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Sprouting the SEEDs (Scholars of Excellence in Engineering Design): Results from the First Two Years of the SEED NSF S-STEM Program at Texas State University

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Abstract

Texas State University received an NSF S-STEM award to support two cohorts of talented, low-income engineering majors, with the second cohort starting their freshman year in Fall 2025. 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. In particular, each SEED scholar was paired with a faculty mentor in their engineering major as soon as they were selected to participate in the program. Before arriving on campus for their freshman year, SEED scholars had a virtual meeting with their faculty mentor to receive initial orientation. Afterwards, they had three to four in-person meetings with their faculty mentor every semester (and virtual meetings during the summer). The faculty mentors provided guidance on academic and professional related matters and helped students navigate the campus resources available to support their success. Most scholars felt that having a faculty mentor was a highlight of the program since it provided them with access to a trustworthy source of information from someone who cared about them. Texas State University has a mandatory 1-credit university seminar course for first-time college students. A special section of this course was created for the SEED scholars, and the section was taught by a member of the project team. Participation in this special section provided a weekly point of contact for the new cohort of SEED scholars and allowed us to use some class sessions for presentations about topics such as the product development process and artificial intelligence. A brief description of the program and early results from the students' self-reported sense of belonging in engineering, engineering design self-efficacy, and engineering identity are presented in this paper. In addition, lessons learned during the first project year are discussed.

SEED Program at Texas State University

The primary goal of the Scholars of Excellence in Engineering Design (SEED) NSF S-STEM project at Texas State University is to support two cohorts of talented, low-income, first-time-in-college (FTIC) domestic engineering students with unmet financial need. This support is provided through scholarships, individualized mentoring by a faculty member in the student's chosen major, and a suite of academic enrichment, career engagement, and talent development activities. Based upon prior work [1, 2] it is expected that the combined impact of these elements will increase students' self-efficacy, strengthen their identity as engineering professionals, and positively influence their persistence toward degree completion. A longer description of the program can be found in Talley et al. [3].

In addition to funded scholars, the program includes a limited number of non-funded SEED guest scholars who receive all SEED services except scholarships. These students are selected from among scholarship applicants who meet all eligibility criteria and are positioned for consideration for future funding through the program in the event of attrition among funded SEED scholars. At present, there are two cohorts of SEED scholars. The first cohort (Cohort 1),

which began in Fall 2024, included 12 scholarship recipients and 1 guest scholar in Fall 2025. The second cohort (Cohort 2), which began in Fall 2025, had 25 scholarship recipients and 2 guest scholars. Thus, in Fall 2025, the total number of SEED program participants was 40. These participants ranged across the various majors in the Ingram School of Engineering including Civil (16), Mechanical (17), Manufacturing (2), and Electrical (5) Engineering.

During calendar year 2025, SEED scholars and guest scholars were invited to participate in a wide range of opportunities including individual mentoring by a faculty member in their engineering major, enrolling in a special section of a required one-credit university seminar course, participation in an Engineering Living Learning Community (ELLC), social events, and workshops on soldering, resume writing, research opportunities on campus, and product design and development.

Incoming, FTIC students are required to take a one-hour course entitled University Seminar (US1100) which is designed to help students transition to Texas State University. The seminar helps students identify challenges of university life and strategies to be successful. Students are exposed to practical learning skills such as time management and test preparation as well as introductions to services on campus such as tutoring, dimensions of wellness, and career services. With support from the Registrar, SEED scholars were enrolled in a special section of US 1100 which permitted them to develop a peer support network. About two-thirds of the topics in US 1100 are common across all sections to expose students to concepts and services that promote students' academic success regardless of major. One-third of the topics were not prescribed by the university, which permitted SEED scholars to be introduced to product design and development, engineering concept generation, and engineering in the age of AI. SEED scholars had an opportunity to interact with members of the engineering industrial advisory board to learn more about engineering life after graduation. The SEED section of US 1100 required meetings with a peer mentor twice during the semester. The peer mentor was a junior in mechanical engineering and offered practical advice on how to navigate the first semester including pre-registration, challenges with roommates, and best off-campus places to visit. Peer-support outcomes included several study groups that formed because of interactions in the course. In addition, several SEED students from the first US 1100 SEED cohort formed a mentoring group that began to plan activities and outreach for the incoming SEED cohort.

