

An Integrated Program for Recruitment, Retention, and Graduation of Academically Talented Low-Income Engineering Students: Lessons Learned and Progress Report

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Abstract

This paper provides the status report of an NSF S-STEM program that is currently in its fourth year in the College of Engineering at the University of Illinois at Chicago (UIC), a minority-serving institution. The paper also offers a list of the lessons learned during the implementation of the project. A summary of the paper materials will be presented at the National Science Foundation (NSF) Grantees Poster Session during the 2022 ASEE Annual Conference & Exposition. The objectives of this S-STEM program are to 1) enhance students' learning by providing access to extra and co-curricular experiences, 2) create a positive student experience through mentorship, and 3) ensure successful student placement in the STEM workforce, or graduate/professional degree programs. Financial assistance is provided to the students who have been admitted to this program. The program supports three cohorts of students. Cohort I and Cohort II consist of 18 and 13 students, respectively. These students started their engineering programs as first-year. Cohort III has 19 students who transferred to the College of Engineering from various community colleges. More than 60% of the students identify as part of underrepresented groups in STEM. Several support and intervention programs have been created through this project. They include 1) a Summer Bridge Program that was taken by all the cohorts before or during their first semester at the UIC, 2) an Engineering Success Initiative course that was taken by all cohorts in their first semester, 3) a Service Learning Project course that is taken by each student in at least two consecutive semesters, and 4) an integrated mentoring program that matches each student with a faculty mentor and an industry mentor. The paper reports a summary of the support components of the program and the lessons learned from them. Out of the 50 students recruited by this S-STEM project, one student has graduated and is working in industry. At the time of this report, of the 50 students enrolled across all cohorts, one graduated to an industry position, 46 remain in school, and 3 did not continue with the program. All the continuing students have passed at least three semesters of their studies. Therefore, the project has a 94% first-year retention rate which is above the university's first-year retention rate. The paper provides more information about the retention and performance (Grade Point Average) of the students.

Introduction to the Scholarship

Despite decades of remarkable organizational and financial investments, the number of talented low-income engineering students is considerably low [1][2]. The University of Illinois at Chicago (UIC) is a research-intensive, urban, Minority Serving Institution and has the federal designations of Hispanic Serving Institution and Asian American Native American Pacific Islander Serving Institution. Although the College of Engineering (COE) at the UIC serves a diverse student population from various ethnic and economic backgrounds, the graduation rate of academically talented, low-income students is lower than that of academically talented, high-income students. Therefore, the important issue of low retention and graduation rates of academically talented, low-income students needs to be addressed.

The S-STEM (Scholarship in Science, Technology, Engineering, and Math) project at the University of Illinois at Chicago started in 2017 to support and increase retention and graduation rate of academically talented low-income engineering students. The objectives of the project are to 1) enhance students' learning by providing access to extra and co-curricular experiences, 2) create a positive student experience through mentorship, and 3) ensure successful student placement in the STEM workforce, or graduate/professional degree program. During the five years of the project, students have been supported financially, academically, professionally, and socially through the different evidence-based activities such as the Summer Bridge program, the GPIP, Service Learning Project courses, and faculty and industry mentorship programs.

This paper summarizes the project's tasks that have been completed in the first 54 months since its inception and describes the activities projected for the remainder of the project.

The First, Second, and Third Cohorts of S-STEM Scholars

Sixteen, 13, and 19 students were recruited, interviewed, and selected for the first, second, and third cohorts respectively, beginning in 2018. Financial assistance was granted to the scholars from all three cohorts based on their individual needs.

Out of 47 scholars, 18 are female and 29 are male. They represent the majority of engineering majors in the College of Engineering. Moreover, 21 scholars are first-generation college students and 6 of them identify as Black/African American and 12 as Hispanic.

Table 1 represents the demographics of all scholars enrolled in the S-STEM program, such as gender, race, and their majors.

