Engineering Educators Bringing the World Together
2025 ASEE Annual Conference & Exposition
Palais des congrès de Montréal, Montréal, QC • June 22–25, 2025 ASEE
Paper ID #46128

BOARD # 447: Sowing the SEEDs (Scholars of Excellence in Engineering Design): Starting the SEED NSF S-STEM Program at Texas State University

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Dr. Tate, associate professor of manufacturing engineering, has established safe handling practices for industrial (such as nanoclay) and engineered (such as carbon nanotubes) nanoparticles in his research and teaching, dealing with advanced polymer nanocomposites. His research lab will serve as the training site on health and safety issues of nanomaterials. Dr. Tate is a mechanical engineer by training and has 16-plus years of academic and two years of industry experience. His research areas include developing, manufacturing; and characterizing the high-performance polymeric nanocomposites for rocket ablatives, fire-retardant interior structures of mass transit and aircraft, lighter and damage-tolerant wind turbine blades, and replacement of traditional composites using bio-based materials. He has mentored undergraduate African-American students under NASA-PAIR at NC A&T University, an HBCU, and Hispanic students under H-LSAMP at Texas State. He is a member of AIAA, ASME, ACMA, ASEE, and SAMPE. He is a recipient of a prestigious national teaching award, the 2009 Dow Chemical Educator of the Year by the Society of Plastics Engineers' Composites Division.

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Sowing the SEEDs (Scholars of Excellence in Engineering Design): Starting the SEED NSF S-STEM Program at Texas State University

Abstract

Texas State University received an NSF S-STEM award to support two cohorts of talented, low-income engineering majors, with the first cohort starting their freshman year in Fall 2024. In addition to the scholarships awarded, this program aims to increase students' engineering design self-efficacy, engineering identity, and improve persistence to graduation. The program includes unique strategies for achieving these goals, emphasizing mentoring and building a sense of community among participants. The SEED scholars were paired with a faculty mentor in their engineering major prior to their arrival on campus for their freshman year. This early contact was intended to open lines of communication with a faculty member, so the students felt they had a trustworthy source of information from someone who cared about them. As Texas State University has a high number of first-generation college students, there was an expectation that this program would likely attract a fair number of first-generation students. Without another family member's experience about how to be a college student, having this faculty mentor gave these students a person who could help them answer questions and navigate the process leading to their first semester on campus. For instance, mentors were able to talk with students about dorm selection, mathematics course placement (including strategies for placing into a higher-level mathematics course), and what to expect in their engineering coursework. Student participation in an Engineering Living Learning Community (LLC) is another unique program feature to enhance community among the SEED scholars. A general description of the program and preliminary results from the students' self-reported sense of belonging in engineering, engineering design self-efficacy, and engineering identity are presented in this paper.

Description of the SEED Program

The main goal of the Scholars of Excellence in Engineering Design (SEED) program at Texas State University (TXST) is to support two cohorts of talented, low-income, first-time-in-college (FTIC) domestic engineering students with unmet financial need by providing them scholarships; individual mentoring by a faculty member in their chosen major; and a suite of academic enrichment, career engagement, and talent development activities. It is expected that the combination of all these elements implemented will increase their self-efficacy, solidify their identity as engineering professionals, and impact their persistence toward degree completion [1-5]. The funded scholars are supplemented by the inclusion of additional students who can receive all SEED services other than scholarships. These additional students are selected from the group of scholarship applicants and are positioned for consideration for future funding through the program should there be attrition in the pool of funded SEED scholars.

An important objective of the project is for SEED scholarship recipients and non-funded guest scholars to participate in carefully scoped and sequenced development activities at different readiness levels during their undergraduate engineering education. For cohort building and peer support purposes, the SEED program takes advantage of the fact that, during the first two years of the curricula, all engineering programs at TXST share many foundational courses.

The support system for students participating in the SEED program consists of the main elements presented below:

First-Year Cohort Seminar. At TXST all incoming FTIC students are required to take the first-year course University Seminar. For each SEED cohort, a special section of University Seminar is offered for students participating in the SEED program. In addition to the required course content, students are introduced to topics and activities that are part of other SEED program elements and build relationships of peer support in a community of practice environment.

Training for Faculty Mentors. Faculty members who are mentoring SEED scholars participated in an eight-hour mentoring training course before they started meeting with students. This training was open to other engineering and engineering technology faculty members to expand the impact of the program and in case there would be a need for additional faculty mentors of SEED Scholars.

