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Understanding Needs of Undergraduate Engineering Students Who View Degree Attainment as "Transactional"

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Abstract

This research paper explores the story of an undergraduate engineering student who identified a low sense of belonging within his department based on survey and interview data collected as part of a larger project. From interview data, the student described how the attainment of his engineering degree was one of many of his ongoing responsibilities, and thus he did not seek out strong connections within his department. His interview data also revealed a lack of career readiness, as he only had a vague idea of what an engineering career might entail. Recognizing that some students who view degree attainment as a transaction (i.e., they prioritize efficiency over engagement) may not value traditional means of support and professional preparation within their engineering programs, we ask the research question: *"What are the unique values and experiences of a student who views attaining an engineering degree as transactional?"*. We conducted a thematic analysis with multiple data streams from one engineering student: responses to a survey about sense of belonging, engineering identity, and personality traits at two time points (one at the beginning of sophomore year and one during the last semester of senior year), and one interview about the student's experiences in engineering immediately after graduation. The student's survey responses at both time points indicated a low sense of belonging, which identified him as an interview participant per our study protocol. He also self-identified as a first-generation Latino transfer student, which provided additional potential insights from the interview data on these intersecting identities. Interview data were coded in four passes. We identified how the student's unique values and experiences, mainly related to his work ethic, took priority over connecting with others or engaging in departmental or university programs. Themes that emerged from the interview data were familiar experiences (seeking hands-on experiences), motivation for engineering degree attainment (familial expectations and desire for job security), degree attainment resources (strong sense of self-reliance, lack of reaching out to other sources of support), and strategic gaps (limited understanding of what an engineer does or how to get an engineering job). Understanding this student's experience provides insights into underlying reasons why some students view an engineering degree as a transaction, which can help shape more effective approaches to their professional preparation.

Introduction

While existing literature suggests undergraduate engineering students' sense of belonging and engineering identity are indicators of their likelihood of graduating and feeling empowered within their major [1], not all undergraduate engineering students desire a strong sense of belonging among their departmental cohort or instructors. With the goal of effective professional formation of diverse types of engineering students, this single case study seeks to provide insights into the experiences of one minoritized engineering student with a low sense of belonging in his engineering department. The goal is to provide insights that will help frame future studies of students who do not value engaging with or belonging in their engineering programs to the detriment of their professional formation as engineers.

Literature Review

Sense of Belonging and Persistence

At a fundamental level, humans have the desire to belong. The desire for interpersonal relationships has an additive effect on that desire. Previous research on students' academic success has primarily focused on the interaction between students' sense of belonging, motivation, self-efficacy, and perception of curriculum [1], [2]. On the college campus and within STEM classrooms, several characteristics are known to commonly exhibit a positive effect on students' sense of belonging. Social capital (people in their social group that can help them become an engineer) provides feelings of acceptance and belief that others desire to see a person perform well [3]. Students who feel engaged within their major and classes often demonstrate a higher sense of belonging than those who do not [5], [6]. Research has also shown a strong positive correlation between engineering identity and sense of belonging within an engineering major [1]. Students more often see themselves as an engineer when they feel they belong. In many cases, there is also an underlying assumption that undergraduate students desire a high sense of academic belonging. A lack of sense of belonging can feed into the absence of a strong engineering identity for some students [3]. Existing literature models extensively cover students' goals and persistence while highlighting the need for additional research on students who do not develop a strong sense of belonging at their university but instead, seek community outside of their academic setting.

Sense of Belonging for Students from Minoritized Populations

Research shows that students' sense of belonging contributes to their persistence in school [7]. Therefore, a low sense of belonging may result in lower perseverance throughout college. Vaccaro and Newman [8] found that three factors influenced students' sense of belonging the most: environmental perceptions, involvement, and relationships. Within these three factors, students from minoritized populations value authenticity the most and derive a sense of belonging in spaces where they feel they can be their authentic selves [8]. Regarding engineering specifically, Verdin et al. [9] discussed diversity in engineering programs, explaining that these programs often attempt to reach diversity quotas without actually taking into account the unique experiences and viewpoints of minoritized populations. This can lead to minoritized students feeling forced into an engineering stereotype, often molded around the historical majority population of White men. Furthermore, prior research suggests that Latino students leave STEM majors due to the academic climate and that the campus climate they experience affects their social and academic integration [10], [11]. Additionally, research shows that ethnically minoritized students reported having a lower sense of belonging than majority students, potentially resulting in poor study progress and premature withdrawal from the university [12], [13].

