Board 414: Tracking the Progress Towards an Engineering Degree of Three Cohorts of Low-income Engineering Students Supported by a Track 3 Multi-Institutional S-STEM Grant

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With a project built on the Model of Co-Curricular Support for Undergraduate Engineering Students[1], East Carolina University (ECU) in collaboration with three partnering community colleges was awarded a Multi-Institutional Track 3 S-STEM Grant (Grant number: 1930497) in January 2020. The intention of the project was to recruit 2 cohorts of scholars with 40 students each. One cohort was to start their pursuit of a Bachelor of Science (BS) in Engineering degree in Fall 2020 and the other in Fall 2021. Each cohort was to be comprised of 20 students who started at ECU as freshmen and 20 students who intended to get an associate's degree from one of the partnering community colleges and transfer to a university to complete the BS in engineering. Despite some early challenges in recruiting students and implementing planned programs due to the Covid-19 pandemic, three cohorts of low-income students have been recruited and supported by scholarships valued at up to $10,000 per year. In addition to scholarship support, various other support mechanisms have been implemented including a week-long summer bridge program for incoming students, a peer mentoring program, a textbook lending library, faculty mentoring, and various collaborative programs involving career speakers, design challenges, and professional development opportunities. With the first cohort of students now entering their senior year and several community college students having already transferred to the university, this paper discusses the recruitment and retention of scholars, details of program activities, and the progress scholars have made towards an engineering degree. This paper also draws comparisons between the scholar cohorts and all students entering the ECU engineering program in the same semester to identify differences in GPA and retention.

Recruitment

In Spring 2020, in-person recruitment events were held in various local high schools throughout Eastern North Carolina. Unfortunately, the onset of the global Covid-19 pandemic forced the cancellation of several planned in-person recruiting events. The uncertainty of the Fall 2020 semester in regards to whether classes would be held in person or remote, caused several students to reconsider starting college with the pandemic ongoing. With potential enrollment declines looming as a result, the large flagship engineering program in North Carolina (NC State University) accepted more engineering students than they traditionally have and as a result, some students ECU would have normally enrolled were instead admitted to NC State and accepted that offer instead. Despite some of the challenges of recruiting scholars, scholarship applications were received from 59 students and scholarships were offered to 23 qualified applicants. Of those offered the scholarships, 11 freshman engineering students were enrolled at ECU in Fall 2020 as part of the first cohort of scholars.

In the second admissions cycle (2021), more relationships had been built between ECU and various teachers and counselors in the targeted geographic region. This allowed for broader dissemination of information about the scholarship program. While the Covid-19 pandemic persisted, some in-person recruiting was able to occur on campus at ECU and in the community

with restrictions. For this cohort, a total of 78 students applied for the scholarships available at ECU. Of those applicants, 37 qualified applicants were reviewed by the scholarship selection committee with 29 scholarship offers made. The second cohort of scholars started at ECU in Fall 2021 with an enrollment of 19 incoming engineering freshmen.

Throughout the recruitment of the portion of scholars at ECU, recruitment efforts were also underway on each of the three partnering community college campuses. Recruitment of community college students presented unique challenges in that enrollment is open until the day before classes start, so identifying qualified incoming students is not easily done before a semester starts. Also, many of the students starting at community college were not prepared to start in calculus, so they would take longer than 4 years to graduate and the selection committee did not want to award students a scholarship knowing that funding would not be able to follow them all the way through to graduation. Additionally, many students who start in math below the calculus level do not persist towards an engineering degree, so the committee wanted to select students who had a demonstrated math aptitude before awarding a scholarship. The scholarship selection process at each of the community colleges was not as straight forward as at the university due to these circumstances. To date, Lenoir Community College (LCC) has enrolled a total of 3 scholarship recipients, Wayne Community College (WCC) has enrolled a total of 5 scholarship recipients, and Pitt Community College (PCC) has enrolled a total of 18 scholarship recipients.

Given the challenges in recruiting scholars to the first 2 cohorts, the Principal Investigator (PI) team discussed with the program officer the possibility of recruiting a third cohort of scholars and was approved to do so. For the Fall 2022 cohort recruitment, a total of 68 applications were received and 12 qualified applicants were reviewed with 11 scholarships being offered by the committee and a total of 8 new freshmen engineering majors enrolling in the Fall 2022 semester.

Table 1 showcases the number of applications received by ECU for each scholar cohort, the number of scholarship offers made, and the total number of students enrolled before any cohort additions or attrition. These numbers include only the applications for the scholarships available to freshmen engineering students at ECU and do not include any applications for scholarships at partnering community colleges.

