**Exploring Expectations, Effort, and Persistence Through Social Cognitive Theory: A Case Study of Persistence in a First-Generation Engineering Student**

**Abstract**

STEM Intervention Programs (SIPs) are increasingly implemented to address student attrition, employing Social Cognitive Theory (SCT) to explicate learning outcomes and changes in self-efficacy. Understanding the experiences of underrepresented students who utilize SIPs is vital to the ongoing development of effective persistence promotive programming. This research reflects a case study of a Hispanic first-generation student who was the recipient of a National Science Foundation scholarship. Concept driven coding was employed to identify SCT constructs across data derived from 1) a submitted personal statement, 2) three individual interviews, and 3) email correspondence between the participant and SIP stakeholders. Observational learning of studying best-practices from tutors and his advisor was enabled through SIP activities. In-person learning and engagement with professors inculcated outcome expectations that aligned with personal goals. Self-regulation skills were learned through SIP activities and engagement with others within his department. The participant indicated unexpected health concerns, roommate challenges, and their effects on academic performance as barriers that prompted temporary program withdrawal. The participant has since successfully rejoined the engineering program, succeeded academically, and indicated SIP contributions as integral to his progress towards degree completion. The objective of this work is to examine in detail using SCT one example of student success in order to both help inform future SIP efforts and justify additional financial investment in student success.

Keywords: Social Cognitive Theory, Self-efficacy, STEM Intervention Programs, Student success

**1. Introduction**

The rigors of engineering education are evinced through student persistence challenges across departments and universities (Sithole et al., 2017; Bettencourt et al., 2020). STEM degree programs simultaneously represent a lucrative career opportunity and a significant challenge to students across the spectrum of social identity, most who enroll in STEM-related majors do not graduate with a STEM degree (Sithole et al., 2017). The interplay of institutional factors and student characteristics are notable contributors to STEM attrition (Sithole et al., 2017). Institutional factors that influence student self-efficacy, motivation, persistence, and success include course load, academic advising, and pedagogical styles (Sithole et al., 2017). Student characteristics associated with persistence include proficiency in mathematics, studying habits, peer mentoring, time management, and self-efficacy (Sithole et al., 2017). Persistence concerns are heightened among underrepresented student populations, students from minoritized backgrounds exhibit considerable difficulties with engineering coursework and adjustment to higher education norms (Palid et al., 2023). Social integration and university environment are significant contributors to student attrition (Birrenkott et al., 2022). Engineering education researchers have highlighted the impact of departmental climate, engineering identity, and academic support on student persistence (Meyer & Fang, 2019). The financial challenges, unfamiliarity with higher education norms, and lower self-efficacy of first-generation students motivate the implementation of programs that promote adjustment to engineering education (Birrenkott et al., 2022). The development of scholarship and mentorship networks that support first-generation student entry and persistence have yielded academic and social benefits to the increasingly diverse engineering student body (Palid et al., 2023). STEM Intervention Programs (SIPs) have emerged as supplemental resources that are designed to attract, retain, and support students from underrepresented backgrounds (Palid et al., 2023). SCT posits the interplay of observational learning, self-regulation, reciprocal determinism, and outcome expectations convey changes in self-efficacy and performance (Bandura, 1986).

Researchers applied SCT to explore the effects of SIP engagement on the degree pursuit experience of a single engineering undergraduate student from a minoritized racial background.

**2. Literature Review**

**2.1 Engineering Student Self-Efficacy**

***Pre-entry Experiences***

Belief in one’s ability to succeed at tasks, termed ‘self-efficacy,’ is inextricable from the motivation, attention, self-regulation, and outcome expectations critical to student success (Van Dinther et al., 2010; Palid et al., 2023). Bandura’s theory of self-efficacy is frequently employed to understand student development across levels of education, providing substantial insight into student persistence in challenging subjects (Painter, 2012; Rittmayer & Beier, 2008; Hu et al., 2022). Analysis of success promotive factors amongst STEM students has highlighted the critical contributions of efficacy promotive academic preparation, self-confidence, self-doubt, STEM interests, and personal motivation (Painter, 2012). STEM self-efficacy is a significant predictor of student performance and persistence in STEM disciplines (Rittmayer & Beier, 2008). Low STEM efficacy is characterized by a lack of confidence in one’s ability to complete relatively simple science tasks (Hu et al., 2022). Conversely, high STEM efficacy is characterized by confidence in the ability to handle complex science tasks (Hu et al., 2022). Models of STEM success have posited triadic reciprocity between programmatic learning environments, student characteristics, and their exhibited behaviors (Kuchynka et al., 2021). Scholarship on STEM disciplines has consistently noted the indirect and direct impacts of self-efficacy beliefs on the academic achievement, self-perception, and perseverance of students from minoritized backgrounds (Rittmayer & Beier, 2008; Han et al., 2022). Stereotypes surrounding STEM careers impact students’ career interests through their influence on self-efficacy and outcome expectations (Luo et al., 2021). Challenging the stereotypes that diminish STEM student efficacy and promoting growth in STEM tasks is achieved through STEM program interventions that occur prior to and during student’s degree progress (Palid et al., 2023; Morton & Beverly, 2017).

