2026 ASEE ANNUAL CONFERENCE June 21–24, 2026 | Charlotte Convention Center, NC
Host Sponsor UNC Charlotte
ASEE AMERICAN SOCIETY FOR ENGINEERING EDUCATION
Paper ID #52969

Under Stress - Scarcity Theory in Engineering: Interpreting low-income students' career decisions using an asset-based approach

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The methodology and theory paper addresses the integration of scarcity theory, from behavioral economics, into engineering education. Theory shows that pathological paradigms or deficit thinking, particularly when held by engineering educators, pose significant challenges for students from low-income backgrounds studying engineering. Because income level is not always a visible characteristic, many students from economically disadvantaged backgrounds may conceal their socioeconomic identity to assimilate with more affluent peers by wearing, for example, a few select expensive name-brand clothing items or going on group outings and paying for meals at expensive restaurants using credit cards that are not easily affordable. Not only are their personal choices impacted by their income level, but their educational and career choices are often constrained by financial considerations. Examples of these decisions include staying at a stable, consistent-earning job that provides little engineering experience over an eight-week summer engineering industry internship that pays a few hundred dollars less. These decisions are oftentimes less understood by engineering faculty who mentor and advise low-income engineering students.

National data indicate that only 51% of low-income students enroll in college compared to 89% of high-income students and 64% from middle-income students[1]—a disparity that reflects systemic inequities in access to higher education. Of the low-income students who enroll in college, many encounter academic barriers such as limited preparation in mathematics[2-3], lower retention rates in college degree programs[4], extended time to graduation, and difficulty concentrating and focusing on their learning due to challenging living situations such as housing and financial insecurity[5]. Many of these symptoms seen at the college level are accumulated shortfalls of the K-12 educational system, because low-income students reside in lower-tax regions and attend less-resourced schools. They also receive fewer advanced learning opportunities regardless of their class ranking. To add to this education debt, students from low-income backgrounds face additional hurdles in the engineering fields. Engineering is perceived as difficult and inflexible, with implicit biases about who belongs in engineering[6-8], a culture that often emphasizes exclusivity and competition[9, 2-3], a curriculum widely regarded as demanding and rigid[10, 11-15], and an environment often described as having a "chilly climate" [2-3]. These educational barriers are compounded by further marginalizing already disadvantaged students.

This method and theory paper provides an in-depth critical narrative of the complex experiences of low-income engineering students.

Scarcity Theory and Career Decisions

Informed by behavioral economics, Scarcity Theory suggests that individuals experiencing financial strain tend to make decisions and engage in behaviors characterized by trade-off thinking, assessing risks under limited resources. This mindset often leads to attentional focus on

immediate outcomes at the expense of long-term goals and imposes a "bandwidth tax" that heightens cognitive stress during decision-making[16-18]. Economically disadvantaged students are often influenced not just by financial limitations, but also by constraints in personal, external, and social resources available[17].

Despite these challenges, many low-income students who are recognized for their "talent" and interest in mathematics or science often choose to study engineering. They view it as an opportunity to escape from a cycle of poverty[19,15]. Engineering is perceived as a pathway to social and economic mobility.

However, faculty working with students from low-income backgrounds may have a hard time understanding students' decisions. The Social Cognitive Career Theoretical model provides a framework for understanding career development by highlighting the relationship between personal, contextual, and learning factors. The theory explains how these factors influence individuals' interests, career choices, performance outcomes, and the supports and barriers that shape career-related decisions. Three main components of this theory are (1) self-efficacy beliefs, (2) outcome expectations, and (3) personal goals.

Methodology

This critical qualitative research study delves into the narratives of engineering students who successfully navigated the engineering fields despite financial instability. This research study employs Scarcity Theory from behavioral economics as its theoretical framework to weave the author's critical autoethnography with ten (10) current engineering student narratives, analyzing important career decisions through crystallization methods that foreground positionality and reflective inquiry. Student narratives were collected using interviews across three years (2022-2025) after the academic term in which each student was enrolled in an introductory gateway course. Ten student narratives of students from low-income backgrounds were selected for this study. Data of the experiences of engineering students at a Research Tier One, Hispanic Serving Institution contained in-depth descriptions of the students' decision-making processes. This institution also had a high percentage of first-generation college students (over 50% of undergraduates enrolled). The interviews for this study were also conducted after students completed one of the required engineering gateway courses. They were recruited during their time enrolled in the course for their engagement in course activities. At the start of the semester, when the students were enrolled in the gateway course, the professor held one-on-one interviews with each student to learn more about their background, interests, and academic and career needs. From the pool of students who agreed to participate in the study at the end of the semester, which included a final interview about their decision-making, students were then randomly selected from a subset who self-identified as coming from a low-income background. This ensured the purposeful selection of participants. Several students remained connected throughout the three years of the data collection; three are included in the analysis of the data presented in this study.