Transfer Student Experiences

Studies have shown that students who transfer from a community college to a large research institution are likely to have difficulties with social and academic integration [14]. Additionally, Lester et al. [15] found that transfer students had virtually no inclination to partake in extracurricular activities and often remained on campus only to attend class. The lack of integration transfer students sometimes feel may be due to the fact that some transfer students

may be older than their peers [14] or the fact that they tend to correlate social engagement with off-campus activities, viewing on-campus social engagement as a distraction [15]. Furthermore, Flaga [16] found that transfer students had to find and use university resources alone, without receiving assistance from the institution or faculty. These resources can be confusing, conflicting, and incomplete [17], which further exacerbates transfer students' difficulties navigating and engaging with university resources. This lack of integration at the university and department levels severely affects sense of belonging, which influences degree persistence and attainment [7].

First-Generation Student Experiences

First-generation college students in engineering majors are typically characterized as having fewer resources offered by their parents to be successful in engineering [3]. However, this can drive the value they place on attaining an engineering career: "Students who pay their own college expenses may then be interested in having a future in engineering because they have a job to pay their own way to attain their degree…" [3]. While these students may be more open-minded in the classroom, first-generation students require a higher sense of belonging to succeed in college [3], potentially because they have no prior experience with or knowledge of college. Stebleton et al. [18] also found a relationship between sense of belonging and levels of depression and stress for first-generation college students, reporting lower ratings of belongingness and satisfaction and greater levels of depression and stress for these students at research-intensive universities. One possible reason for this may be the large size of the universities, making it difficult for first-generation students to be academically and socially integrated. Regarding engineering identity, Liptow et al. [19] discussed how first-generation students often correlate family responsibilities and community engagement with engineering identity. Furthermore, Verdin et al. [20] found that engineering identity and degree persistence were correlated and that first-generation students' sense of belonging is likely to benefit from opportunities where they can explore their interest and recognition in engineering.

While the experiences of transfer, first-generation, and minoritized students in engineering have been explored, this case study presents the unique perspective of a student with all of these identities describing his experience in an engineering degree program. We seek to explore the underlying reasons why a student with these intersecting identities views degree attainment as transactional.

Methods

Data Collection

Data for this study were drawn from a larger project exploring undergraduate student experiences within an engineering program that was undergoing curricular change. The program was within a college of engineering at a land grant institution in the southeastern U.S. For the larger study, a variety of student characteristics, beliefs, and perceptions were assessed through a survey [21] and follow-up interviews with selected participants [22]. Survey factors are summarized in Table 1. Surveys were deployed to all students in the engineering program in the last third of each semester over multiple years. During each year of the project, six to eight students were interviewed. Selection criteria were students with a relatively low or high sense of belonging at two levels: within their engineering department and within their required engineering courses.

Because responses to the sense of belonging items were determined to have a non-normal distribution, we used a parametric variable (median) to sort students into low and high sense of belonging at either the department or course level and recruited participants whose responses were greater than one quartile above or below the median. The median value for sense of belonging gathered at the department level was 5.9, and the median for the course level was 5.0 (both on a scale of 1 to 7, from low to high). The student in this case study identified his sense of belonging as 2.8 at the department level and 1 at the course level during his last undergraduate semester.

The bounds of this exploratory single holistic qualitative case study [23] were the experiences of a single student in his civil engineering major and department from sophomore year through graduation. Data sources for this case study included the student's responses to surveys at two time points: at the end of the student's first semester of sophomore year and at the end of the last semester of the student's senior year. Specific survey data included in our analysis were sense of belonging at the department level, engineering identity, future-oriented motivation, and personality traits. The case study also included data from an interview with the student about his experiences in engineering, which was conducted immediately after graduation. Interviews were conducted by two interviewees to ensure the interviewers did not impose their values, beliefs, or experiences into the interview. Responses were electronically transcribed to ensure accurate capture of the student's response. These processes ensured ethical and procedural validation in the data collection process [24].