***STEM programming***

Intervention programs and scholarships have been developed to address retention deficits and underrepresentation of minoritized populations within STEM programs (Pierszalowski et al., 2021; Palid et al., 2023; Morton & Beverly, 2017). STEM programming outcomes are assessed through retention, academic performance, psychological outcomes, graduate school intent/admission, employment, and occasionally non-generalizable measures (Palid et al., 2023). Common program features include supplemental learning opportunities, mentorship, skill building, financial aid, socializing, and bridge programs (Palid et al., 2023). The implementation of intervention programs improves students’ self-efficacy across higher education departments (Van Dinther et al., 2010). Immersion in the social culture of the profession and provision of scaffolded mastery opportunities empower students to actualize their STEM interests through higher education (Palid et al., 2023). Social cognitive theory-based programs yield significantly higher effects when compared to other theory-bound interventions (Van Dinther et al., 2010). Strong belief in one’s ability to succeed at tasks, a key focus of social cognitive theory programming, is highly correlated with STEM major selection and persistence (Byars-Winston et al., 2010; Van Dinther et al., 2010). Inhospitable social climates can diminish self-efficacy perceptions; however, high self-efficacy mediates the impact of environmental perception on academic outcomes (Byars-Winston et al., 2010). Programs that provided students with practical experiences that contributed to subject related mastery improve self-efficacy, an instrumental variable affecting student motivation and learning (Van Dinther et al., 2010). Goal setting and self-reflection are key contributors to learning progression, which empowers subject mastery (Van Dinther et al., 2010).

**2.2 First-Generation Engineering Student Experiences**

***First-generation Student Persistence and Attrition***

First-generation students comprise one-third of the college student body; however, 56% earn a bachelor's degree within 6 years when compared to 74% who weren’t the first in their family to attend (Ives et al., 2020). Students who are the first in their families to attend college exhibit lower self-efficacy, higher negative outcome expectations, and experience more perceived barriers when compared to those who have a history of college attendance in their immediate family (Gibbons & Borders, 2010). Despite commendable values and efforts, first-generation students experience higher attrition rates amidst the formidable stressors imposed through lower familiarity with higher education rigor and limited family support (Gibbons & Borders, 2010; Hartman et al., 2019). Researchers have noted that first-generation students often experience the compounded effects of multiple stressors; they are statistically more likely to be low-income, nonnative English speakers, and hold minoritized racial identities (Ives et al., 2020; Cataldi et al., 2018). Higher education inclusivity movements have challenged deficits-based models of first-generation experiencing through deepening awareness of persistence promotive factors (Martin et al., 2020). Non-deficit models of first-generation student experiences have highlighted their values for family honor, financial security, lower risk taking, and avoidance of failure (Boone & Kirn, 2016). Family relationships provide vital emotional support and encouragement to first-generation students (Martin et al., 2020). Continuing-generation students report comparatively higher amounts of family guidance pre-entry and report that their families transitioned into the provision of more emotional support upon program commencement (Martin et al., 2020). Promoting the entry and persistence of first-generation students imbues engineering education with novel approaches to problem-solving that emerge through alternative perspectives (Verdín & Godwin, 2015; Boone & Kirn, 2016). Preservation of their unique perspective necessitates systemic change to create more inclusive programming (Martin et al., 2020).

***First-generation Student Strengths and Challenges***

Students whose parents do not have college experience enter with less cultural capital, incurring the added challenge of navigating the novel higher education environment without the added familiarity of family guidance (Cataldi et al., 2018; Wang et al., 2022; Austin et al., 2018). The impact of lower cultural capital is felt among students who are academically well prepared, highlighting the importance of adjustment support (Cataldi et al., 2018). First-generation students commonly balance the rigors of higher education with obligations to family and external employment (Boone & Kirn, 2017). The distinct experiences of first-generation students also contribute to unique strengths, they exhibit higher capacity for independent work and more resilience when compared to continuing-generation students (Minicozzi & Roda, 2020; Alvarado et al., 2017; Boggess, 2020). Resilience mediates the relationship between perceived stress and psychological wellbeing, perceived support and academic performance, and household income and psychological well-being among first-generation students (Boggess, 2020). Student attributes, aspects of their family system, and characteristics of their social environments prompt the development of resilience (Austin et al., 2018).

