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Exploring the Influence of Students' Perceptions of Course Assessment on Retention and Professional Identity Formation

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Exploring the Influence of Students' Perceptions of Course Assessment on Retention and Professional Identity Formation: A Pilot Study

Abstract

Student performance on course assessment is critical in determining who gets to pursue a career in engineering and who does not. However, individuals with minoritized identities in engineering (e.g., women, LGBTQ, disability, minoritized racial and ethnic groups, etc.) continue to experience achievement discrepancies and limited recruitment in engineering programs as compared to their peers from overrepresented identity groups (e.g., White, men, heterosexual, non-disabled, etc.). At the same time, engineering programs continue to experience significant attrition in the second year, which has been attributed to student uncertainties about their major and lack of belonging but has not been extensively explored.

In this pilot study, we explore the following research questions: 1) How do students' perceptions of assessment structure in second-year Mechanics of Materials courses influence overall course performance? and 2) How do these perceptions influence students' identities as engineers? To answer these questions, we interviewed and qualitatively analyzed semi-structured interviews with nine undergraduate engineering students who had been enrolled in a Mechanics of Materials course within the past two years across three different universities. Findings from this pilot analysis reveal that the relationship among participant perceptions of performance on course assessments, sense of belonging, and identity formation is complex and nuanced. While participants garnered a sense of belonging in ways not directly associated with course performance, they described course performance as impacting their confidence as future engineers. Future work regarding student perceptions of assessment techniques on identity formation and retention are discussed.

Introduction

Course assessments play a significant role in determining career readiness for a student entering into the engineering workforce. Students who perform well on these assessments and earn high academic achievement are considered to have mastered the content knowledge and skills necessary for the engineering field, graduate from their programs, and become engineers. Yet, prior studies have shown that achievement discrepancies continue to persist among students with minoritized identities (e.g., women, LGBTQ, disability, minoritized racial and ethnic groups, etc.) as compared to their peers with normative engineering identities (e.g., White, men, heterosexual, non-disabled, etc.) [1]. At the same time, engineering programs continue to experience attrition in the second year, which has been attributed to lack of belonging and students' uncertainty about their chosen major [1, 2]. The second year of an engineering program is critical for retention because students use performance in courses such as Statics, Dynamics, and Mechanics of Materials for a few reasons. First, these courses provide foundational engineering knowledge and concepts on which other courses are built. Second, because this is the first time most students are learning the basis of core engineering concepts, terms, and analytical procedures, students also use these courses to make meaning of their identity within the broader group identifications of engineering [3]. Therefore, faculty design of and,

subsequently, student performance on these assessments may contribute to slow progress toward broadening participation in engineering and diversifying the engineering workforce.

The course assessments that we use to determine career readiness for engineering students are designed using a variety of assumptions. Some of these assumptions are directly linked to the curriculum of our courses such as those related to prior knowledge of a prerequisite course. Other assumptions, however, are not directly tied to course content but still significantly impact the ways students engage in assessments and navigate their courses to become engineers [4]. These more implicit assumptions include those about prior life experiences, disability status, current living status, etc., and tend to be embedded in assessment type (e.g., exams, homework, etc.), problem contexts (e.g., analyzing the handle of a bicycle), assessment policies (e.g., late homework policies, if any), and the length and frequency of assessments to be completed throughout the duration of a course. Such assumptions privilege certain ways of knowing, doing, and being in engineering that inherently exclude and marginalize students from minoritized groups, such as those listed above [5, 6, 7].

However, prior research has not sufficiently examined the inherent biases and assumptions that can influence course performance. Prior work in this area as quantitatively focused on what students are not learning by measuring achievement through standardized test scores [3]. In contrast, we use a qualitative, asset-based approach to understand how to improve second year retention efforts and promote the inclusion of all student groups. Specifically, we seek to understand how student perceptions of assessment influence achievement and ultimately sense of belonging and professional identity formation in engineering. In this paper, we address the following research questions: 1) How do students' perceptions of assessment structure in second-year Mechanics of Materials courses influence overall course performance? and 2) How do these perceptions influence students' identities as engineers?

Background

Assessment methods vary by the faculty member teaching the course as well as the standards, requirements, and outcomes that the course is designed to meet. While faculty members are expected to fulfill specific content requirements within a broader engineering curriculum, they are also granted autonomy in determining the pedagogies, policies, and assessments that guide the course and assess student learning. In order to understand implications of assessment for student achievement, identity formation, and ultimately, retention, it is important to understand how traditional assessment methods are currently utilized and how they can be leveraged to cultivate assessment practices that are inclusive and accessible to all students.