Survey Results

At the beginning of each long semester, we survey our students (both scholarship recipients and guest scholars) to check in on their current senses of belonging to their engineering majors, their engineering design self-efficacy, and their engineering identity [4, 5, 6]. The results of the three semesters of survey data are reported below. Since our second cohort of SEED scholars came on campus in Fall 2025, the results only report one semester in college for this group. The first cohort has been on campus for three semesters and thus we can begin to see trends in their changes in self-perception over that time. Figure 1 presents the changes of students' sense of engineering belonging by semester in college. The first cohort's average results are presented in maroon and show a steady increase with each semester in college. This overall trend was expected because many of these students participated in the university's ELLC, which immediately gave them a group affiliation on campus (a contributor to sense of belonging [7, 8])

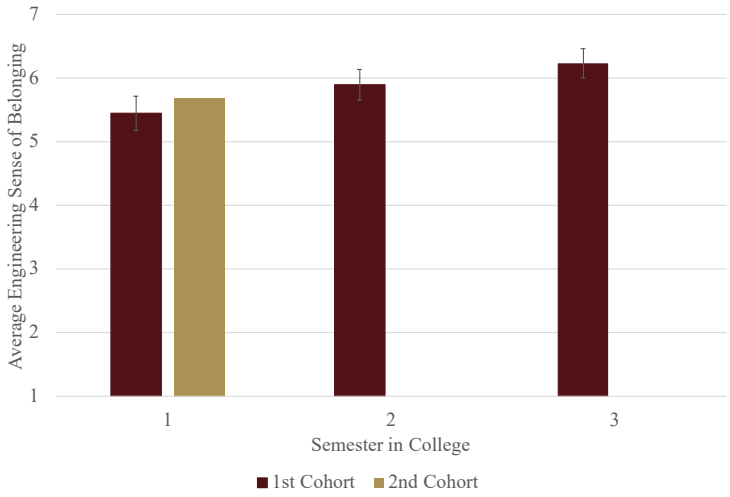

Figure 1: Students' Sense of Engineering Belonging by Number of Semesters in College

in addition to their membership in the SEED program, and because a few students from the first cohort have dropped out of the program due to low GPAs. Using only paired data we see increases in the belongingness means each semester, although the differences are not statistically significant. The sense of belonging of the second cohort of students is similar to the first cohort for their first semester in college, with no statistically significant difference between these groups. As there is an overall higher rate of participation in the activities the grant has hosted this second year, we are hopeful that the second cohort will show even greater gains in their senses of belonging from the first to second semesters.

In Figure 2, the students' engineering design self-efficacy is presented. This chart presents the mean score with standard error bars for the participating students by semester in college. While a large gain in self-efficacy is noted from the first to second semester, the third semester results are very similar to the second semester. In comparing either the second or third semester self-efficacy to the first, there is a statistically significant increase in engineering design self-efficacy ($t(16) = 3.80$, $p = .002$ for first to second semester and $t(10) = 2.43$, $p = .035$ for the first to third semester comparison). The second to third semester engineering design self-efficacy results were not statistically significantly different. We hypothesize that early this jump is due to the coursework these students are experiencing in their programs of study. Most of our 1st cohort SEED scholars were introduced to the engineering design process as part of their special section of their university seminar course in their first semester on campus, but their course sequences do not involve much more design experience until they are in their upper division coursework. While we offered engineering design workshops the spring of their freshman year, very few of our scholars participated. As such, those workshops would not have had a significant impact on the average self-efficacy of the group. We expect to see significant gains in these scores (as the scales goes up to 100) as our scholars reach their junior and senior years. The second cohort of students show

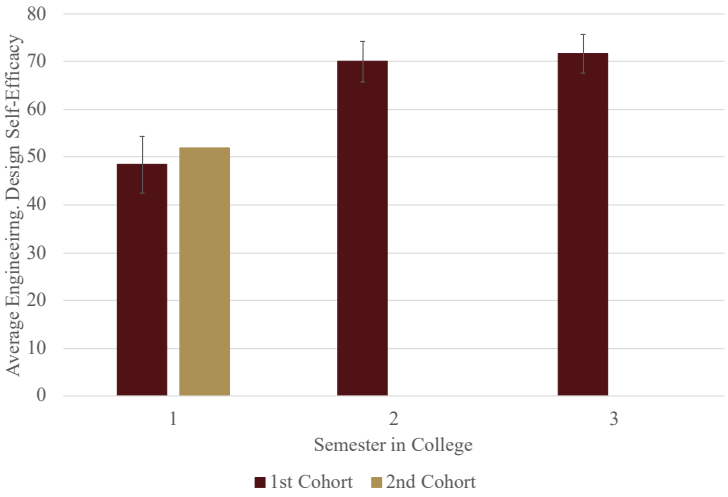

Figure 2: Engineering Design Self-Efficacy by Semester in College

similar rates of engineering design self-efficacy during their first semester on campus as did the first cohort (no statistically significant difference). As many of them are also attending the special section of university seminar (taught by the same faculty member as the first cohort and using the same lesson plans), we are expecting a similar increase in self-efficacy amongst our scholars for their second semesters.