The economic ramifications of low student retention have prompted the expansion of higher education models of student success and spurred student support implementation (Maritza Paz et al., 2015; Austin et al., 2018). Amidst burgeoning trends towards holistic conceptualization of student success, social mobility measures are increasingly integrated to higher education institution rankings (Atwood et al., 2020). Implementation of pre-entry programming, STEM mentoring, and scholarship programs have yielded promising outcomes in student social integration and academic progress (Birrenkott et al., 2022; Maritza Paz et al., 2015). Opportunities including professional development, career fair preparation, faculty research engagement, design competitions, mentoring programs, and engineering facility tours have been implemented to promote first-generation student retention (Birrenkott et al., 2022; Nepal et al., 2018). Goal achievement, planning, academic focus, independence, and responsibilities are highly influential protective factors for first-generation students (Austin et al., 2018). Engagement with high school activities, grandparents, siblings, hobbies, and high school mentors contribute to student outcomes; however, they are less influential than mastery experiences at promoting student persistence (Austin et al., 2018). Initiatives promoting social integration are important resources for students navigating the challenges of college adjustment and vital for students who enter with comparably low familiarity with college rigors (Atwood et al., 2020).

**2.3 Bandura’s Social Cognitive Theory**

Expanding on his Social Learning Theory (SLT), Albert Bandura accentuated the interplay individual factors, exhibited behavior, and environmental context in his Social Cognitive Theory (SCT) (Bandura, 1986). Bandura noted the impact of modeled behaviors and observed consequences in shaping the expectations and efforts exhibited by process observers (Bandura, 1986). Terming the impact of environmental conditions on personal expectations and behaviors “reciprocal determinism,” Bandura explicated individual behaviors through deepened understanding of the efficacy expectations and outcome expectations that motivate actions (Bandura, 1986). The inculcation of self-efficacy beliefs and outcome expectations inform an individual’s self-regulation, goal setting, and motivated behaviors (Bandura, 1986; Byars-Winston et al., 2010). Bandura’s theory has been expanded through increased attention to the implications of minoritized status within an environment on self-efficacy and goal setting (Lent et al., 1994).

**2.4 Self-Efficacy**

Self-efficacy is one’s confidence in their ability to succeed at a task. Efficacy expectations are calibrated through personal accomplishments, vicarious experiences, social persuasion, and experiences of emotional arousal (Bandura, 1977; Limberg et al., 2022). In educational contexts, interactions with faculty and sense of belonging are sources of social persuasion that contribute to efficacy development (Painter, 2012). Current and expected GPA are indicators of personal accomplishment (Painter, 2012). Observing peer success or failure provides vicarious experiences that contribute to efficacy development (Painter, 2012). A student’s physical ability to complete tasks is indicative of physiological efficacy contributors (Painter, 2012). The development of self-efficacy mediates the impact of stress and informs the cultivation of adaptive behaviors (Lim et al., 2014; Limberg et al., 2022).

Researchers have integrated assessment of cultural capital, career appraisal, and financial stress in their expanded conceptualizations of self-efficacy beliefs (Lent et al., 1994; Lim et al., 2014; Fosnacht & Calderone, 2017; Avci et al, 2020). Social cognitive career theory conceptualizes the interplay of environment, interpersonal modeling, and sociocognitive variables relative to the formation of career goals and attitudes (Lent et al., 1994; Wang et al, 2022). Amidst increasing diversification, researchers have noted the effects of cultural capital on student and teacher achievement self-efficacy (Radulovic et al., 2020; Avci et al., 2020). The threat to goal attainment posed by the student debt crisis and its associated financial stressors has heightened attention to the impact of finances on undergraduate career appraisal and help-seeking (Fosnacht & Calderone, 2017; Lim et al., 2014). The expansion of self-efficacy to specific domains of learning enables analysis of the impact that supportive individuals serve in the development of the self-efficacy integral to goal attainment (Wang et al., 2022; Avci et al., 2020; Lim et al., 2014; Stewart et al., 2020). Levi et al. (2014) highlighted the relationships between academic, social, and emotional self-efficacy. Exploring college student success, researchers identified emotional self-efficacy as a significant predictor of the hopefulness that affected grade expectations and subsequent academic achievement (Levi et al., 2014). The significant impact of learner self-efficacy on motivation and knowledge acquisition empowers the application of SCT in explication of higher education trends (Van Dinther et al., 2010). The implementation of campus based SCT and SLT informed educational programs is promotive of student self-efficacy (Van Dinther et al., 2010).