The two primary forms of traditional assessments are summative and formative. Formative assessments are treated as a measurement of student learning throughout the course, and both faculty and students can use these assessments to monitor and respond to student learning progress [4]. Summative assessment, on the other hand, is used as an evaluation of performance at the end of a course or period of instruction [4]. They are most often used to capture overall performance, rather than a tool to facilitate learning. While faculty tend to use both forms of assessment, the iterative and accessible feedback associated with formative assessment has been shown to significantly bolster learning by helping students "perceive their growing competence and ability to perform engineering related tasks" [10]. Examples of these assessment types

include course projects, e-portfolios, and other means for students to build and demonstrate their knowledge that are conducive to their own interests and consider the multiple intersections of students' social identities [10].

Such feedback is also important for adopting unconventional assessment approaches or those that students have not yet been exposed to. For example, Morton et al. [11] found that students did not appear to possess an innate capacity for in-depth levels of reflection regardless of assessment type. Therefore, it is important for faculty to provide opportunities for students to understand and implement feedback in order to further develop their competence and progress in their learning. They concluded that faculty needed to provide opportunities for students to understand feedback if they were to further develop their knowledge and skillset in their courses [5]. Similarly, other research in this area has emphasized self-regulation and reflection as the heart of the learning process [6] and as crucial elements in formative assessment practice, given that it is fostered appropriately [7]. Therefore, by evolving how we situate and design assessments in engineering classroom settings, we can assess and evaluate student learning ways that emphasize iterative feedback, that consider students' diverse backgrounds, and that build on students' prior knowledge to create a more inclusive learning environment that values and respects students' individual needs and identities.

Theoretical Framework

The framework that grounded our study is Tinto's Model of Motivation Persistence [8], shown in Figure 1. In this model, Tinto describes motivation using three components: 1) self-efficacy (i.e., a person's belief that they can succeed in a specific situation or at a specific task); 2) sense of belonging (i.e., the extent to which a person perceives themselves as a valued member of a community); and 3) perceptions of curriculum (i.e., the perceived quality, value, and utility of a curriculum and its associated content). In this study, we apply Tinto's Model to consider how changes in assessment strategies influence students' self-efficacy, sense of belonging, and curricular perceptions may contribute to retention in engineering programs and ultimately professional formation as engineers. In the context of this pilot study, we used Tinto's Model as a sensitizing framework to inspire the creation of the interview protocols and inform data analysis.

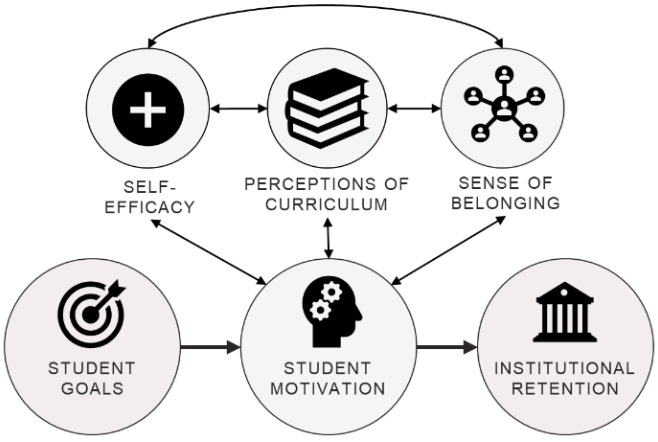

Figure 1: Tinto's Model of Student Motivation and Persistence adapted from [14]

Methods and Materials

For this study we utilized inductive qualitative analysis. Throughout the process, we focused on the unintended ways assessments impacted students' sense of belonging and engineering identity formation [9]. A pilot interview protocol was conducted in order to understand the holistic experience of the interviewees in their Mechanics of Materials course, such as: their specific experience with and perceptions of course assessments, their overarching sense of engineering identity, and lastly how the course content and assessments influenced them moving forward in their undergraduate program.

All data collection and analysis procedures were conducted by the first three authors. Nine interview participants were recruited via email and included acquaintances and/or colleagues from each of the researchers' respective academic institutions. The interviewees were all undergraduate students currently enrolled in an engineering major who had completed a mechanics of materials course within the last three semesters (3 interviewees. Interviews lasted between 30-40 minutes and were conducted in-person or via Zoom virtual meetings per participant preference and comfort. A list of example questions from the interview protocol can be found in Table 1. Audio recordings of the interviews were transcribed and all identifying information was removed. Transcripts were coded over the course of several phases using a combination of a priori and emergent coding techniques informed by Charmaz [10]. This process is outlined in Figure 2.