Participant Selection

In this case study, analysis of survey responses at both points in time guided our decision to select this student for an interview. The theoretical frameworks for this study are engineering identity [25] and belongingness [26]. Godwin [25] identified three main factors for engineering identity: recognition, interest, and performance/competence. Our prior work with this population [27] resulted in a fourth factor, with recognition splitting into self-awareness and recognition by others:

- Self-awareness: beliefs that they see themselves as an engineer
- Recognition: beliefs that others see the student as an engineer
- Interest: personal interest in engineering
- Performance/competence: beliefs about being able to accomplish tasks in engineering and understand engineering concepts

The belongingness framework [26] proposes four main factors:

- *Competencies for belonging:* skills and abilities to recognize and craft the self to align with norms of a group
- *Opportunities to belong:* enablers of space necessary for people to find and build connections
- *Motivation to belong:* an inner drive to belong
- *Perceptions of belonging:* self-evaluation of whether or not one fits with those around them

Items within these factors were identified in previous validity and reliability testing of the survey [21], and composite scores for each survey factor were calculated for the two sets of survey data for this participant.

Data Analysis and Interpretation

Interview data were initially coded using *a priori* coding to identify key themes related to engineering identity and sense of belonging, effectively incorporating theoretical validation in our analysis. This stage was followed by open coding to identify other aspects of the student's engineering journey related to our research question. Specifically, we were looking for descriptions of experiences that related to the student devaluing a sense of belonging in engineering. As a transfer student from a minoritized population, we were also looking for experiences that align with those populations - challenges with social and academic integration (transfer); strong connections to their families and communities outside of school, focus on work to support their families (racially minoritized populations). The third coding phase organized these codes into key themes by using their context to understand the underlying ideas and beliefs behind each code. The fourth phase evaluated underlying characteristic commonalities across certain themes, allowing us to define and consolidate these themes. The first author was the primary coder for the first three coding passes, and the first and third authors conducted the fourth pass collaboratively, discussing ties to theory and integrating quantitative and qualitative results in the process. This process ensured procedural and theoretical validation [24].

Results

Findings From Survey Responses:

Table 1 shows a list of survey factors, their definitions, and the student's composite factor scores for the two time points included in this case study. As the student progressed toward graduation, his composite scores for all factors increased or remained the same except for his perception of sense of community at the university level, which decreased. The student's survey responses at both time points revealed a very low sense of belonging at the university, department, and course levels. Based on his goal orientation factor scores, he had a strong desire to master course materials (mastery approach) but was not motivated by the achievement of good grades (performance approach) or the ability to navigate a course with minimal work (work avoidance). He indicated an intrinsic desire to master coursework, which was further substantiated by his high level of conscientiousness (personality trait). While he noted a sense that his current coursework prepared him for the future (perceived instrumentality) and that his career goals were realistic (alignment), he did not demonstrate making connections between what he was doing now and his future in engineering (future on present). He also indicated a low value for thinking about long-term goals (value).

Although he indicated a low sense of belonging in his engineering department, his high confidence in his choice of major and feeling capable of mastering tasks were supported by his high level of persistence within his major (grit: consistency of interest). Also, from sophomore to senior year, his sense that science and engineering are instrumental in changing the world (science agency and engineering agency) increased, along with a sharp increase in him seeing himself as an engineer (engineering identity: self-awareness).

Table 1: Summary of the survey factors, definitions, and the student's responses to survey questions during the first semester of his sophomore year and the last semester of his senior year. Note: Clarity and Alignment (subconstructs of Future Time Perspective) were not assessed at the time the student first completed the survey.