**2.5 Observational Learning**

Observational learning refers to the feedback loop between witnessed behaviors and individual behavior change. Bandura (1986) assessed the effects of modeling on shaping individual efforts. Modeling entails cycles of attention, retention, and rehearsed application of desirable behaviors (Limberg et al., 2024). Early research on observational learning attended to the impact of modeling on aggressive behavior and moral judgement (Fryling et al., 2011). The application of observational learning has extended to all levels of education and across the breadth of diverse learner identities (Broadbent & Poon, 2015; Plavnick & Hume, 2014; Han et al., 2022; Zimmerman & Rosenthal, 1974). Initiatives to promote STEM efficacy noted the benefits of K-12 observational learning of STEM principles (Milford & Tippett, 2015). Interpersonal opportunities provided through mentorship, peer facilitation, and formal teacher-advisor relationships are success-promotive avenues for additional observational learning (Richards, 2022). STEM self-efficacy and program commitment are assisted through interpersonal learning opportunities (MacPhee et al., 2013). Minoritized STEM student populations benefit from mentorships, which provide invaluable social capital to groups that have lower familiarity with the academic rigors and support resources inherent to higher education (MacPhee et al., 2013).

**2.6 Reciprocal Determinism**

Bandura (1986) describes reciprocal determinism as a process of forming new learning through interpersonal transactions and intrapersonal development. Evaluating the feedback loop proposed by Bandura, Williams and Williams (2010) explores self-concept and performance relative to mathematical ability across 30 nations. The results supported Bandura’s theoretical position, noting that data from 26 out of 30 countries indicates people consistently used feedback about their performance to shape their self image and adapt future outcome expectations accordingly (Williams & Williams, 2010). Tested reciprocal pathways between higher education academic performance and self-efficacy have highlighted the significant impact of achievement on efficacy while challenging the proposition that improving student self-efficacy translates to subsequent achievement (Honicke et al., 2023). Improving student self-efficacy does not inherently confer achievement, scaffolded academic mastery is necessary in promoting coherent efficacy beliefs and outcome expectations (Honicke et al., 2023). Kuchynka et al. (2021) explicated STEM student development through a triadic model, highlighting the reciprocal impact between programmatic engagement, the development of self-efficacy, and enhancement of STEM intentions. Students exhibit active learning through self-assessment, engagement with multiple sources of feedback, and learning-based decision making (Kuchynka et al., 2021). Inculcating feedback from higher education resources promotes development of self-efficacy and contributes to their exhibited persistence, aspirations to higher levels of mastery, and the cognitive effort required for complex problem solving (Kuchynka et al., 2021).

**2.7 Outcome Expectations**

Efficacy alone does not promote outcome attainment; rather, hopeful outcome expectations influence efficacy and exhibited efforts towards desirable outcomes (Williams, 2010; Levi et al., 2014; Sheu et al., 2022). The relationship between efficacy and outcome expectancy is debated, the influence of outcome expectancy on individual efficacy and inconsistent operationalization of their relationship are ongoing debates within SCT research (Williams, 2010). The path between efficacy development and outcome expectations is informed by individual behavior and appraisal of consequences (Bandura, 1986; Reesor et al., 2017; Sheu et al., 2022). Bandura’s SCT and behaviorism explored the effects of reinforcement and punishment on behavior (Tadayon-Nabavi & Bijandi, 2012). Bandura’s research on aggression demonstrated that observed punishing consequences of others who exhibited antisocial behavior diminished aggressive behavior among observers (Bandura 1986; Malone, 2002). The role of reinforcement and punishment in social learning is nuanced, the effects of modeling on observer behavior can vary by individual learner cognitions about performance (Reesor et al., 2017; Tadayon-Nabavi & Bijandi, 2012). Extrinsic and intrinsic factors inform the outcome expectations espoused by learners (Bandura, 1986). Attempts to clarify the link between outcome expectancy and efficacy have identified the impact of incentives on behaviors that promote desirable outcome expectancy (Williams, 2010). The effects of incentives on efficacy and outcome expectancy are pronounced for behaviors that involve behavior regulation and weaker for specialized physical skills (Williams, 2010).