Table 1: Sample questions from semi-structured interview

Do you feel like a part of the engineering community at your institution?
Were you satisfied with how you performed in the class?
What aspect of the course do you feel like your opinion is most based on?
Describe your assessment experience in your Mechanics of Materials course.
Do you believe the assessments accurately reflected your understanding of the material?
How important are assessment scores to you?
Do you feel that a bad assessment score or poor performance in a class reflects your ability to be a successful engineer? Why or why not?
How is your confidence affected by your assessment scores?

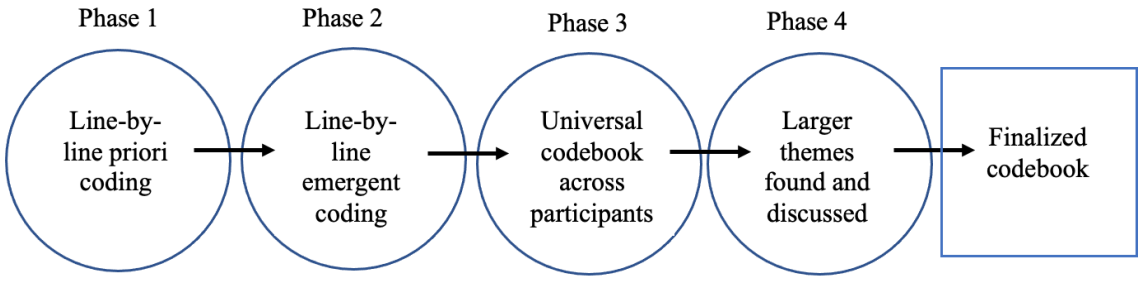

Figure 2: Summary of coding process

For the first two phases, each researcher independently analyzed the transcript for the participants they interviewed (i.e., three analyzed transcripts per interviewer). In Phase 1, we used a priori line-by-line coding to apply Tinto's Model of Motivation and Persistence [8]. During this phase we began to familiarize ourselves with the interview transcripts and gain initial insights into the ways course assessments and content were influencing student motivation and intent to stay in engineering. In Phase 2, we employed emergent line-by-line coding to capture relevant incidents and ideas not captured using a priori approach and to develop a preliminary codebook integrating a priori and emergent codes. Phases 3 and 4 included a collaborative analytical effort to examine codes and trends across all participants. In Phases 3 and 4, we applied the preliminary codebook across all participants and developed a final version of the codebook by combining similar codes into categories to identify larger themes. The entire research team met iteratively to discuss codebook meaning, definitions, and application until consensus and completion of the finalized codebook.

Table 2: Final codebook consisting of a priori and emergent codes

Code/Sub-Code	**Definition/Example Quote**
Self-Efficacy	A passive or active belief in one's ability to succeed in a specific task
Self-Efficacy in being an engineer	"I mean, they [assessments] impact most of our grade. So in that way, I think they're important. But I try not to focus too much on it, and just focus on learning the material, because I think that helps more. But it is harder when they place so much emphasis on it. On our grade... I think if you learn this stuff, you can be an engineer, just fine." - Clark
Sense of Belonging	An either active or passive set of actions that leads a student to feel that they belong in engineering.
Belonging with others	"When I studied with groups it was nice to hear what other people are struggling with and knowing that I'm not the only one that's confused on certain topics and stuff like that." - Daisy
Belonging with content	"I guess my sense of community is less with the engineers, but with the engineering school. I am not really into the engineering clubs, nor do I really have any desire to. I do enjoy the work! That is probably the place where I feel a strong sense of community for sure." - Glenn
Perceptions of Curriculum	The student's perceived value and importance of the course resulting from their sense of belonging and self-efficacy.
From application	"...It's just more applied. So you can do problems that actually mean something in the real world. Whereas in earlier classes there is more theoretical stuff, building up to this." - Clark
From professor	" I think it was mainly the professor. There were little things, like he would talk so quietly or when he answered questions, he didn't actually answer the question and that was like 80% of my opinion on the class was, 'I hate it because of that teacher.' The other part was we never got tested so I never actually knew if I was understanding what was going on." - Dylan
From perceived utility	"I don't necessarily think that the class, the formulas, and everything, memorizing the formulas is terribly important. Thing is more so understanding, you know, where the most stress is going to be placed on a beam or where things are going to happen, and be able to know how to use those formulas" - Theodore

Results and Discussion

Influence of Assessment on Belonging, Self-Efficacy, and Curricular Perceptions

All participants in our study felt that they belonged in the engineering field. However, we found that every participant had some sort of coping strategy or technique for engaging in the assessments in their courses to maintain a sense of belonging to and identification with engineering. These strategies included changing perceptions of the engineering curriculum, disassociating course performance with performance expected in the future workplace, and seeking solace with others.