Table 1. Cohorts I, II, III scholars' information

Information		Gender		First Generation	Race ¹					Major ²						
		F	M		H	AA	A	AI	W	BME	ChE	CME	ECE	CS	IE	ME
Number of Scholars	Cohort I ³	6	10	7	6	2	3	2	3	1	2	3	0	4	2	4
	Cohort II	5	8	3	0	1	5	0	7	1	1	1	1	7	0	2
	Cohort III ³	7	11	11	6	3	4	1	4	2	0	2	3	9	1	1
	Total	18	29	21	12	6	12	3	14	4	3	6	4	20	3	7

¹ H: Hispanic, AA: African American, A: Asian, AI: American Indian, W: White.

² BME: Biomedical Engineering, ChE: Chemical Eng., CME: Civil, Materials, and Environmental Eng., ECE: Electrical & Computer Eng., CS: Computer Science, IE: Industrial Eng., ME: Mechanical Eng.

³ Originally, there were 18 Scholars recruited for the first cohort but one of them dropped out of the University after the first year and the other one dropped out after the second year. Also, one of the third cohort's students dropped out after the first year.

Progress and State of the Scholarship

Different types of activities have been designed for the scholars. In the remaining subsections, the feedback and lessons learned from the tasks which were completed will be described as well as the progress of the ongoing tasks.

Feedback and Lessons Learned from the Completed Activities

S-STEM Scholars *Eligibility and Selection*. In Darabi et al [3], the main criteria for selection of the scholars were described. For the first cohort of the scholars, 45 students were interviewed, 18 of them were offered the scholarship and all of them accepted. Among 36 potential scholars who were interviewed for the second cohort, 14 of them were offered and 13 accepted. For the third cohort, among 35 candidates who were interviewed, 19 were offered and all of them accepted the scholarship.

Table 2 shows the average high school GPA and cumulative GPA for all three cohorts of the scholars.

Table 2. Scholars' high school and cumulative GPA

Cohort/Metric	Number of Scholars	Average High School GPA (out of 4.00)	Average Cumulative GPA (out of 4.00)
Cohort I	16*	3.76	3.52
Cohort II	13	3.92	3.88
Cohort III	18**	3.41	3.31
Total	47	3.67	3.54

* Two of the first cohort scholars left the program because of personal reasons.

** One of the third cohort of scholars dropped out of the University.

Summer Bridge Program (SBP). The Summer Bridge Program, which is designed to prepare scholars for transitioning into college, includes a residential and immersive experience. Cohort I and II attended the SBP in the summer prior to entering the University (summer 2018 and 2019, respectively). The SBP structure, execution, and assessment results were reported in detail by

Nazempour et al [4]. During the SBP, scholars from cohort I and II were paired with undergraduate ambassadors who guided the cohorts through academic, professional, and social questions as they became acquainted with the university and their major.

Due to COVID-19 pandemic, Summer Bridge Program for cohort III was held virtually via Zoom, in Spring 2021. During this 2-hour online workshop, cohort III scholars became acquainted with the program, faculty mentors, and some of the cohort I and II scholars. There was also a Q/A session for cohort III scholars to ask their questions to scholars of other cohorts and the program faculty.

Faculty Mentorship Program. To ensure all scholars have access to resources and feel supported, each scholar was assigned to a faculty mentor from the academic department corresponding to the scholar's major. Cohort I and II scholars were assigned to their faculty mentors during the Summer Bridge Program and cohort III scholars were assigned to the faculty mentors prior to the SBP.

Scholars are mentored by their assigned faculty mentors throughout the program. They have the opportunity to meet with their mentors several times a semester and be assisted not only in academic fields but also with their time management, graduate study goals, internship application preparation, and grade improvements.

Introductory Engineering Course. Engineering Success Initiative (ENGR194) was offered for the first time in Fall 2018 for cohort I. The course was also offered to cohort II of scholars in Fall 2019 after some minor modifications. This course was designed to create the opportunity for scholars to interact with professionals of different disciplines and cultural backgrounds and attend seminars and symposia on different subjects. The ENGR194 implementation and its impact on students' academic success and retention were described in detail by Nazempour et al. [5].