**2.8 Self-Regulation**

Bandura defined self-regulation as the process of integrating feedback to form adaptive behaviors that promote progress towards preferred outcomes (Bandura, 1977). Teaching an individual to reward themselves after successful behaviors maintains change beyond the application of external feedback (Bandura, 1977; Williams, 2010). Social cues are vital sources of feedback, shaping individual behaviors into context appropriate approaches to meeting needs (Bandura, 1977). Regulation strategies emerge from extrinsic and intrinsic sources (Bandura, 1977). Learners develop skills, adopt performance standards, and evaluate consequences of new behaviors in their self-regulation towards desirable outcomes (Bandura, 1977).Self-regulation processes are reflected through metacognition, time management, effort regulation, peer learning, elaboration, rehearsal, organization, and critical thinking (Broadbent & Poon, 2015). Research on the impact of academic support resources has highlighted their role as a temporal precursor to self-efficacy and outcome expectations among college students of color (Sheu et al., 2022). Receiving social support promotes self-efficacy and outcome expectations through indirect effects on behavior modification (Sheu et al., 2022).

**3. Methodology**

 The research study was approved by the Institutional Review Board (IRB) and qualified for exempt review. Research was conducted at a large, R1 classified, public, predominately white university (PWI) in the southeastern United States. The College of Engineering and Computing within this setting contains seven engineering programs: civil and environmental, computer, electrical, mechanical, biomedical, chemical, and aerospace. Purposive sampling was employed to capture the experiences of a participant who is 1) a recipient of a National Science Foundation scholarship, 2) engaged with an engineering program SIP, and 3) self-identified belongingness to an underrepresented student population. The participant is a first-generation student, male, and Hispanic. Data on the participant’s experience of engineering education and involvement in the SIP was derived from three interviews, a personal statement submitted for SIP consideration, and email correspondence with engineering faculty. Thematic analysis was employed to explore the development of self-efficacy relative to SIP involvement (Saldaña, 2016). Concept coding was driven through application of SCT constructs, identifying participant statements in alignment with empirically grounded learning processes and strengthening the study’s connection to existing engineering education literature (Glense, 2016; Saldaña, 2016). The principal investigator of the project is an associate professor in chemical engineering. The research team included a research assistant professor in civil and environmental engineering, an assistant professor educator in counselor education and supervision, and an external principal consultant who has a Ph.D. Interviews were conducted by a research team member who had no prior relationship with the participant to protect against threats to objectivity (Glense, 2016). Researchers utilized an audit trail, facilitated member checking, triangulated participant data sources, and addressed team biases to bolster the trustworthiness of findings (Glense, 2016). Attending to calls for furthered research on the unique experiences of underrepresented students within engineering education and the promising outcomes of SIPs, researchers sought to answer the following research question: “What are the SIP experiences of an undergraduate engineering scholarship-recipient from an underrepresented student background?”

**4. Results**

Jim is a Hispanic male and the first in his family to attend post-secondary education. Jim’s decision to pursue college education marked the first departure in recent family history from manual labor careers. In his scholarship personal statement, Jim reflected on the value of post-secondary education and the significance of first-generation student status, highlighting his ambitions for family advancement. His academic interests in science and math converged with his passion for playing musical instruments, Jim felt excited by the opportunity to apply himself in careers that aligned with his individual identity. Seeing potential for an audio engineering career through program completion, Jim stated that “majoring in engineering...is a culmination of all my dreams, passions, efforts.” He entered undergraduate engineering during COVID as a recipient of a National Science Foundation scholarship. The combined impact of roommate interpersonal issues, academic challenges, and unanticipated physical health impairment exerted pressures that contributed to Jim’s eventual withdrawal from the scholarship program and undergraduate engineering. He pursued his interests in music and engineering through entering technical college for electrical engineering and playing music. He reported a high interest in attaining an engineering career that would enable his part-time pursuit of a degree in music composition. The career vision he established prior to higher education entry was unshaken by transitions away from a four-year program, striving to actualize his creative potential through a career in tech development. Jim rejoined the four-year engineering program after reestablishing a sufficient GPA through community college attendance.

**4.1 Self-Efficacy**

Jim indicated that his interest in science and math began early and calcified in high school, success in these subjects guided his career appraisal. The success at physics and enjoyment of math that he experienced in high school provided clarity about career direction, stating “with math and science (enjoyment)...engineering was one of the ones that made the most sense.” High school counseling, teacher guidance, and self-motivated study empowered Jim’s career appraisal and assessment of their economic viability.

Jim described the challenges endured during COVID era educational protocols. Jim stated, “I had to get more active and get into class,” noting that attending predominately online or hybrid classes was challenging for the “lack of movement.” He adjusted to the restricted class format and affiliated lifestyle changes by incorporating exercise, stating “(going to the gym) did help a lot, because exercise has been shown to help a lot with boosting energy and stuff.” Jim engaged with in-person classroom sessions as hybrid course attendance became available, identifying being “active” in class as supportive of his learning.