Journals and memos from the author and professor as observers in the students' gateway course, along with the student narratives, were analyzed to explore how scarcity theory played a role in career decisions. First, student data, primarily the transcribed and coded interviews, were analyzed by filtering the data using scarcity theory tenets; then, by reviewing Social Cognitive Theory elements. To protect the confidentiality of the students' individual experiences, themes were developed that contained multiple participant experiences. Once the themes were established, the author reflected on the themes by incorporating her lived experiences as a student. Once the autoethnographic, thematic experiences were documented, they were compared to the student narratives in the detailed interviews. Throughout the study, peer reviewers were consulted to seek input on interpretations and mitigate bias. Data from peer reviewers who were consulted and who experienced similar educational experiences in their engineering education were not included but supported the validation of the research process.

Before presenting the findings, I want to be self-reflexive and present my positionality as author and researcher of this paper. I identify as a Latina academic who grew up in poverty in the U.S.-Mexico border and then went on to navigate a privileged higher educational system. I attended the Massachusetts Institute of Technology (MIT) as an undergraduate, which exposed me to diverse perspectives and unimaginable opportunities, and then continued at Harvard University Graduate School of Education. The microaggressions and negative (and positive) interactions with faculty impacted my passion for supporting and advocating for underrepresented students within engineering fields. These experiences shaped my educational trajectory and my positionality as a researcher.

Limitations. The findings in this paper may be limited to the socio-cultural and economic characteristics of students who primarily enroll at the institution of study. In addition, as a qualitative study with a relatively small and context-specific sample, the results are not intended to be statistically generalizable to all engineering programs or institutions. Rather, the value of these findings lies in their transferability, and readers should consider the extent to which the institutional context, participant characteristics—particularly students from low-income backgrounds—and disciplinary norms described in this paper are like their own settings when deciding how the insights may apply. Furthermore, the perspectives analyzed reflect the experiences and interpretations of participants at a particular moment in time, and changes in institutional policies, leadership—especially instructional leadership—or student demographics may shape future outcomes in ways that differ from those reported in this study.

Critical Analysis of Career Experiences

The results that follow are integrated autoethnographic experiences specific to navigating career decisions alongside current students' narratives that trace their career choices. Together, they surface how perceptions of risk, security, and possibility are shaped by classes, racialized, and institutional contexts, rather than individual motivation alone. These insights highlight how

engineering students and faculty can inhabit similar spaces yet operate under profoundly different financial and psychological constraints.

Trade-off thinking. Pursuing my education at MIT required taking out substantial student loans—a decision that represented a significant trade-off. I invested in what I perceived as a guaranteed pathway to success, recognizing the privilege yet bearing the cost of access. During my time at MIT, I felt indistinguishable from my peers; socioeconomic differences seemed invisible within the academic environment. However, there were times when my reality set in: many of my peers had access to private tutors, family support related to career decisions, or the financial flexibility to volunteer in research labs and unpaid opportunities that further enhanced their credentials. The reality of financial disparity emerged most clearly upon graduation, when the burden of repayment became tangible, and the long-term implications of debt crystallized.

Continuing my education offered temporary relief, postponing the inevitable financial responsibility and allowing me to delay high monthly payments. Ultimately, my entry into public service was a strategic decision shaped not only by interest and values, but also by the structural incentive of potential loan forgiveness. In this way, my career trajectory was not purely an expression of passion or merit; it was also a calculated response to the financial constraints produced by my educational choices.

In contrast, many of my engineering students, particularly those from low-income backgrounds, navigated trade-offs from a different starting point. Rather than “investing now and paying later,” they often work substantial hours while enrolled in college, draw on veteran benefits, commute from home, or attend part-time to avoid or minimize debt. Their choices reflect deliberate attempts to prevent future financial encumbrance, even when these strategies reduce the time and energy available for studying, engaging in co-curricular activities, or pursuing high-impact practices such as research or internships. Some students forgo opportunities at more prestigious or geographically distant institutions to remain close to family support networks or to maintain employment, prioritizing stability and obligations.

These two differing perspectives offer insight into the complexities of a scarcity mindset and career decision-making. From my vantage point, taking on significant debt for an MIT education appeared to be a rational, even inevitable, trade-off in pursuit of long-term mobility and professional security. For many of my students, however, the prospect of carrying similar levels of debt feels untenable given their current obligations, family expectations, and limited safety nets. This divergence raises important questions for engineering educators: Is the prestige of a university a beneficial trade-off for acquiring high educational debt, particularly for students without intergenerational wealth or robust financial backing? Are students choosing more affordable schools, not primarily because of their talents and interests, but because of the price tag of attending a private, Ivy League college renders those options effectively inaccessible?

