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S-STEM: Educational supports designed using Growth Mindset for academic resilience

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S-STEM: Educational supports designed using Growth Mindset for academic resilience

The University of Texas at San Antonio S-STEM Scholars Program, funded by the National Science Foundation (NSF) under award number 2322770, is designed to support academically talented engineering students with demonstrated financial need in persisting in their degrees and excelling in their fields. The primary objective of the program is to bolster students' self-efficacy and promote sustained engagement and success in their engineering degree trajectories. Throughout the academic year, despite their potential, many students face obstacles such as time management challenges, personal setbacks, and academic hurdles, including low grades and struggles understanding course content. Despite these challenges, S-STEM Scholars persisted by using unique strategies to approach their work and sustain their motivation.

This paper presents the design and initial implementation of these support interventions during the program's inaugural year and provides qualitative themes from the first cohort's growth that support the intended outcomes of the project, including the ways students demonstrated growth mindset principles and how they related their future engineering work to their backgrounds.

UTSA's S-STEM Scholar Program Design

The UTSA S-STEM Scholars Program incorporates a faculty development component to strengthen classroom teaching practices that align with the program's student-centered objectives. Faculty instructors who teach within each Scholar cohort receive training on integrating growth mindset principles (Dweck, 2007), culturally responsive teaching (Gay, 2000), and culturally relevant pedagogical (Ladson-Billings, 1995) approaches into their courses. These professional development sessions are conducted at the end and/or beginning of each semester and focus on aligning course objectives, lesson activities, and assessments with the program's theoretical foundations, which incorporate growth mindset and CR^2. The goal of these trainings is to enhance faculty capacity to engage diverse learners effectively, promote inclusive learning environments, and reinforce the program's overarching aims to improve student persistence and success in engineering education.

Methodology

This longitudinal study employs a mixed-methods design to investigate the implementation and outcomes of the University of Texas at San Antonio S-STEM Program. The program provides targeted mentorship and structured workshops aimed at fostering individualized academic support and enhancing motivational and persistence-related factors among S-STEM Scholars. Data sources include participant focus groups, grades, and survey instruments designed to capture changes in self-efficacy (Bandura, 1977), mindset orientation (Dweck & Leggett, 1988; Elliot & McGregor, 2001), and academic resilience over the course of students' degree progressions. The analysis seeks to elucidate how participants utilize support strategies, adapt their learning mindsets, and develop persistence and self-efficacy in response to the program

interventions throughout their academic years. This study reports results for the first year and the first cohort of nine (9) Scholars of the UT San Antonio S-STEM Program.

Direct S-STEM Scholar quotes are included in the results section as data that showcases the themes found within the focus group. Findings from this study are expected to contribute to understanding the efficacy of theory-informed support strategies in promoting persistence among financially vulnerable engineering students.

Results

Themes that emerged from the qualitative data highlighted how students gained confidence within their courses, including specific course-related factors that shaped their confidence. Additionally, students described how they approached academic challenges, often adapting their strategies to achieve more effective and desired results. Another theme centered on the sources of motivation that encouraged students to persist in their engineering coursework. Finally, students offered suggestions for how faculty can better support engineering students from low-income backgrounds, particularly those who identify as first-generation college attendees.

Moments of Confidence and Classroom Factors. Focus group findings indicated that S-STEM Scholars experienced measurable gains in academic confidence—self-efficacy—after their first year of participation in the program. Students attributed this growth to visible improvements in their academic performance, particularly the progression from grades in early exams to midterms and then final exams. These positive trajectories fostered a sense of efficacy and reinforced students' belief in their ability to succeed academically.

Participants emphasized that pedagogical clarity related to well-aligned course instruction enhanced their comprehension and performance. One student said the following about the structure of her class: "The professor, she's actually good. It's very straightforward. What she teaches is on the exam."

Smaller class sizes were also identified as pivotal factors contributing to the perceived success of S-STEM Scholars. One quote that exemplifies this theme among the Scholars is the following:

> "In the beginning [of the semester], there was a lot of people in the class, but then…you see people who don't show up or people who dropped out. And it ended up being a much smaller class. So, people got a little more closer…and then we're talking in a group chat too…and it ended up being a nice environment."

Additionally, faculty practices that normalized academic challenges and encouraged collaborative engagement supported increased persistence. Classroom environments that facilitated peer interaction were particularly valued, as they fostered both educational and social connections. Attendance patterns also emerged as a significant variable; regular class participation was associated with stronger peer relationships and improved course outcomes.

Strategies for Difficult Assignments and Changing Approaches. Over time, students demonstrated an evolution in their learning approaches, shifting from a "try harder" mindset to a "try different" mindset, in line with Growth Mindset (Dweck, 2007). This transition reflected a growing capacity for metacognitive awareness and adaptive learning. S-STEM Scholars reported leveraging diverse strategies such as studying with peers, completing practice exams, engaging actively in instructional activities, and utilizing supplementary resources, including instructional videos and online tutorials. A female Scholar's quote shows this strategy:

> "So, when I go to different classes, I have to figure out a different method for each one, because each class has different subject, different foundation…I try not to be stuck on one approach. I try looking at it in multiple ways…like figure out people who have taken this class, who are taking it right now [repeaters] and see how they do it…I try to connect with anybody and everybody."

Interaction with peers and graduate students also provided access to academic social capital and tacit knowledge associated with navigating the hidden curriculum of engineering programs (Villanueva et al., 2018). A male Latino student said:

> "For me, it was, like, in my research…I learned the impostor syndrome…like that I'm not smart enough to be [doing] research…because I'd seen these graduate students…how they document so complex, presenting so sophisticated, and I wondered if I was smart enough to be there. And I think what helped me was my graduate student, who was in charge of me, helped me a lot, explained to me everything…I explained to her how I feel, and she said, 'No. You are smart. You are just a sophomore. Don't compare yourself to people who are doing their PhD, that have a lot of experience…It's not going to be the same.'"