In his scholarship essay, Jim indicated financial assistance as an important factor in the development of engineering efficacy. He worked throughout high school to “help (his) parents” who struggled with medical issues related to their occupation as field laborers, describing higher education as an “opportunity...to demonstrate my full potential.” Jim stated, “my ambition is to remove and mitigate some of the stress and burden of paying for college.” In his application letter, Jim stated that his academic potential would be actualized absent financial stressors. Appraising the value of financial support, Jim indicated “my focus will be solely to gain mastery and comprehension in my studies.”

Jim indicated that scholarships made higher education “possible,” addressing the “financial conflict of coming to school” as a “barrier.” He noted that institutional selection was “mainly because that was the school to offer the most financial opportunity.” He addressed financial considerations while processing his appraisal of graduate studies, “even if you do obtain a higher-level degree, doesn’t mean that your salary will increase as a result...” His decision self-efficacy was heightened by attending a seminar that illustrated the potential benefits and challenges associated with graduate-level education.

**4.2 Observational Learning**

Observational learning occurred through Jim’s scholarship peer network and professor guidance. Jim indicated his learning preferences, stating “I will have all the teachers illustrate how the concepts that we will learn are applicable in the real world.” Having professors who were able to connect concepts to application, he developed an awareness of the interrelated concepts across engineering specialties, stating “(a) company might not just hire electrical...they might hire a little bit of everything to hire mechanical, chemical, and electrical to sustain, develop, and research...to maintain the infrastructure of a company.” Immersion in engineering education exposed Jim to classes and professors that expanded the scope of his career search and prompted consideration of a transition to an aerospace engineering major. His relationships with professors and fellow students strengthened and provided vital career insight and opportunities to address uncertainty about course content. Making friends provided space to process engineering difficulties and camaraderie in studying. Jim found professors “approachable” as he progressed through classes, stating “(professors) went out of the way during lectures to make sure everyone’s following along.” Jim praised professors, noting their effectiveness across hybrid, online, and in-person modalities. Describing the observed effective traits, Jim stated “anticipating where students may have trouble with (a concept) and having an example on hand” reflected a “well prepared” professor. He observed their flexibility and intentionality, inculcating similar attitudes in his self-assessment and approach to learning. This approach enabled him to find classes less “intimidating” as he refocused on developing engineering skills and finding tools to aid him.

**4.3 Reciprocal Determinism**

Environmental opportunities promoted Jim’s skill development and shaped personal motivation. Reflecting on the success promotive environment facilitated by the scholarship programming, he stated receiving “tips and advice” on success enabled improvements in his decision-making. He emphasized the importance of resource seeking and tool acquisition, stating “I’ve had to look into how to better organize myself into how to better improve myself.” Jim’s individual development was supplemented by interpersonal resources. The availability of walk-in tutoring and awareness of supplemental instruction provided by the scholarship program was important to Jim’s achievement mindset.

Adapting to COVID era health protocols and their impact on class format presented a novel environmental challenge during the first year of Jim’s undergraduate education. He developed sleep apnea in the same year and indicated “drowsiness throughout the day” and “staying inside” as significantly impactful throughout the academic semesters. Difficulties attaining restful sleep influenced his concentration and prompted him to incorporate exercise for its energizing effects.

Beyond the difficulties imposed by sleep apnea, interpersonal challenges with his roommate prompted further adjustment. Jim responded quickly, stating “I put in a room (transfer) request, and was able to move somewhere else.” He stated the transition was important to help maintain his focus on developing effective homework habits; the transition also spurred him to refocus on using available resources to bolster academic progress. The availability of professors was critical to Jim’s growth, he stated “I feel most the professors are down to help you if you need help during office hours...”

**4.4 Self-Regulation**

Describing his strengths, Jim indicated persistence and resourcefulness as important characteristics. Jim persisted while many of his fellow students dropped out of high school pre-calculus, “when things get hard, I like to keep going and not give up.” He overcame struggles by requesting additional guidance from his teacher and readily integrating feedback. He experienced challenges balancing studying with other obligations, stating daily studying as a goal he worked towards. Jim incorporated tools to address this goal, stating “I’ll set timers for when I should start working on certain activities to complete the task (by) the deadline.” The utility of timers and calendars informed Jim’s continued use as he worked to better organize his academic efforts.

Difficulties attaining restful sleep prompted Jim to pursue a sleep appointment, the prescribed CPAP machine took weeks to acquire. He persisted through the challenge, incorporating sleep hygiene practices and lifestyle modification to address the impact on his academic performance.

