$). In both cases, students who identified as underrepresented minorities, specifically Black/African American (n=1) or Hispanic (n=2), rated these statements below 4. Military status was observed to be trending ($\alpha = 0.10$) for all statements within the interest dimension. Students who have no military service (n=36) rank their interest identification lower than those in ROTC (n=5).

Demographic vs Dimension

We also looked at each demographic by dimension. The relationship between gender and performance/competence was determined to be statistically trending ($p = 0.069$). Females' answers trended lower on the scale, with 75% answering under five on the Engineering Identity scale (disagreeing with affirmative statements of identity). Ethnicity was correlated with recognition as a whole (statistically significant, $p=0.0241$). The entirety of the Black/African American or Hispanic ($n = 3$) students in this population ranked their engineering recognition below four on the Engineering Identity scale. Type of tuition payment was the only demographic to correlate with two identity dimensions, recognition and interest ($p = 0.074$ and $p = 0.017$ respectfully). Students on a full scholarship ($n=5$) reported lower recognition and interest scores.

While protocol-testing and interviewer-training interviews have been completed, at this point in the study no data-collection interviews have been completed. However, we will be analyzing student interview responses in a similar manner to our previous study [5]. Qualitative analysis will be conducted to look for the presence of six motivational themes identified in previous work – grit/determination, acceptance of failure, change in behavior, change in mindset, and denial of failure – as well as incidents of achievement goal, self-efficacy, and attribution theory. We believe the conversational element of the interviews will allow for greater depth than seen in previous (survey-based) responses. These six emergent themes from our prior work are subject to change with further data collection.

Conclusions & Future Work

The limited population size of this study makes it difficult to support any broad conclusions at this stage. However, preliminary relationships report interesting results that will be useful in continuation of this work. As shown above, interest and performance/competence are directly related for our sample population, engineering students at a STEM-oriented private university. Demographics such as gender, ethnicity, military status, and type of tuition payment notably influence identity across all three dimensions. We cannot yet make any statements on motivational patterns of this particular group, as the interview phase has not yet been complete.

In future work our sample population we will be from a university that is not STEM oriented, such as a liberal arts college with an independent engineering college or a large research institution, to capture a broader range of engineering students and their identities. Once we obtain a more diverse range of identity responses, we will be able to complete a more reliable analysis, as well as explore differences in identity and motivation by institution type.

Current work is being dedicated to set up CIT interviews, so interviews can be completed with the next sample of students Fall 2020. From these interviews, we plan on analyzing recurrent patterns relating to motivation and connecting these themes to engineering identity responses. We hope to see an improvement in depth of response and in conducting CIT interviews, and identify further areas of improvement before launching a more broadly disseminated study.

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