Some students felt that they belonged in spite of struggling with the material because they knew others were also struggling with the material. For example, Daisy described, "When I studied with groups it was nice to hear what other people are struggling with [course material] and knowing that I'm not the only one that's confused on certain topics and stuff like that." Therefore, we identified the subcode, 'Sense of Belonging due to others', which was developed for participants who described their engineering identity as being fundamentally shaped by peers, as opposed to the engineering content.

In contrast to Daisy, other participants, such as Glenn, described that that engaging directly with the content in their engineering courses provided them with more of a sense of belonging than interacting with people associated with engineering:

> I guess my sense of community is less with the engineers, but with the engineering school. I am not really into the engineering clubs, nor do I really have any desire to. I do enjoy the work. That is probably the place where I feel a strong sense of community for sure.

Our findings also highlighted that, for our participants, sense of belonging or developing an engineering identity was not necessarily dependent on assessment performance.

While students explicitly attributed belonging and identity to course content or to their peers, they did not directly connect belonging and course assessment. However, when specifically asked about assessments, new findings emerged that warrant future exploration. These findings speak to how student confidence and success can be affected by assessments. Participants like Theodore and Daisy indicated the belief that their assessment performance reflects their dedication to learn and willingness to put in effort as a student. Most of these participants also emphasized the importance of their test scores. In contrast, other participants believed that their performance on an assessment does not speak to his success as a future engineer. For example, Clark emphasized that learning the topic was more important than an assessment score. However, all participants indicated that assessment performance impacted their confidence as a future engineer. Future work is necessary to further parse out the nuances identified here between course performance, perceptions of assessments, sense of belonging, and professional identity formation.

Influence on Student Engineering Identity Formation

When asked about ways to improve assessment styles, several participants mentioned that they wanted to understand their mistakes on assessments and be given the opportunity to fix them. This supports the principle of implementing a feedback strategy to enhance learning, and ultimately, performance. If the goal is to promote retention in Mechanics of Materials courses and engineering, our findings indicate assessments should be intentionally developed that promote student self-efficacy and provide multiple means for developing and demonstrating knowledge. For example, Trinity is especially averse to multiple choice questions on assessments and expressed the need for, "... more short answer [questions], just any opportunity for me to demonstrate my understanding that's not up to a 25% chance of getting it right".

Those who perceive their educational experience as a reflection of the knowledge they have retained are, as Glenn said, "Far more inclined to understand how material selection affects the quality of whatever they're designing". This leads to a strong identity that is based less on what they thought about the content itself and more on how it impacted their knowledge and understanding on a broader spectrum. This finding also highlights implications for future work that focuses on creating assessments that build on students' prior knowledge structures and experiences to make meaning of course concepts rather than just 'covering material'.

Conclusion

Previous research does not account for factors that may influence student performance on core engineering assessments, which we contend may influence their sense of belonging and professional identity formation and ultimately, their retention in engineering programs. To gain a better understanding of the ways assessment can influence student retention, we conducted a pilot study in which we utilized Tinto's Model of Motivation and Persistence to examine students' perceptions of these assessments and how their performance on these assessments influenced sense of belonging and professional identity formation.

Our findings revealed more questions than answers that warrant further investigation. We found that while students did not necessarily attribute assessment performance (i.e., achievement) to developing a sense of belonging in the engineering field, they did highlight that achievement did influence their self-efficacy toward becoming a future engineer. At the same time, they point to the need for integrating concepts of Universal Design for Learning (UDL) into engineering courses [15, 17]. Such assessments guide faculty toward creating adaptive and accessible instructional and assessment practices that are responsive to students' diverse needs, backgrounds, and identities. Lastly, our findings point to a need for educators to create assessments that allow students to disassociate failure as a student on an exam from failure as an engineer. Garnering a sense of engineering identity that does not only rely on assessment structure or scores is essential to the modern engineering student. Future work is necessary for further exploring and integrating all of these important components into a new generation of engineering adaptive assessment practices that promote belonging and professional identity formation of all students in engineering.

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