Student Mentoring. As soon as a student is selected as a SEED scholarship recipient or guest scholar, a faculty member from the engineering major that the student is planning to pursue is assigned as their SEED mentor. The mentor initiates virtual meetings during the summer to provide guidance and support before the students arrive on campus and continue in person throughout the academic year.

Cohort Talent Development. In addition to the first-year cohort seminar, scholars have other opportunities to build professional development skills and participate in professional learning communities. For example, during their first year at TXST, interested students have the option to live in an Engineering Living and Learning Community (LLC), which most of the participants in the first cohort are doing.

Product Design and Development Workshops. These workshops provide SEED Scholars an opportunity to learn about the process that companies use to design and develop new products and provide a tangible connection point between knowledge acquired during an undergraduate engineering education and the practice of the profession.

Co-op Workshops. These workshops introduce students to the purpose and benefits of co-op experiences, help them prepare their resumes, acquaint them with the co-op job interview process, guide them on how to identify and apply for co-op opportunities, and prepare them for success in co-op positions.

Undergraduate Research Workshops. These workshops address the purpose and benefit of undergraduate research experiences, discuss the typical role of an undergraduate student in a research project, familiarize students with the research activities underway at Texas State, and guide students on how to identify existing research opportunities on and off campus.

Summary of SEED Program Activities and Baseline Survey Results – Fall 2024

For the first cohort of SEED Scholars, there are 16 scholarship recipients and 5 guest scholars. The average scholarship amount was just under $12,000. Of those students, all but four (two scholarship recipients and two guest scholars) chose to live in the Engineering Living Learning Community (LLC). The LLC program allows the research team to offer additional programming to the SEED Scholars. Additionally, all but three (one scholarship recipient who had a conflict due to marching band and two guest scholars) enrolled in the special section of University Seminar, which was taught by a member of the research team and allowed a scheduled time each week to present topical materials to the students. In Fall 2024, various research team members

gave presentations on the engineering design process, idea generation, artificial intelligence, and the tallest tower building contest as part of a holiday party. Additionally, there were social events. The kickoff event allowed the scholars to meet everyone and take part in a photo scavenger hunt of various labs and student success resources. The teams were comprised of faculty mentors and all their mentees. A Halloween party included a design challenge to build a peg leg for a pirate costume. That party wound up being scheduled during the registration window for students in the LLC, and so it involved considerable class advising and registration assistance in parallel with the design challenge.

During the first part of the fall 2024 semester, the research team conducted a survey of our SEED scholars and guest scholars to ascertain the initial levels of belongingness to their engineering majors, their engineering design self-efficacy, and their engineering identity. Of the 21 students in the SEED program, 20 responded to the survey request. One of those responses was to decline to participate in the survey, and two did not complete the entire survey. The results of these surveys are presented below. Figure 1 shows the responses to the statement, "I belong in my engineering major / engineering program," which was adapted from the Social Fit measure by adding the word "engineering" [6]. While the largest number of responses was to "Agree," it is notable that seven of the seventeen students (41%) noted only "Somewhat Agree" to "Somewhat Disagree." Thus, while some students are showing early senses of belonging to engineering, others are starting their programs of study on "shakier grounds," belongingness-wise.

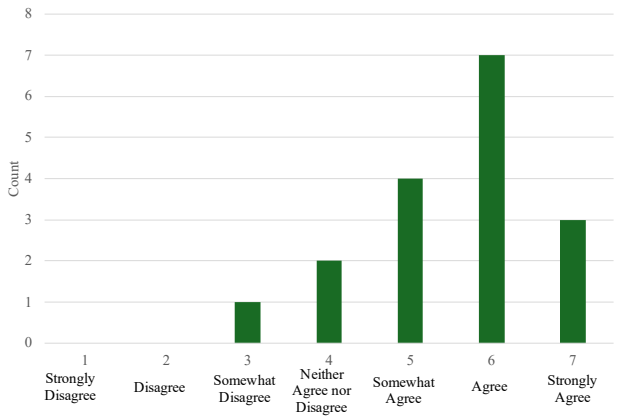

Figure 1: Belongingness to Engineering Major Fall 2024 Results (n = 17)

The students were also asked to rate their level of confidence in conducting the engineering design process using the Engineering Design Self-Efficacy Measure [7], and those results are presented in Figure 2. As these students completed this survey at the start of their first semester in college, it is not surprising to see that the majority of them (11 of 19 or 58%) rated their ability below "Moderately Can Do." These students would be considered novice learners, and so their self-efficacy is expected to be fairly low before taking engineering courses.