Reflecting on the challenges, successes, and new learning experienced in his first year of undergraduate engineering, Jim stated his advice to himself prior to program entry would be “just stay on top of stuff, don’t get overconfident.” He availed himself to the scholarship program implemented helping resources, noting progress in academic and social domains. The after-class activities scheduled by the program enabled Jim to feel “closer” and “more comfortable” with professors and other students in the program. The internship programming empowered Jim’s regulation of academic stress through providing recurring tutoring and outreach highlighting available resources for student success. Jim was attentive to the variable degree of support he was able to elicit from campus-based helping resources. Describing the variable support from tutors, he noted “sometimes they have the poor (tutors) doing like six classes so they can’t spend too much time with you.” He indicated that a “dedicated tutor” would further support the academic progress of scholarship program members.

Self-regulation was demonstrated through improved study habits, recruitment of academic support, and challenging unrealistic expectations. The accumulation of health and interpersonal stressors impacted Jim’s academic performance in one course. Appraisal of his ability to continue as a full-time student culminated in a choice to withdraw from the engineering program and the scholarship program. Jim stated, “It’s best to save my GPA so that I can transfer to a local community college.” His pivot away from the scholarship program did not entail changes in his career goals. Jim oriented towards earning an associate degree in electrical engineering and saving money through community college attendance. Describing his learning from four-year college attendance, Jim indicated the values of “chip away at (homework) every day and ask the professor (for help).” Accruing 35 credit hours and a 3.4 GPA during community college attendance empowered Jim’s readmittance to his initial engineering program.

**4.5 Outcome Expectations**

Engineering represented an opportunity to unite strengths with interests through specialized areas. Jim selected electrical engineering with a goal, “I would like to eventually get to work in the audio industry...and work on the development of those products.” Jim noticed synchronicity between the courses, stating “it really just helps draw things together.” The cohesion between classroom learning and weekly developments in physics further connected Jim’s persisting interests with engineering practice. His career commitment was furthered by the experience, echoing pre-entry interest in “development”, and integrating new awareness of “research-oriented...hands-on field (work)” to his career plan.

Expectations of financial security and personal fulfillment were drivers of Jim’s academic persistence. The opportunity to merge personal interests with professional careers emerged through his growing awareness of the suitability of electrical engineering for audio industry careers. He expressed an expansive view of his career potential, noting specific companies and their ongoing developments in audio engineering that he’d like to contribute through. The positive experience with the scholarship program and maintained interest in engineering prompted Jim to pursue scholarships more related to his audio industry inclinations. Jim oriented towards an associate’s level degree in electrical engineering and advancing music composition skills. His plan entailed “working as an engineer in tech...and then I would go to school part time for music.” Appraising his transition to a technical college, he reported ongoing values for the “flexible” instructional approaches observed during four-year public university attendance.

**5. Discussion**

Jim indicated aspects of the scholarship program that enhanced his undergraduate engineering experience, reflected on the challenges that prompted temporary withdrawal, and returned to the engineering program after reestablishing the required academic rigor. Self-efficacy was cultivated through consistent career development support from school staff and faculty, his interest in math and science empowered entry to undergraduate engineering. This finding is consistent with research highlighting the efficacy promotive influence of early exposure to engineering concepts and interpersonal encouragement surrounding engineering selection (Martin et al., 2020). The availability of financial aid was integral to Jim’s entry into engineering studies. In his personal statement and interviews he repeatedly noted that financial security was fundamental to his motivation and expected success. Bovee et al. (2019) identified scholarship support to be significantly predictive of engineering student self-efficacy, interest, and utility value. Jim’s endorsed values are consistent with quantified differences between non-scholarship and scholarship receiving engineering students. Upon program entry, Jim found the practical application of concepts and additional instruction provided by professors to be vital observational learning opportunities. He indicated improvements in engineering self-efficacy through in-person classroom activities and valued professors’ availability for follow-up questions. Jim reported a desire for more scheduled check-ups with program leaders, stating it provided “accountability…and helpful academic navigation advice.” He indicated the tutoring and supplemental instruction support as critical support during early engineering courses, stating it would be valuable to continue these supports into higher level classes. The SIP had a positive impact on Jim’s engineering identity, social involvement and pragmatic support provided through the scholarship were cited as integral to entry and identity formation.