Factor	***A high score indicates...***	Scale: 1 - 7		***+/- Δ***
		Sophomore	***Senior***	
Sense of Community – University level	The student feels a sense of belonging, and being accepted, comfortable and supported, at the university level.	3.0	1.6	-
Sense of Community – Engineering Department level	The student feels a sense of belonging, and being accepted, comfortable and supported at the department level.	2.5	2.8	+
Sense of Community –Course level	The student feels a sense of belonging, and being accepted, comfortable and supported, at the course level.	1.0	1.0	
Goal Orientation – Performance Approach	The student is driven by getting good grades and performing well in the course.	1.0	1.0	
Goal Orientation – Mastery Approach	The student is driven by a desire to learn the course material.	7.0	7.0	
Goal Orientation – Work Avoid	The student is driven by a desire to expend as little effort as possible in the course.	1.0	1.0	
Future Time Perspective – Perceptions of the Future (PF)	The student is certain about wanting to be an engineer.	4.4	5.8	+
Future Time Perspective – Perceived Instrumentality (PI)	The student finds their course useful for their future career.	7.0	7.0	
Future Time Perspective – Value of thinking about the future (VU)	The student perceives that there is value in thinking about long-term goals.	1.9	3.0	
Future Time Perspective – Connections to the future (CN)	The student perceives a connection with their future goals.	4.2	7.0	
Future Time Perspective – Clarity (CL)	The student has a well-defined future goal, deep into the future.	-	5.8	
Future Time Perspective – Alignment between ideal and realistic future selves (AL)	The student has an ideal future possible career that is also realistic.	-	7.0	
Future Time Perspective – Effects of future on present (FoP)	The student recognizes that their future goals affect what they do in the present.	1.0	1.0	
Grit	The student has a persistent interest in and maintains sustained effort toward long-term goals.	4.6	6.1	+
Engineering Identity: Self-Awareness	The student feels they recognize themselves as an engineer.	1.0	7.0	+
Engineering Identity: Recognition	The student feels they are recognized by others as an engineer.	1.0	2.5	+
Engineering Identity: Interest	The student feels they have an interest in becoming an engineer	5.0	7.0	+
Engineering Identity: Performance/ Competence	The student feels they can perform engineering tasks and master engineering concepts.	6.0	6.0	
Science Agency	The student believes that learning science will empower them to affect change in the world.	2.2	7.0	+
Engineering Agency	The student believes that learning engineering will empower them to affect change in the world.	4.6	7.0	+
Personality Extraversion	The student receives their energy from being around people, feels comfortable speaking to new people, enjoys larger groups and events, likes sharing their opinions and thoughts	1.0	1.0	
Personality - Agreeableness	The student prioritizes social harmony, treats others kindly, acts altruistically, tends to be conflict-averse	1.6	5.2	+
Personality - Conscientiousness	The student is goal-oriented, has high impulse control, shows attention to detail, is organized, has a strong work ethic and is emotionally stable	3.4	7.0	+
Personality - Emotional Stability	The student is easily stressed out, prone to mood swings, feels more insecure, worries and feels anxious	5.7	5.5	-
Personality - Intellect/Imagination	The student is intellectually curious, interested in learning and trying new things, excited by a challenge	4.6	7.0	+

Interview Findings:

During the initial coding pass, deductive coding identified and categorized statements by themes within the frameworks of Belongingness and Engineering Identity. A code for other unique statements that helped provide underlying explanations for our codes was also created. This was primarily to help us draw links between themes across the student's responses.

A second deductive pass was made, focusing on sense of belonging at all levels. The resulting statements identified as related to belongingness were analyzed in a third, inductive pass of coding. By using context to understand the root meanings and feelings behind the codes related to belongingness, thematic codes were developed in this pass. In the fourth pass of coding, we grouped codes together into themes based on the data and similarities among the key feelings behind the codes. This resulted in four themes that captured the student's experiences: familiar experiences, motivation for engineering degree attainment, degree attainment resources, and strategic gaps. The codes and themes are shown in Table 2.

Table 2: A fourth coding pass generated four themes emerging from related characteristics across codes identified during the third coding pass. Third pass codes were generated from *a priori* codes related to belongingness.

Third Pass Code	Fourth Pass Theme
Focus & Energy Expenditure Outside of School	Familiar Experiences
Hands-On Focus	
Feeling Unlike Typical Engineers	
Familial Expectations	Motivation for Engineering Degree Attainment
Focus on Degree Completion	
Risk Aversion	
Navigational Capital	Degree Attainment Resources
Self-Reliance	
Pride in Self	
Lack of Long Term Goals	Strategic Gaps
Lack of Clarity of Career	
In-The-Moment Decision Making	

