Reporting the Progress and Latest Status of an Ongoing S-STEM Project

Prof. Houshang Darabi, University of Illinois at Chicago

Dr. Houshang Darabi is a Professor of Industrial and Systems Engineering in the Department of Mechanical and Industrial Engineering (MIE) at the University of Illinois at Chicago (UIC). Dr. Darabi has been the Director of Undergraduate Studies in the Department of MIE since 2007. He has also served on the College of Engineering (COE) Educational Policy Committee since 2007. Dr. Darabi is the recipient of multiple teaching and advising awards including the UIC Award for Excellence in Teaching (2017), COE Excellence in Teaching Award (2008, 2014), UIC Teaching Recognitions Award (2011), and the COE Best Advisor Award (2009, 2010, 2013). Dr. Darabi is an ABET IDEAL Scholar and has led the MIE Department ABET team in three successful accreditations (2008, 2014, and 2020) of Mechanical Engineering and Industrial Engineering programs. Dr. Darabi has been the lead developer of several educational software systems as well as the author of multiple educational reports and papers. Dr. Darabi's research group uses Big Data, process mining, data mining, Operations Research, high performance computing, and visualization techniques to achieve its research and educational goals. Dr. Darabi's research has been funded by multiple federal and corporate sponsors including the National Science Foundation, and National Institute of Standards and Technology.

Rezvan Nazempour, University of Illinois at Chicago

Rezvan Nazempour is a graduate research assistant at the University of Illinois at Chicago. She is completing her Ph.D. in Industrial Engineering and operations research at the Mechanical and Industrial Engineering Department. She received her BSIE and MSIE from Iran University of Science and Technology (IUST) and Alzahra University, respectively. Her research interests include educational data mining, graph mining, and machine learning.

Dr. Anthony E. Felder, University of Illinois at Chicago

Anthony's current focus is on engineering education and its restructuring to better meet the diverse needs of students and industries. Anthony is also active in ophthalmology research for the multimodal imaging of retinal oxygenation and novel medical device design.

Dr. Shanon Marie Reckinger, University of Illinois at Chicago

Shanon Reckinger is a Clinical Assistant Professor in the department of Computer Science at the University of Illinois at Chicago. She received her PhD in Mechanical Engineering at the University of Colorado Boulder and an MS degree in Computer Science Education at Stanford University. Her research interests include computational fluid dynamics, numerical methods, and computer science education.

Prof. Didem Ozevin P.E., University of Illinois at Chicago

Dr. Ozevin is an associate professor of the Department of Civil and Materials Engineering. Dr. Ozevin received her Ph.D. from Lehigh University in 2005. She worked as a research scientist at Physical Acoustics Corporation till 2010. Her research is integrating structural design and damage assessment methods, and real time process and damage detection.

Dr. Renata A Revelo, University of Illinois at Chicago

Renata A. Revelo is a Clinical Assistant Professor in the department of Electrical and Computer Engineering at the University of Illinois at Chicago. She earned her B.S. and M.S. in Electrical and Computer Engineering and her Ph.D. in Education Organization and Leadership from the University of Illinois.

Prof. Jeremiah Abiade, University of Illinois at Chicago

Laboratory for Oxide Research and Education Department of Mechanical and Industrial Engineering University of Illinois at Chicago

Dr. Betul Bilgin, University of Illinois at Chicago

Betul Bilgin is Clinical Assistant Professor of Chemical Engineering (CHE) at the University of Illinois at Chicago (UIC) and has been teaching the Senior Design I and II courses for 6 years and Introduction to Thermodynamics for two years. Since her appointment in 2014 she has been exploring active learning, peer instruction, team-based, hands-on, application-based techniques in her classes to fully engage her students. She was selected as a UIC Teaching Scholar for Spring 2017, named as an American Institute of Chemical Engineers (AIChE) "35 under 35" winner in the education category for 2017 and named as American Society for Engineering Education (ASEE) "20 under 40" awardee for 2018.