Figure 3 presents the three domains of engineering identity for the first cohort of students by semester. The students' interest in engineering has remained consistently high throughout these three semesters, with no statistically significant differences in this domain of identity. There have been statistically significant gains in the other two domains of identity: recognition and performance/competence. As these students have begun moving through their engineering programs, they feel like more people identify them as engineers (the recognition domain) with statistically significant gains between the first and second semester in college ($t(16) = 2.39$, $p = .029$) as well as between the first and third semester in college ($t(11) = 3.44$, $p = .006$). Further, they are feeling more confident in their abilities to conduct engineering work (the performance/competence domain) with a statistically significant increase from the first to second semesters in college ($t(16) = 2.43$, $p = .027$). This domain has overlaps with students' engineering design self-efficacy, which is the students' self-belief in their ability to conduct engineering design. While the self-efficacy measure specifically targets engineering design tasks and the identity domain considers all aspects of engineering work, there are clear similarities in these self-concepts. As such, the similar gains between these two measures are as would be expected. The second cohort of students' engineering identity results are not statistically significantly different than the first cohort in their first semester, which is a trend observed for each survey measure and an indication that our students are starting from relatively similar points in the development of their engineering identities, senses of belonging, and engineering design self-efficacy. As each measure showed no statistical difference by cohort for the first semester, we expect to be able to combine the data from both cohorts in future analysis.

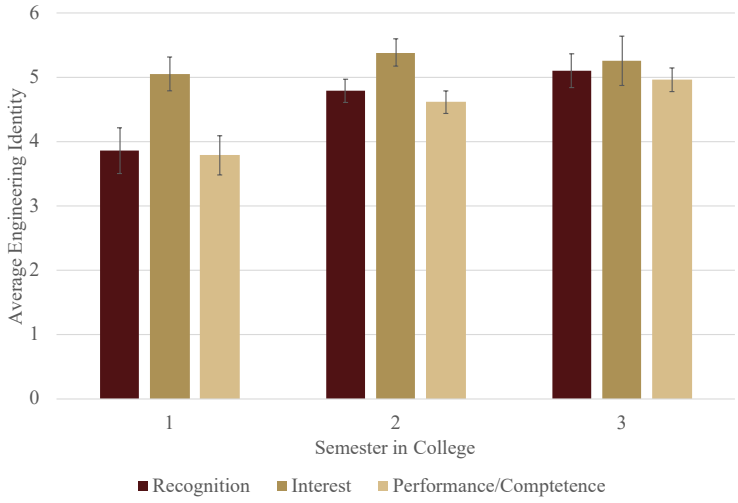

Figure 3: Engineering Identity for the First Cohort of Participants by Semester in College

Lessons Learned and Plans for Next Year

From a student perspective, one of the most valuable benefits of participating in the SEED program has been the personalized mentoring received from a faculty member in their chosen engineering major. Students who actively engage in the mentoring process feel comfortable reaching out to their mentors for guidance on matters such as campus opportunities, identifying resources to improve their academic performance in specific courses, and selecting courses for

the following semester. Beginning the mentoring process during the summer before students arrive on campus has eased their transition to college and provided a reliable point of contact who they can turn to when issues arise during their first weeks on campus. Having a peer mentor in the SEED section of US 1100 was well received by students, as the peer mentor could provide guidance and advice on matters with which faculty mentors may be less familiar, such as extracurricular activities available on campus and off-campus housing options near the university.

Involving SEED students in the selection and planning of events helped increase student participation. Student feedback also indicated that workshops focused on undergraduate research or product design and development might have higher attendance when students reach their junior year. In contrast, first- and second-year students prefer activities that are perceived as social events aimed at cohort building rather than academic work. Activities framed in this way can still incorporate technical elements, such as a short design challenge, when they are presented as engaging, hands-on experiences that students perceive as fun and informal rather than as formal class assignments.

Finally, the participation of non-funded SEED guest scholars broadened the reach of the program by extending its benefits to a small number of students who met all scholarship criteria but could not initially be funded due to limited SEED scholarship funds. When a student in the first cohort lost the SEED scholarship for academic or other reasons (such as changing majors or no longer being Pell-eligible), guest scholars from the same cohort were considered for the scholarship. As a result, several students who began as guest scholars are now receiving the SEED scholarship.

Plans for next year include implementing a peer mentoring program for SEED scholars, continuing to schedule social events aimed at cohort building, and conducting workshops on co-ops, undergraduate research opportunities, and product design and development. Regarding peer mentoring, one option under consideration is training high-performing students from the first cohort to serve as peer mentors for students in the second cohort. For the product design and development workshops, an alternative being explored is conducting them alongside a long-term project focused on designing a product and building a physical prototype of the proposed design. If this approach is pursued, the product will need to be carefully selected to engage students while remaining simple enough to avoid excessive time commitments. Finally, a concerted effort will be made to assist students from the first cohort in securing summer internships as they transition from their sophomore to their junior year.

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