Familiar experiences: The combined themes of "Focus & Energy Expenditure Outside of School," "Hands-On Focus," and "Feeling Unlike Typical Engineers" centered around past experiences and areas of expertise that are not viewed by the student as common among engineers. For example: *"I worked construction, you know, since I was young…," "...always busy, I didn't really have time to like chit chat and like, make friends…."* and *"Typically what I hear of engineers is they're boring, you know, like they're, they're not really any fun."*

Beyond these observations, he noted that because he was focused on his out-of-school goals, he was not inclined to befriend engineering students:

> *With my background there is like, a long time I didn't feel included, I still don't to this day, I don't feel included because, um, because of my background, because of my path to becoming a civil engineer, um. And, so different from a typical student.*

From this compilation of the student's quotes, we see that he had construction expertise that he chose to continue during his time in college. He placed a low priority on interactions with student peers to prioritize his time on his work outside of school. He also noted that he was different from other engineers and mentioned knowing only a couple of engineers.

Motivation for engineering degree attainment: The themes of "Familial Expectations," "Focus on Degree Completion," and "Risk aversion" indicated a common thread of the need for stability and upward mobility post-graduation strongly influenced by his family.

> *So, my family's from Colombia, South America and, um, growing up here we, we had different opportunities than she did growing up in Colombia and something she always told us to pursue was to get an education and make something of ourselves.*

This student had full confidence that he would attain his engineering degree. From an early age, his outlook toward the future included working as hard as he could to graduate college. Quitting or failing was not an option.

Degree attainment resources: The codes of "Navigational Capital," "Self-reliance," and "Pride in self" are rooted in where the student found confidence, value, and resources to progress toward graduation. He sensed that although *"...people that do belong, um, are willing to help you along the way,"* he felt that he had to be self-sufficient: *"I feel like they could tell. You know, that, that I was different, but I was trying…just gotta work hard. Takes a lot of work."*

This student mentioned the importance of hard work throughout his interview. For example, "*My learning has always been a reflection of my hard work…*" and "*I've always believed that you can, you can, you can work to get where you want to get.*"

Although others like his mother and a former supervisor who was an engineer had encouraged him that he could "do engineering," he routinely circled back to his own work ethic and touted his self-reliant attitude as the reason he graduated.

Strategic gaps: "Lack of long-term goals," "Lack of clarity of career," and "In-the-moment decision making" demonstrate how the student was ambivalent about his career choice. *"I'm open-minded so like I've always considered all types of things, um. But, this is what, I guess, always worked"* and *"any job, I'm willing to do anything…"* Other comments indicate his focus on the present: *"Right now the main focus is just getting a job."* His primary long-term goals ended at graduation; his focus was on graduation, not career readiness.

> *Right now is like the most nervous point in my life because I'm just now about to start working as a civil engineer and I mean, I can tell you that I feel like it's going to be a good fit but I don't really know.*

While the student did make mention of some personal family goals and hopes of owning a business one day, there was little clarity on how he hoped to use his degree, and he expressed a variety of past experiences in which the direction of his work was guided by what he enjoyed at the time.

Findings from Mixing Survey and Interview Analyses

The student made mention of ***familiar experiences,*** including jobs he had worked in the construction field since he was twelve years old. This had been his source of income before and during his undergraduate years. In fact, he had dropped out of school to work full-time at one point and returned to complete his engineering degree. On several occasions, he mentioned his confidence and familiarity with a variety of hands-on jobs not directly related to his engineering degree. His feeling toward these experiences was consistently positive, but he also used these experiences to explain ways in which he saw himself as unlike most engineers and noticed that he was "different." His sense of competency, motivation, and opportunities for engagement was focused outside the academic environment. This aligns with his low sense of belonging in engineering based on his survey responses that indicated he did see himself "fitting" in engineering.

He noted that his variety of commitments outside of school prevented him from investing in relationships with peers or instructors. He did not note any adverse experiences with those around him on campus and in fact, noted that people around him were always willing to help. However, he was often very busy, which limited his opportunities to fit in.

The student's ***motivation for engineering degree attainment*** was primarily focused on degree attainment, with little thought given to life after college. His descriptions of being a hard worker, detail-oriented, and not inclined to quit are supported by his survey responses (high factor scores for mastery approach, conscientiousness, and grit.) He also mentioned the importance of the degree for achieving his goals but did not have a clear definition of what those long-term goals may include. This was also substantiated by his survey responses indicating his tendency to find courses useful for his future career, but not to recognize connections between his future goals and his present actions.