Reporting the Progress and Latest Status of an Ongoing S-STEM Project: An Integrated Program for Recruitment, Retention, and Graduation of Academically Talented Low-Income Engineering Students

Abstract

This paper provides the details of a poster that will be presented in the National Science Foundation (NSF) Grantees Poster Session at the 2021 ASEE Annual Conference & Exposition. The poster will report the status of an NSF Scholarships in Science, Technology, Engineering, and Math (S-STEM) project. The objectives of this project are 1) enhancing students' learning by providing access to extra and co-curricular experiences, 2) creating a positive student experience through mentorship, and 3) ensuring successful student placement in the STEM workforce, graduate, or professional school. The students who are supported by this project receive financial and educational assistance through various evidence-based modules integrated with their undergraduate education starting with the summer prior to matriculation.

The students supported by this grant were recruited through one of the two project cohorts. The paper describes features such as demographics, high school GPA, and ACT/SAT scores of the participating students. The paper provides information about the completed and ongoing tasks of the project to date. The completed tasks include the development and evaluation of a summer bridge program and a freshman engineering success course. The ongoing tasks consist of the design and implementation of a service learning project course, and the design and implementation of an industry mentorship program. The paper also describes the modifications made to project tasks and resources to minimize the adverse impact of COVID-19 on the scholars. Moreover, the paper reports detailed assessment and evaluation data about the completed project tasks, and the academic success metrics of the scholars.

Introduction to the Scholarship

The number of low-income engineering students is disturbingly low despite decades of significant organizational and financial investment. There is a disparity in graduation rates of low-income students. This disparity increases significantly when we compare these rates for academically talented students [1], [2].

In the College of Engineering at the University of Illinois at Chicago, as a research-intensive, urban, and Minority Serving Institution, the graduation rate of academically talented, low-income

students is lower than that of academically talented, high-income students. The issue of low retention and low graduation rates of academically talented, low-income students is an important issue that needs to be addressed.

In 2017, the S-STEM program started at the University of Illinois at Chicago with the following objectives to support academically talented low-income engineering students: 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 school. During the five-year grant that currently sustains the S-STEM project, different evidence-based activities [3], [4] are implemented to support the scholars financially, academically, professionally, and socially.

This paper summarizes the completed tasks of the project in the 42 months since its inception and summarizes the activities projected for the remainder of the project.

S-STEM Scholars First and Second Cohorts

The first and second cohorts of the scholars were recruited, interviewed, and selected in 2018 and 2019, respectively. The selection criteria and details of the recruiting procedure were described in Darabi et al. [5]. In addition to the provided support program, both cohorts of scholars received financial assistance based on their individual needs. Scholars' demographic including gender, race, and their major are represented in Table 1.

Table 1. Cohorts I and II scholars' information

Information		Gender		First Generation	Race[1]					Major[2]						
		F	M		H	AA	A	AI	W	BioE	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
	Total	11	18	10	6	3	8	2	10	2	3	4	1	11	2	6

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

[2] BioE: Bioengineering, ChE: Chemical Eng., CME: Civil & Materials 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.

Progress and State of the Scholarship

The progress of the project nearly 42 months after its inception will be reported in this section. Various activities have been designed for the scholars. We will discuss the feedback and lessons learned from the completed tasks and describe the progress of the ongoing tasks in the remaining subsections.

Feedback and Lessons Learned from the Completed Tasks

S-STEM Scholars Eligibility and Selection. The main criteria for scholar selection were described in details in Darabi et al. [5]. 45 potential scholars were interviewed for the first cohort, 18 of them were offered the scholarship and all of them accepted the offer.

Also, for the second cohort, 36 potential scholars were interviewed, 14 of them were selected by the Award Committee members and offered the scholarship. 13 of them accepted the offer.

Table 2 represents the average high school GPA and SI (a linear function of ACT and high school GPA- for details, see Darabi et al. [5]) for both cohorts of the scholars.