Table 1 Scholarship Applications, Offers, and Enrollments by Cohort

Cohort Start Term	Applications	Offers Made	Students Enrolled
Fall 2020	59	23	11
Fall 2021	78	29	19
Fall 2022	68	11	8

Scholar Retention and Cohort Additions

Some students lost eligibility for the S-STEM scholarship by changing majors, having too low of a GPA, or having a significant change in family finances resulting in ineligibility for the award to continue. One scholar had to leave the university due to a medical problem and has been unable to return. As scholars left the cohorts, replacement scholars were identified from students

enrolling at ECU in the same semester as the scholars who lost their scholarship. One transfer student came to ECU for one semester, but was offered a major scholarship to attend NC State University and opted to continue her studies there.

Table 2 delineates the original size of each cohort of incoming freshmen at ECU and shows how many students have been removed from the cohort by losing their scholarships for a variety of reasons. Additions to the cohorts from students in the same entering class at ECU are shown along with community college transfer students added to each cohort. So long as students continue to pursue an engineering degree at ECU, they continue to be invited to scholar events and activities, even if they are no longer financially supported by scholarships.

Table 2 Cohort Size, Additions, Removals and Retention by entering term

Cohort Start Term	Original Cohort Size At ECU	Scholars losing scholarship	Members Added from ECU	Members Added from CC Transfers	Retained in Engineering†
Fall 20	11	6*	5	6	20/22 (91%)
Fall 21	19	4**	2	2	19/23 (83%)
Fall 22	8	0	0	0	8/8 (100%)

* includes 1 student lost due to a medical withdrawal, 1 student lost to a change of major, 3 students who were no longer financially eligible, and 1 student who transferred to another university

** 4 students lost due to a change of major out of engineering

† When accounting for engineering retention, students who lost S-STEM scholarships for financial reasons or who are still in pursuit of an engineering degree at any institution are considered retained if they are still enrolled in engineering coursework as of the Spring 23 semester.

One the goals of this S-STEM program was to promote success among community college students by integrating them into various activities. There has been some success at supporting students to obtain their associate's in engineering degree and to transfer to a BS in Engineering program, but there have also been some challenges in recruiting and retaining students at the community colleges. Many of the students at community college struggled with the required math courses and after trying calculus decided that they no longer wanted to pursue an engineering degree. Other students had difficulty balancing school and work with many community college students having less parental financial support than their peers at the university. The partnering community colleges have also had some inconsistency in program leadership with faculty turnover in the engineering programs at each partner. This has presented difficulty for students to be able to consistently take all the classes they needed to pursue their engineering degree. Additionally, with the cost of attendance at the community college being significantly lower than a university, it was difficulty to identify a pool of applicants who were both eligible for calculus and had enough demonstrated financial need to qualify for the scholarships. Table 3 showcases the number of scholarships awarded by each partnering community college and the progress of those scholarship recipients toward an engineering degree. At this point in the program, the goal was to have awarded scholarships to 40 community college students and funding was in the budget for each of those scholars to have 4 semesters of support at community college. Both LCC and WCC have decided to terminate their associate's

in engineering programs. The PI is in discussions with another community college in Eastern North Carolina about partnering with this program to be able to support as many community college students as was originally expected.

Table 3 Community College Scholars progress toward degree

Community College	Scholarships Awarded	Scholars losing scholarship	Scholars Transferring to University	Retained in Engineering[†]
LCC	3	2*	0	1/3 (33%)
WCC	4(5)	2**	4***	4/5 (80%)
PCC	18	9	4	9/18 (50%)

*2 scholars a LCC dropped out of the engineering program

**At WCC 1 scholar lost the scholarship due to poor academic performance. Another CC2W student was identified as a potential scholar candidate, but was financially ineligible while a CC student, upon transfer to university this student was awarded a scholarship, but has subsequently lost the scholarship due to a change in financial eligibility for federal aid, but this student continues to be in pursuit of a BS in Engineering degree and is counted among the 3 retained in engineering.

***The 3 scholars transferring from WCC to ECU include 1 WCC student who did not receive a scholarship while at CC2W, but was awarded one based upon the higher cost of attendance at ECU

Scholar Activities

Welcome Dinner

A dinner was held on the campus of ECU for all incoming scholars at both the university and community college partners in both August 2021 and August 2022. Scholars were invited to a meal, had opportunity to tour engineering lab facilities, and saw a presentation from the Dean, Department Chair, and project PIs. A "human bingo" game was developed as a mixer to allow students to get to know each other.