Godwin and Kirn [28] noted that "Students with higher engineering identities were more likely to value their future goals of becoming an engineer and view present tasks as connected with their future goals. The FTP constructs of instrumentality and perceptions of the future are most closely tied to students' current and envisioned future selves that affect their goal setting and behaviors". Our student demonstrated high scores for instrumentality and perceptions of the future, which align with his strong desire to become an engineer; however, engineering identity is much lower for the student in this case. This is likely due to the notion that his future time perspective ends at graduation, and he has only vague notions of what an engineering career would entail.

Existing literature shows us that it is particularly common for first-generation and transfer students to place emphasis on completing what they start (graduating). For students who do not have much financial support, the cost of not going straight into the workforce is a hurdle in itself. But those who press toward a degree in engineering often know they have no choice but to succeed; they cannot "afford" to fail [29]. Leaving their program means walking away from a financial investment, but taking long amounts of time to complete a degree means lost opportunity cost of being in the workforce [29].

For this student, ***degree attainment resources*** were primarily centered in self. He looked to his family and one mentor for guidance, but otherwise, he relied on his intrinsic motivation to

complete his engineering degree. His sense of self-confidence was tied to hard work rather than confidence in engineering career readiness; he took pride in the hard work he put into all of his work, both in school and outside of school. These indications that his competencies centered around his coursework rather than belonging align with his desire to master course material and low sense of belonging, as indicated in his survey responses. This is supported by findings in the literature that while institutions view degree attainment as transformational – they want to help students develop - some students see the process of earning a degree as transactional – they want to graduate [30].

One interesting finding from this student's interview was that the transition to online learning during the COVID-19 pandemic resulted in him being in contact with his instructors more often because the coursework became harder for him in the online environment. Prior to the pandemic, he focused on being efficient with his time and did not interact much with his instructors or course activities. He did perceive this as a positive interaction that helped him complete his coursework and resulted in him being "more involved" and recognized by his instructors.

Strategic gaps were noted in our analysis of the student's interview. The student knew he wanted to graduate but stated that he had been so focused on graduating that he felt like he was "back to square one" now that he had obtained his degree. As a recent graduate, he was still working in the construction field and looking for engineering jobs. When asked about his impressions of his major and what engineers in his field do, his answers were very general and lacked detail.

He indicated having worked roles where he was around engineers, perceiving them and their roles from the perspective of an outsider. When asked about his ambitions within engineering, he noted a couple of areas he preferred not to work in but also noted that he just really wanted "any job." This lack of clear direction is confirmed by his survey responses, indicating a low value for thinking about long-term goals.

Conclusion

This case study focused on a minoritized, first-generation transfer student who prioritized degree attainment over social and academic integration. Through survey and interview data, we were able to identify that his sense of belonging in engineering was low, but that he expressed being okay with that, citing working at various jobs outside of school as consuming most of his time and being a source of pride. Furthermore, the student conveyed a strong sense of motivation for graduating and discussed degree attainment in relation to job security and financial security. These factors indicated a transactional view of degree attainment, as he was more interested in completing college and obtaining a job than engaging in the overall college experience. He expressed low value for thinking about the future and vague notions about engineering careers, which limited his career readiness. These findings suggest that students with this transactional view may highly value hard work and have a strong sense of determination that would not be apparent based on their lack of engagement in academic support systems and social activities in engineering degree programs. These can be considered as assets to build on to help these types of students prepare for careers in engineering. Future research should focus on an asset-based approach to understanding the experiences of transfer students, first-generation college students, and students from minoritized populations. Engineering programs should also consider leveraging the assets that students bring–particularly those who are underrepresented in

engineering programs-to limit the extent to which they see an engineering degree as transactional.

A limitation of this work is that it is a single case study with data drawn from a larger study focused on engineering student experiences in general, not specifically the experiences of minoritized, first-generation, or transfer students. In future work, our interview protocol will be modified to focus more specifically on the needs of students who view attaining an engineering degree as transactional to provide educators and researchers with insights into the professional formation of this unique group of students.

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