ENGR194 was offered for the cohort III of scholars in Spring 2021. We modified it based on our evaluations of the earlier offerings. The course content included math and science discussion groups, four-year study plan development, major selection, entrepreneurship challenge, time and stress management, introduction to undergraduate research projects and internship, engineering identity construction, and introduction to math application in engineering disciplines.

Guaranteed Paid Internship Program (GPIP). GPIP is a novel program within the College of Engineering that guarantees qualified, academically talented students a paid internship or research opportunity if they commit to return to the College the following fall semester. Cohorts I and II participated in the Guaranteed Paid Internship Program (GPIP) in Summers 2019 and 2020, respectively. Scholars completed their program in academic research laboratories inside or

outside of the University of Illinois at Chicago, technology companies, or makerspace. The Award Committee members created a survey to evaluate the impacts of COVID-19 on the scholars' internships status, in Summer 2020. The results showed that 44 percent of the confirmed internships were canceled because of COVID-19 and the remaining ones changed to the virtual environment.

Progress of the Ongoing Tasks

Service Learning Project Course (SLP). This course was implemented for the first time for cohort I in Fall 2019. Cohorts II and III also attended the SLP in Fall 2020 and 2021, respectively. Throughout this course, scholars have the opportunity to engage with their local community. Each cohort of scholars were divided into different groups and each group was led by a faculty mentor and presented their progress during their weekly class to their mentors and classmates. Table 3 describes a summary of the scholars' projects.

Table 3. SLP projects summary

Cohort	Project Title	Impacted Community	Expected Impact of the Project	Status
I	Project Makerspace	Berwyn, Illinois (Chicago Suburb)	Introduce students to Makerspace and engineering career.	Completed
I	Undocwiki	Undocumented students in Chicagoland and state of Illinois	Increase the transition rate of undocumented students to higher education and inform them about the available resources.	Completed
I	Development of Engineering Curriculum for local K-8 STEAM School	N. Lawndale (Chicago West side)	Develop engineering components of a curriculum for primary school students.	Completed
I	Improve Engr 100	UIC engineering students	Improve ENGR100 course curriculum to make students familiar with the available resources and general engineering ideas.	Completed
I	Solar-powered fridge for community gardens	Little Village Community	Enable the community to store and have access to fresh produce.	Completed
II	Adopt Our Classroom	Chicago Public Schools	Implement a Web-based app to facilitate the connection between public school teachers and industry professionals.	In-progress
II	Air Quality in Little Village	Little Village Community	Develop an open-source device to determine the quality of the air and empower community youth to advocate for their community's health.	In-progress
II	University Park Water Crisis	University Park	Design a system to better improve and track the water quality in University Park.	In-progress
II	VRESSE: Virtual Reality to Excel	Chicagoland area high schools	Create civil and computer science lesson plans through Minecraft education to help	In-progress

	Student STEM Engagement		educate children on those engineering fields in a fun and interactive way.	
III	Food4Homeless	Local homeless communities in Chicago	Create a system that will help eliminate food waste and benefit the homeless community by distributing food that restaurants throw away at the end of the night to the local homeless communities in Chicago.	In-progress
III	Solar Panel Fridge Project	Little Village / Amor de Dios United Methodist Church / ENLACE	Create a solar panel fridge in Little Village near the local community church to allow community members to access food given to the church by food donations at any time of the week, not just during food donation days.	In-progress
III	Women in Community Connections	Isolated women	Create an app that connects women within the same community.	In-progress
III	CBCM Project	Chicago Bird Collision Monitors (CBCM)	Create a program for CBCM volunteers to input and view data on the number of birds killed by collision injuries in Chicago.	In-progress
III	Community Fridge Project	The Love Fridge/ Lower income communities of Chicago	Convert fridges that the love fridge has operating in the Chicago area to operate on solar panel, the fridges are meant to support those who suffer from food scarcity in Chicago.	In-progress
III	Engineering Majors Introduction for High School Students	High school student with limited resources.	Create engineering related activates/projects that will teach high school students about the different engineering majors.	In-progress

Scholars from cohorts I have completed their SLP projects and all of them were successful. Cohort II is expected to finish their projects by Summer 2022. Also, Cohort III scholars are expected to complete their SLP projects by Summer 2023.