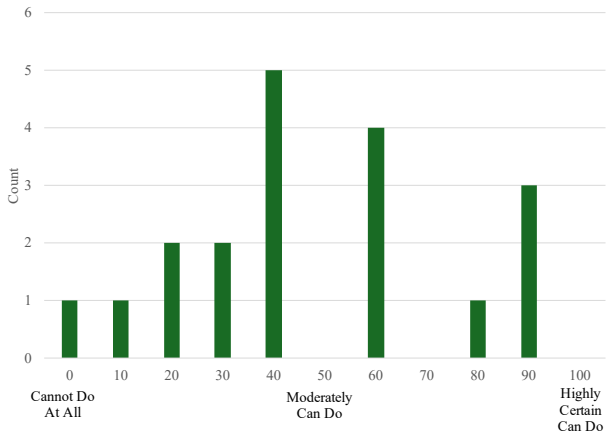

Figure 2: Engineering Design Self-Efficacy Fall 2024 (n = 19)

The students were further surveyed about their engineering identities using the Engineering Identity measure [8]. This measure probes three aspects of the students' identities: recognition of them as engineers by others, their interest and personal fulfillment in learning about and doing engineering, and their confidence in doing well in various aspects of engineering coursework. The students' identity varied based upon the aspect of their identity that was being probed. Two fifths of the students (8 of 19 or 42%) did not think that others yet viewed them as engineers, which is believed to be a result of the timing of this survey at the outset of their engineering majors. The students' confidence in performing well in their engineering coursework was much higher, with 12 out of 19 (63%) ranking their own abilities as above neutral. The strongest positive response was to the student's interest in engineering, which had 18 of 19 students (95%) ranking their interest above neutral. This strong interest in engineering is encouraging for the prospects of student retention in the field.

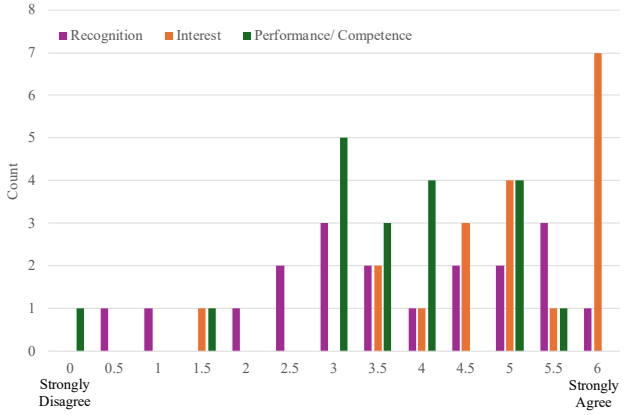

Figure 3: Engineering Identity Fall 2024 (n=19)

Plans for the next recruiting cycle

The research team is hopeful there will not be a repeat of 2024's FAFSA delays and plans to start selecting the next cohort of SEED Scholars soon after the close of the Spring 2025 semester. At the time of this writing, the scholarship opportunity is open in NSF's ETAP portal to accept applications from the next round of scholars. The opportunity is being advertised at university recruiting events on campus and is emailed to engineering students who accept admission to the

university. Additionally, a flyer about the scholarship program is emailed to area high school counselors.

Lessons Learned & Conclusions

The research team learned a lot about the math placement process at TXST. As such, the team has revised how to evaluate applications for math readiness and has prepared guides for students to understand their placement and how they can catch up in their math coursework via standardized tests. The mentoring aspect of this program, anecdotally, has appeared to have the greatest impact thus far. These students have been able to reach out to receive help with course registration and housing issues and have developed a relationship with a faculty member who is in their corner. It would be amazing if every university had the resources for each student to be paired with a faculty mentor, at least during their first year on campus.

Acknowledgements

This material is based upon work supported by NSF under Award No. 2322557. Any opinions, findings, conclusions, or recommendations expressed in this material are those of the authors and do not necessarily reflect the views of the National Science Foundation.

The authors wish to thank Felipe Gutierrez, Christine Hailey, Michelle Londa, and Stacey Kulesza for their contributions to this research project.

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