Table 2. Scholars' high school GPA and SI score

Cohort/Metric	Number of Scholars	Average High School GPA (out of 4.00)	Average SI Score (out of 4.00)
Cohort I	16*	3.761	3.344
Cohort II	13	3.916	3.777
Total	29	3.830	3.538

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

Summer Bridge Program (SBP). The Summer Bridge Program consists of a residential and immersive experience designed to prepare S-STEM scholars transitioning into college and sustaining success throughout their undergraduate years [6]. Both Cohorts I and II attended the SBP in the summer prior to entering the University (summers 2018 and 2019, respectively).

During the SBP, scholars were paired with undergraduate ambassadors to be guided with academic, professional, and social questions as they became acquainted with the university and their major. The details of the execution and assessment results of the Summer Bridge Program can be found in Nazempour et al. [6].

Mentorship Program. Each scholar was assigned to a faculty mentor from the academic department corresponding to the scholar's major during the Summer Bridge Program to make sure that all scholars have access to resources and feel supported. Scholars will be mentored by faculty

throughout their undergraduate years at the University. The faculty mentors stay with their mentees until they graduate. The mentees meet with their mentors several times a semester. Faculty mentors help their mentees not only with their academic advising but also with their time management, graduate study goals, internship application preparation, and improving their grades.

Introductory Engineering Course (ENGR194). In Fall 2018, ENGR194 (Engineering Success Initiative) was offered for the first time for Cohort I. The investigators decided to modify some modules of ENGR194 after analyzing the evaluation results. They removed math focused study group and completely changed the entrepreneurship challenge module. After these modifications, the course was offered to Cohort II in Fall 2019. The ENGR194 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 details of ENGR194 implementation and its impact on students' academic success and retention were described in Nazempour et al. [7].

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

Sixteen out of 17 of Cohort I and all Cohort II scholars attended GPIP in Summers 2019 and 2020, respectively. They completed their program in academic research laboratories inside or outside of the University of Illinois at Chicago, technology companies, or makerspace.

In Summer 2020, the Award Committee members created a survey to evaluate the impacts of COVID-19 on the scholars' internships status. The survey 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

Execution of a Service Learning Project Course (SLP). A Service Learning Project course was implemented for the first time in Fall 2019 for Cohort I scholars. Throughout this course, scholars have the opportunity to engage with their local community. Cohort II scholars also attended the SLP in Fall 2020. Both cohorts of scholars were divided into eight different groups (four groups for each cohort). Each group was led by a mentor and presented their progress during their weekly

class to their mentors and classmates. A summary of the scholars' projects is represented in Table 3.

Table 3. SLP projects summary

Project Title	Impacted Community	Expected Impact of the Project
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.
Project Makerspace	Berwyn, Illinois (Chicago Suburb)	Introduce students to Makerspace and engineering career.
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.
Adopt Our Classroom	Chicago Public Schools	Implement a Web-based app to facilitate the connection between public school teachers and industry professionals.
VRESSE: Virtual Reality to Excel Student STEM Engagement	Chicagoland area high schools	Introduce low-income students to engineering fields using augmented/virtual reality.
Improve Engr 100	UIC engineering students	Improve ENGR100 course curriculum to make students familiar with the available resources and general engineering ideas.
Solar-powered fridges for community gardens	Little Village Community	Enable the community t store and have access to fresh produce.
Design of an air monitoring device to empower the community of 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.

Cohorts I and II will continue to work on the SLP course for one and three more semesters, respectively. They are expected to finish their projects by Summer 2021 and Summer 2022, respectively.

Recruiting Industry Mentors. Industry mentors are racially and ethnically diverse which will help scholars in their engineering identity development. The main goals of industry mentorship include 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 College of Engineering Industrial Advisory Board has guaranteed to provide all S-STEM Scholars with industry mentors. All 16 Cohort I scholars were assigned to industry mentors and had multiple mentor-mentee meetings.

In July 2020, an industry mentor meeting was held by the Award Committee members and all industry mentors attended the meeting to evaluate the industry mentorship program performance.

We created a survey to seek industry mentors' opinions regarding the mentor-mentee communication, activities, and reporting system.