Framing these experiences side by side complicated simplistic narratives of “smart financial choices” versus "risk-taking.” Instead, it suggests that what counts as a reasonable trade-off is

deeply contingent on students' prior experiences with economic scarcity, their expectations about future earnings, and their confidence that institutional prestige will translate into real social mobility. These integrated narratives invite faculty to interrogate how advising, program design, and institutional messaging may implicitly assume access to financial buffers, and how such assumptions shape which pathways are framed as realistic or desirable for different groups of students.

Tunneling—attentional focus. As a student, my focus was narrow and unwavering: graduate, complete my degree, and secure a high-paying job. Every decision I made—how I spent my time and what opportunities I pursued—was filtered through this lens. I attended every career fair I could, refined my professional presentation and resume, and joined the Society of Hispanic Professional Engineers (SHPE), which provided the mentorship and practical guidance that my parents could not provide. Without family experiences to draw on for crafting a resume or preparing for interviews, I actively sought out opportunities that promised the greatest financial return for my time.

One such opportunity was a tutoring position through the MIT Public Service Center, where I taught mathematics at the local YMCA. The pay, $25 per hour including travel time, was higher than any other position accessible to me as a student at that time. Although unrelated to my long-term career goals, the experience became formative, ultimately shaping my career trajectory, sparking an enduring interest in education.

I now observe similar patterns of tunneling (attentional focus) in my students. One student routinely finished exams early to return to work and clock in on time, continuing his work into the night and weekend. Another student, a veteran who had advanced significantly in her engineering studies, left the program for a high-paying position in another city. When I asked how she planned to complete her degree, she responded, "I'll figure it out. I always have." Her response reflected both resilience and the pragmatic, economic-driven decision-making characteristic of students weighing educational aspirations against immediate financial demands.

Tunneling—attentional neglect. Reflecting on my experiences, I recognize many instances in which I deprioritized essential aspects of my career development in favor of financial stability. The tutoring job, while financially rewarding, diverted my attention from opportunities to gain experience in my chosen field. As an MIT student, I had access to abundant learning opportunities in mathematics, computer science, and engineering. My inattention to these experiences was not due to a lack of interest, but to a practical focus on earning income. In pursuit of immediate financial security, I overlooked formative opportunities that would equip me for long-term professional growth. Tunneling explains why high-value career opportunities at MIT receded into the background while paid work took center stage. My interests were not about disinterest or low motivation; they were rational responses to immediate financial pressures that made unpaid or low-paid opportunities feel unaffordable.

I now observe parallel patterns among my students, many of whom face similar constraints. Some forgo tutoring or office hours because their employment takes precedence over academic engagement. For students balancing financial insecurity, prioritizing paid work often necessitates the sacrifice of experiences that contribute to deeper disciplinary learning and professional preparation. The need to maintain income tunnels their attention toward what pays now, even when they understand the long-term value of academic engagement.

This framing can help engineering faculty see that when students skip office hours, decline unpaid research, or "under-invest" in co-curriculars, they may be enacting the same survival logic rather than lacking commitment or ability. This finding underscores that access is not just about whether opportunities exist, but about whether students have the slack (time, money, and energy) to even register and act on those opportunities.

Bandwidth tax. The concept of bandwidth tax, the diminished cognitive capacity and executive functioning that accompanies financial strain, resonates deeply with my own educational journey. During my studies at MIT, sleepless nights spent in the library or in Athena computer clusters were commonplace. However, unlike my peers, I juggled additional responsibilities that extended beyond coursework. I depended on campus employment, such as sorting mail in my dormitory, which I selected for its flexibility in accommodating my academic schedule. The demands of managing coursework, finances, and personal well-being often felt overwhelming. I lacked resources to hire tutors, visit family for emotional support, or purchase necessities without adding to my workload. I was functioning with reduced bandwidth while meeting course expectations.

This constrained bandwidth is something I now see mirrored in my students' lives. Many of them manage caregiving responsibilities, jobs, and coursework concurrently, stretching their cognitive and emotional capacities. One student, for example, was unable to attend exam review sessions because he needed to assist his mother in providing care for an elderly client. Another, an undocumented low-income engineering student, enrolled in classes part-time to pay tuition in cash. Constant concern for his family's safety and financial survival impaired his ability to fully focus on his engineering courses. In these cases, students were not simply "busy"; they were living with chronic bandwidth tax. Missing review sessions or enrolling part-time are not just time-management issues, but they are manifestations of constrained cognitive space. In other words, scarcity not only limited time and resources but also narrowed cognitive space for academic engagement and self-development.