 COVID era educational policies posed a significant challenge, as Jim’s preferred learning methods predominately occur during in-person instruction. He adapted self-regulation strategies to mitigate the influence of COVID restrictions, integrating healthy coping skills through gym time and establishing study habits that maintained programmatic progress. The development of coping self-efficacy is a growing area of interest within engineering education, as it supports the persistence of underrepresented students and empowers progress through the rigors of intensive higher education (Sookwah & Gholizadeh, 2023). Outcome expectations were calibrated through reflection on personal interests and course facilitated learning. Jim’s coursework highlighted overlap between his audio industry interests and the potential for engineering research to connect his passions with a financially secure occupation. Competence, interests, and recognition are promotive of student’s engineering identity development, support programmatic retention (Major et al., 2019; Patrick et al., 2018). Jim indicated SIP support systems contributed to academic development, recognition of his successes, and connected his interests to professional opportunities. The financial aid availed through SIP involvement was integral to Jim’s engineering progress, a vital contribution for first-generation students.

The utilization of SCT to understand Jim’s experience was informed by the theory’s widespread use in engineering research and relevance to the desired impact of SIP programming. These findings support continued usage of SCT to explicate engineering student agency, understand the unique experiences of underrepresented student populations, and highlight areas for additional analysis.

This research reflects the engineering program experiences of a single participant from an underrepresented background. Inherent to qualitative inquiry are limits to generalizability. Qualitative methods edify research through supplementing the understanding of nuanced experiences through participants voices. Qualitative findings are bolstered through trustworthiness measures that support the rigor of analysis and preserve the participant voice throughout dissemination of findings (Glense, 2016).

 Jim praised the SIP for conducting outreach regarding the availability of instructors, advisors, and tutors for academic guidance. The program provided seminars, activities, and financial support to support engineering students. Jim noted a desire for more subject specific tutoring options as an opportunity for SIP expansion. The emergence of COVID and its associated restrictions, disbanding of valued engineering extracurricular organizations, and difficulty attaining a CPAP for medical issues impacted Jim’s academic persistence.

Future research can edify engineering education and program development through employing mixed-methods approaches to quantify the outcomes of underrepresented students across educational levels, identify contributors to persistence, and integrate qualitative participant statements to understand the lived-experience of program involvement. Understanding the engineering identity development of underrepresented students who are engaged with an SIP can aid retention efforts through quantifying the changes in competence, interest, and recognition and utilizing data to bolster deficits in SIP programming. First-generation students at Hispanic-serving institutions exhibit significant differences in engineering identity development, necessitating additional analyses of SIP characteristics that promote identity formation and assessing programmatic outcomes of first-generation students (Arnett et al., 2021). Jim indicated the SIP positively impacted his engineering identity development, a well-documented persistence factor (Arnett et al., 2021). Conducting longitudinal studies on the development of engineering identity among minoritized student groups is essential to accurately identifying the effects of SIP interventions relative to identity formation across the span of years spent in program. Longitudinal studies reveal lower academic performance and confidence associated with STEM-minority status, necessitating further inquiry into STEM program variables that mitigate barriers to success (MacPhee et al., 2013). Our research is responsive to calls for studies on underrepresented engineering students, interpreting their experiences through an empirically grounded theory, and exploring their experience with an SIP to identify contributors to success.

**6. Conclusion**

 Previous research has identified significant differences in undergraduate engineering experiences and outcomes across the spectrum of social identity. Our findings expand the engineering education literature through analyzing the SIP experiences of a first-generation, Hispanic, undergraduate engineering student. The SIP provided financial aid, tutoring, professional development, outreach, and modeling that promoted Jim’s integration into novel higher education norms and engineering culture. Recruiting the lens of SCT, participant data reflects the development of self-efficacy and self-regulation skills throughout SIP involvement. Jim’s self-motivated implementation of healthy study habits promoted academic success despite numerous setbacks. In future research, quantitative measures of self-efficacy and regulation can further clarify the impact of SIP involvement over time. The programmatic supports availed through the SIP were vital to engineering program entry and ongoing contact with program faculty empowered Jim’s return to undergraduate engineering education.

**7. Recommendations**

 Removing barriers to education will benefit the workforce of tomorrow. In some cases, the barriers are financial. Additional scholarship funding for students with high levels of financial need could mitigate these barriers. In other cases, barriers are related to academic performance. Access to tutoring, supplemental instruction, peer study groups, teaching assistants, and faculty can help students master the academic challenges. Finally, barriers often arise from external issues such as health care or interpersonal relationships. Ensuring that more students have a support network to aid their educational journey. The SIP shows that a combined effort of support (financial, academic, and personal) can result in student success.

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**COMPETING INTERESTS DISCLAIMER:**

Authors have declared that they have no known competing financial interests OR non-financial interests OR personal relationships that could have appeared to influence the work reported in this paper.

Disclaimer (Artificial intelligence)

Author(s) hereby declare that NO generative AI technologies such as Large Language Models (ChatGPT, COPILOT, etc.) and text-to-image generators have been used during the writing or editing of this manuscript.

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