S-STEM Scholars discussed how talking with others helped them understand their situations better. While they felt that they were "not smart enough" or like they were "struggling a lot," after talking with peers, they learned that they were all "in the same boat."

Students described an interactive process of evaluating and refining their strategies, noting that effective approaches often varied by course and semester. Many adopted a reflective approach, testing strategies across at least one exam cycle to determine their efficiency. Participants also noted that their initial assumptions about time and effort requirements were frequently underestimated, requiring continual adjustment to manage academic workloads effectively.

Motivation, Resilience, and Persistence. Motivational factors rooted in family expectations and gratitude for educational opportunities were prominent among participants, particularly for those with family members residing in other countries.

> "I have it set in my mind, 'I can't give up!'…I try not to make that an option. If it gets hard, I just have to push through…A big motivation is my family…knowing how much they put to have this opportunity for me. I just can't let them down. So, it's not an option for me."

Students frequently framed their persistence within the context of broader life goals, including financial stability, professional advancement, and the desire to contribute positively to their families and communities. Their careers were a means to support this motivation. One Scholar said: “Something that helped me focus more is like…I see the opportunities that I have. I see some kids in Mexico they don’t even have something to eat…What excuse do I have…?”

When encountering academic or personal difficulties, students employed coping mechanisms such as taking short breaks, reframing their challenges, or recalling their underlying motivations for pursuing engineering degrees. In addition, participation in professional conferences and networking events served as significant sources of motivation, broadening students’ academic exposure and enhancing their confidence in their disciplinary competencies.

Research, Funding, and Career Pathways. Although S-STEM Scholars reported general awareness of research, funding, and career pathways, they concurrently expressed uncertainty regarding how to navigate these opportunities. This indicated a need for earlier and more structured exposure to institutional and external resources related to undergraduate research and professional development. Participants emphasized the value of being guided toward research experiences within university laboratories and later, toward nationally competitive research opportunities. Students also sought clearer direction on where to locate information about available programs, funding mechanisms, and application procedures.

Recommendations for Supporting First-Year Students. When asked to provide recommendations for enhancing program support for first-year students, current S-STEM Scholars highlighted the importance of structured peer mentoring initiatives. Students perceived peer and near-peer influences as particularly effective in fostering confidence to engage in research and pursue extracurricular learning opportunities. In some cases, peers were considered more relatable and influential than faculty in promoting engagement.

Additional recommendations included early integration into research environments, increased visibility of scholarship and paid research opportunities, and incorporation of guest speakers from diverse backgrounds to expose students to a range of career trajectories in engineering. Participants also urged that seminars and professional development events be scheduled with attention to students’ work and class commitments, acknowledging the practical constraints often faced by low-income and first-generation students.

Discussion

Findings from this study highlight the multifaceted nature of academic persistence and success among low-income, high-achieving engineering students. The progression from fragile confidence in the first year toward growing self-efficacy reflects both cognitive and affective dimensions of learning. Faculty play a critical role in shaping these trajectories through pedagogical clarity, classroom climate, and opportunities for active engagement. The evidence suggests that when instructional approaches are transparent, structured, and aligned with

assessments, students interpret improvement as evidence of their own capabilities, an essential component in developing engineering identity and belonging within their careers.

Equally important are the social dynamics within the classroom. Peer interaction, both formal and informal, emerged as a powerful factor in reinforcing academic motivation. Consistent attendance and smaller class learning environments enabled the development of supportive peer networks that fostered resilience. These findings align with research on the significance of community and social capital in STEM retention. Faculty who intentionally cultivate peer connections through collaborative learning, discussions, or mentoring opportunities can enhance students' engagement and confidence, particularly for those facing financial or social barriers.

Students' adaptive learning approaches demonstrate the value of teaching metacognitive and strategic learning skills early in engineering curricula. The observed shift from a "try harder" mindset to a "try different" mindset underscores the potential of faculty-led interventions that encourage reflection and experimentation in problem-solving. Faculty who model or facilitate strategy adjustment help students sustain motivation when they encounter academic difficulties. Embedding structured reflection or study groups may further institutionalize these practices.

Motivational factors rooted in familial aspirations and gratitude for opportunity indicate that persistence is often sustained by deep personal narratives. Faculty and advisors can validate and build on these motivations by acknowledging the socioemotional context of learning, linking coursework to students' long-term goals, and providing mentoring that integrates both academic and personal development. For low-income students in particular, recognition of these dimensions can strengthen a sense of purpose and belonging within engineering pathways.

Students' uncertainty regarding research, funding, and career pathways points to the need to design early program interventions to demystify academic and professional systems. Structured exposure to research environments, transparent communication of funding opportunities, and mentorship that addresses the "hidden curriculum" can mitigate inequities in access to high-impact experiences (Villanueva Alarcon, 2022). Faculty partnerships with research offices, scholarship coordinators, and peer-mentoring programs collectively bridge informational gaps.

Students' recommendations for peer mentoring, visible role models, and thoughtfully scheduled professional events underscore a call for equity-minded program design. Institutions and faculty who consider the logistical realities of low-income students, particularly work hours and class conflicts, demonstrate inclusivity through intent and structural responsiveness. Programs that institutionalize peer leadership and provide early entry points into research and professional networks can significantly enhance retention and success in engineering disciplines.

These findings affirm that supporting low-income engineering students extends beyond financial aid to encompass pedagogical practices, relational support, and access to opportunity structures. Faculty who integrate clarity, empathy, reflection, and mentorship into teaching play a role in fostering academic achievement, a growth mindset, and professional identity formation.

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