Summer Bridge Program

In both August of 2021 and 2022, incoming freshmen scholars were invited to move into the dorms at ECU a week before classes were scheduled to start. During this week, the students had a variety of activities to acclimate to campus, to get to know each other, to meet the faculty, and to learn about various supports on campus. Students connected their computers to campus wifi, downloaded needed software, met with an engineering academic advisor, engaged in mixers with engineering faculty, visited the campus tutoring center, and toured engineering facilities at some industry partners. Students were able to engage in recreational activities such as a low-ropes course and a night of video games, billiards, and ping pong. One of the featured events of the summer bridge was a scholar panel where returning students were invited to share their experiences with incoming students and the incoming freshmen could ask the returning students questions. Figure 1 is a picture from the student panel during the summer bridge. Figure 2depicts a design challenge students participated in during the summer bridge in which they had to design the tallest tower out of soda straws with limited supplies.

Covid-19 was a factor in the summer bridge program in both 2020 and 2021. A summer bridge was planned for the scholars coming in 2020, but was unable to be held due to many of the residence life staff being furloughed. In 2021 a full summer bridge program was planned, but some of the activities were cut short because one of the scholars tested positive for Covid in the middle of the week.

Weekly meetings

The PI hosts meetings weekly throughout the semester with each cohort of scholars to present various upcoming opportunities on campus and to hear about any concerns the students may have. Some of these meetings have brought in guest speakers such as the director of the campus financial wellness hub to talk about making good financial choices while a student. These meetings have showcased campus events such as career fairs and how to prepare for them, have discussed finding student organizations of interest, have discussed the backgrounds of each of the faculty so students can begin to identify a faculty mentor, and more.

All Scholar Saturday Events

Several events have been held on the partnering community college campuses for all scholars to come together. During these events there have been design-build competitions, career speakers, professional development opportunities, and a chance for scholars from various campuses to meet fellow scholars and faculty from each partnering institution. Activities have included a rocket building and launch activity where students designed and 3D printed custom nose cones (Figure 3) and a sumo robot design competition where students built an Arduino-based robot and competed to see which robot could outlast the other in a sumo ring (Figure 4). Students have had the opportunity to hear from local engineer professionals including some alumni from the partnering institutions. The invited career speakers were chosen to tie into the theme of the day's activities, for example, at the all-day event where students used 3D printing to create rocket nose cones, the students saw a presentation by the president of Eastpoint Prosthetics, a business located near LCC's campus that uses 3D printing techniques to fabricate limbs for amputees. The president of Eastpoint who delivered the presentation shared that he and his son were both LCC alumni. A picture from this presentation is shown in Figure 5. Students also had their resumes critiqued and had the chance to participate in mock interviews to practice their professional presentation skills.

Social Events

In order to provide scholars with an opportunity to build more relationships, particularly relationships across campuses, students have been invited to dinners off campus and to take part in an escape room activity where students had to work together to solve various logic puzzles.

Service Events

Scholars have also been invited to engage in service events such as serving as marshals for the college graduation, scoring math tests for the local MathCounts competition, and helping so support campus outreach events such as the university open house.

Figure 1 Student panel for returning sophomore scholars to present their experiences and answer questions from incoming freshman scholars in 2021 Summer Bridge