Bandwidth tax caused by financial strain compresses cognitive and emotional capacity, even for high-achieving students. This challenges meritocratic narratives that treat performance as an unfiltered signal of talent or effort. It foregrounds the invisible cognitive cost of constantly managing scarcity. This also points to the need for faculty and programs to interpret under-participation and slower progress not as lack of grit or commitment, but as evidence that scarcity is actively taxing students' executive functioning, attention, and ability to plan and act.

Discussion

The findings of this critical autoethnography highlight the intersection of financial scarcity and career development through the lens of Social Cognitive Career Theory. This theory posits that self-efficacy beliefs, outcome expectations, and personal goals shape individuals' career trajectories within their social and environmental contexts. Participants' and my own experiences influence these core elements of the theory while illuminating hidden strengths and adaptive capacities often overlooked in deficit-oriented frameworks.

Self-efficacy plays a pivotal role in shaping how engineering students engage with career opportunities and persist in pursuing their career goals despite financial barriers. For low-income students, economic scarcity and systemic inequities constrain access to opportunities that foster career self-efficacy, such as internships, research experiences, and professional and academic networking. Yet rather than reflect on a lack of agency, students' decisions demonstrate adaptive self-regulation and contextual intelligence. For example, students who prioritize paid employment over non-compensated academic activities are exercising pragmatic judgment shaped by their economic realities. Their choices embody contextual self-efficacy—a belief in their capacity to navigate multiple domains of responsibility simultaneously, even when institutional structures do not support such intersectional demands.

Similarly, outcome expectations among students from low-income backgrounds often center on achieving financial security and family stability, rather than abstract markers of professional prestige. This focus reframes the idea of "attentional focus—tunneling" not merely as neglect of long-term prospects but as goal realignment—a reflection of the immediate, high-stakes environment in which low-income students act. In this light, actions that appear short-sighted within traditional models of academic capital are, in fact, expressions of strategic prioritization. Students make calculated decisions to sustain their families and themselves, which can, over time, cultivate financial literacy, long-term resilience, and a strong internal locus of control—traits essential to career adaptability.

The bandwidth tax further illustrates how chronic financial strain taxes cognitive and emotional capacity, yet within this constraint, low-income students exhibit remarkable adaptive resourcefulness. They learn to optimize limited time, navigate bureaucratic systems, and forge informal support networks that enable persistence in engineering programs known for their intensity. Their decisions, whether to take a flexible job on campus, reduce course loads, or engage family members in logistical support, reflect creative problem-solving within systemically narrow margins. These behaviors, though shaped by scarcity, exemplify self-efficacy in action under constraint.

By interpreting these career decisions using an asset-based approach, students from financially constrained backgrounds demonstrate agency, creativity, and perseverance as they construct viable career pathways against structural inequities. While scarcity can narrow cognitive focus and restrict opportunity, it also cultivates situated expertise, an ability to assess trade-offs,

improvise under pressure, and sustain motivation in complex circumstances. Recognizing these forms of adaptive capital reframes scarcity-driven decision-making not as evidence of deficit but rather as an expression of self-efficacy and strategic resilience.

Implications for Engineering Educators

This study illustrates that scarcity-driven decision-making among low-income engineering students does not indicate a lack of motivation or ability. Rather, it shows an adaptive response to structural and contextual constraints. Recognizing these adaptive behaviors as demonstrations of agency, resourcefulness, and contextual intelligence has significant implications for how engineering education can become more inclusive and responsive to low-income students' lived realities.

Engineering educators play a central role in reshaping classroom practices to account for the diverse socioeconomic conditions influencing student engagement. Instructional design often assumes a uniform capacity for time, financial investment, and cognitive bandwidth, and inadvertently privileges students with fewer external responsibilities and more economic and social capital. Engineering faculty can mitigate these inequities by integrating flexibility into their pedagogy. Examples of these practices include offering asynchronous learning options, multiple and alternative assessments, or opportunities for extended deadlines that consider other obligations. Engineering faculty can also reframe "rigor" to acknowledge perseverance, self-regulation, and problem-solving under constraints as legitimate demonstrations of engineering competence. Engineering faculty can also encourage reflective learning that connects technical problem-solving to social and economic contexts, making connections to their students' lived experiences as relevant sources of engineering insight and knowledge. Finally, faculty should consider normalizing brave conversations centered on financial instability that reduce stigma and deficit thoughts and foster trust. These conversations will signal that socioeconomic challenges are part of the engineering experience.

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