Recruiting Industry Mentors. The College of Engineering Industrial Advisory Board has guaranteed to provide all S-STEM Scholars with industry mentors. The main goals of industry mentorship are improving mentee's technical and professional skills and competency, developing their engineering identity, and creating a community that supports career growth and psychological and socioemotional well-being. The group of industry mentors is racially and ethnically diverse which will help scholars in their engineering identity development. All Cohort I and II of scholars were assigned to industry mentors and had multiple mentor-mentee meetings. Cohort II of scholars will also be assigned to industry mentors by the end of Spring 2022.

An industry mentorship program was structured to create an influential mentorship culture, and consists of four stages: Participant matching, participant preparation, participant interaction, and evaluation of outcomes. In the participant matching stage of the module, the subgroup implemented different surveys including "Surface and Deep Level Similarities Questionnaires"

(for mentors and mentees) and “Short Myers-Briggs Type Indicator”. We asked mentors and mentees to complete these questionnaires and used them to match cohort II scholars with their mentors.

COVID-19 Modifications to the Project

The COVID-19 pandemic has affected some of the project activities. The following modifications were made to the project in response to input from faculty and students:

- **Educational Activities:** Almost all UIC classes are offered virtually (in a synchronous or asynchronous mode) in Fall 2020 and Spring 2021. Moreover, in the same semesters, a Credit/No Credit grading policy modification and course withdrawals for all undergraduate students were offered by the University. This policy applied to our scholars as well. Also, the course interventions such as SLP courses were offered in a synchronous mode (using UIC-licensed Zoom, Blackboard Collaborate, or WebEx) until the COVID-19 pandemic is under control.
- **Advising and Mentoring:** Mentoring and advising sessions such as mentor-mentee meetings were conducted virtually in Fall 2020 and Spring 2021.
- **Research Data Collection:** Three methods are used for research data collection: interviews, surveys, and educational record reviews. Virtual environment such as Zoom has been used for all the targeted interviews.
- **Project Investigators Meeting:** The level of student monitoring has been increased by faculty mentors since Spring 2020. Frequent virtual meetings were held to help them regarding the negative impacts of COVID-19 on their lives such as include financial, medical, and psychological impacts. Appropriate experts/resources also offered to the students with crisis. In addition, students whose unmet financial needs are increased due to COVID-19 receive financial support in form of additional scholarship awards from the S-STEM project.

Generation of Knowledge

The progress of the project has been disseminated through three poster presentations [3] [6] [7]. In addition, engineering identity focused interviews with Cohort I Scholars have been conducted and the results have been published [8]. As a part of the support program of this project, the execution details and assessment results of a Summer Bridge Program was published to an educational conference [4]. The implementation of an introductory course and its impact on students’ academic success and retention was also published to an educational conference [5].

Also, the structure of the industry mentorship program for undergraduate students was accepted by an engineering education journal.

Conclusions

We have recruited 47 scholars across three different cohorts. Our scholars come from a diverse set of backgrounds, which reflects the diversity of the campus and Chicagoland. One of the cohort I scholars has already graduated and started a job and other 46 students are currently continuing their engineering degree programs. Since all the continuing students have been passed three semesters of their studies, the project has a 94 percent first-year retention rate. The Summer Bridge Program, mentorship programs, an introductory engineering course (ENGR 194), and a Service Learning Project course were offered to scholars during their studies at UIC as part of the project. In addition, some modifications were made to the project tasks and resources with the purpose of decreasing the impacts of COVID-19 on students' lives.

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