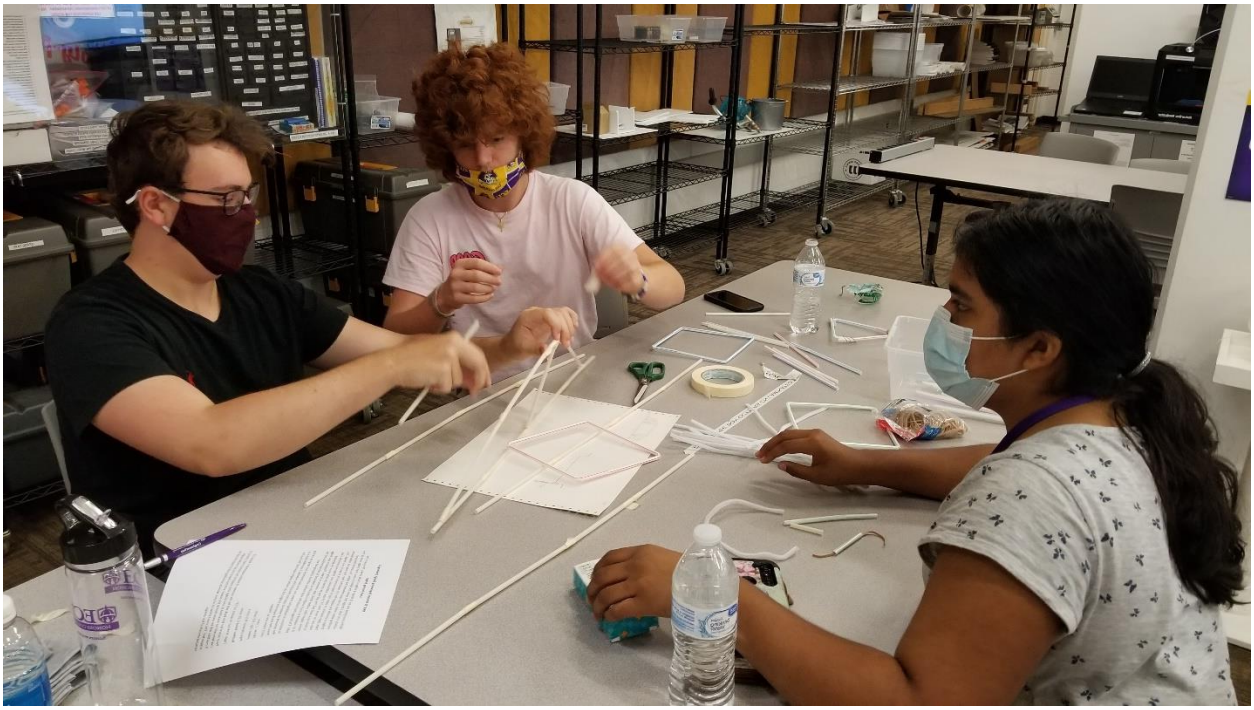

Figure 2 Soda straw tower design and build challenge during summer bridge

Figure 3 Students building rockets during a collaborative scholar event

Figure 4 Students building and coding a sumo robot

Figure 5 Career speaker presenting information about 3D printed prosthetics

Academic Performance and Progress Towards an Engineering Degree

The students who have been selected for this program have mostly persisted towards an engineering degree. Of the 45 students who have been awarded scholarships at ECU who started as freshmen at the university, 40 are still in pursuit of an engineering degree. This is particularly noteworthy given that many of these students started their collegiate experience during the Covid-19 pandemic when classes were forced online and many traditional college experiences students would have on campus were either modified, cancelled, or postponed.

As can be seen in Table 4, the mean GPA for students in each scholar cohort is higher than the mean GPA for all students who entered the engineering program at ECU during the same academic period as the respective cohort. A total of 89% of all scholars have been retained in the BS in Engineering program and that number would be higher if one student did not have a major medical issue requiring her to leave the university. When accounting for retention, students are included if they are still pursuing an engineering degree even if they have lost eligibility for their scholarship for reasons such as financial changes.

Table 4 Persistence and GPA information for each cohort of scholars

	Total Students*	Retained to Year 2**	Retained to Year 3	Still in pursuit of BS in Engineering	Mean GPA
Cohort 1	16	14 (88%)	14(88%)	14 (88%)	3.18 (3.13)
Cohort 2	21	18 (86%)	TBD	18 (86%)	3.24 (3.03)
Cohort 3	8	TBD	TBD	8 (100%)	3.01 (2.95)

*Includes only students who started at ECU who were either part of the cohort from their freshman year or who were added to the cohort in a later semester and does not include transfer students

**Retention numbers include students who have lost eligibility for the scholarship, but who have continued to pursue an engineering degree.

Summary and Expectations Moving Forward

This paper presents the outcomes after 3 years of work on a multi-institutional Track 3 S-STEM grant. Results are promising indicating that supported students are persisting at the university and that the GPA of supported students is on average higher than the GPA of students' peers in the same entry class. There is some concern with the ability to retain students at community college. Given that two of the three partnering community colleges are terminating their associate's in engineering program, the PI is currently working to establish a new partnership with a larger and more stable community college. Discussions are currently underway to provide scholarships to students at a fourth partner college in order to impact more students that would be possible under the current arrangement. Moving forward it is anticipated that more students will transfer from the partnering community colleges to ECU. The programming created by this project has potential to be sustained and to impact students positively for many years to come. Of particular significance is the summer bridge program, the scholar activities, and the partnerships across institutions to support students.

References

[1] Lee, W. C., & Matusovich, H. M. (2016). A model of co-curricular support for undergraduate engineering students. Journal of Engineering Education, 105(3), 406–430.