Moreover, the Award Committee members created a subgroup to specifically work on the industry mentorship module. The subgroup is working to establish an influential mentorship culture by developing and managing four mentorship stages including participant matching, participant preparation, participant interaction, and evaluation and outcomes.

COVID-19 Modifications to the Project

Due to the COVID-19 pandemic and in response to input from faculty and students, the following modifications were made to the project:

- Educational Activities: All the course interventions, including the Service Learning Project courses are offered in a synchronous mode (using UIC-licensed Zoom, Blackboard Collaborate, or WebEx) until the COVID-19 pandemic is under control. For Fall 2020 and Spring 2021 semesters, almost all UIC classes are offered virtually (in a synchronous or asynchronous mode). Also, the University offered a Credit/No Credit grading policy modification and course withdrawals for all undergraduate students for the Fall 2020 and Spring 2021. This policy applied to our scholars, as well. The health and safety of students are the number one priority of the administrators when it comes to these decisions.

- Advising and Mentoring: For the Fall 2020 and Spring 2021 semester, all advising and mentoring sessions, including the meetings between the scholars and faculty mentors, and the meetings between the scholars and industry mentors are conducted in a virtual environment.

- Research Data Collection: We used three methods for research data collection: interviews, surveys, and educational record reviews. All the targeted interviews are conducted in the virtual environment using Zoom. The educational record reviews do not require the presence of students. Therefore, the health and safety of the students are not affected by the data collection activities. The COVID-19 has had no negative impact on our research data collection plans.

- In-person Courses and Laboratories: In rare cases, when it is not possible to virtually run a course or a laboratory, they are held using an in-person mode. Currently none of the S-STEM scholars has an in-person class or laboratory. If an in-person class becomes necessary, the students and instructors are mandated to have the appropriate mask wearing

and social distancing. The class sizes are reduced to allow for social distancing. Also, for important larger events (up to 50 people) such as workshops, UIC has rigorous COVID testing facilities and every participant can be COVID tested ~6 hours before each event as an extra safety precaution.

- Project Investigators Meeting: Faculty mentors have increased their level of student monitoring since Spring 2020. They hold frequent virtual meetings with the scholars to help them with managing the potential negative impact of the COVID-19 on scholars' lives. These include financial, medical, and psychological impacts. The students with crisis are referred to appropriate experts or resources for mitigating their crisis. UIC has several resources that are freely available to its students with crisis including a counseling center, and a medical center. 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. We have been able to shift some funds from the support activities budget to scholarship award budget of the project to pay to the students with increased unmet financial needs (up to a total of $10,000 per year per student).

Generation of Knowledge

The execution details and assessment results of a Summer Bridge Program as a part of the support program of this project was published to an educational conference [6]. Also, the results of the implementation of an introductory course (ENR194) and its impact on students' academic success and retention was published to an educational conference [7]. In addition, the progress of the project has been disseminated through two poster presentations [5], [8].

Moreover, engineering identity focused interviews with Cohort I Scholars have been conducted and the results have been disseminated by R. A. Revelo et al [9].

Conclusions

We have recruited 31 scholars of which two left the program because of personal issues. Both cohorts of scholars come from a diverse background that reflects the student diversity on campus and college demographics. Various evidence-based activities including the Summer Bridge Program, mentorship programs, an introductory engineering course (ENGR 194), and a Service Learning Project course were offered to scholars. Also, for minimizing the impacts of COVID-19 on scholars, some modifications were made to the project tasks and resources.

Acknowledgment

References

[1] L. N. Fleming and K. C. Smith, "Engineering identity of Black and Hispanic undergraduates: The impact of minority serving institutions," *Age (Omaha).*, vol. 23, p. 1, 2013.

[2] G. S. May and D. E. Chubin, "A retrospective on undergraduate engineering success for underrepresented minority students," *J. Eng. Educ.*, vol. 92, no. 1, pp. 27–39, 2003.

[3] E. M. J. Fischer, "Settling into campus life: Differences by race/ethnicity in college involvement and outcomes," *J. Higher Educ.*, vol. 78, no. 2, pp. 125–161, 2007.

[4] E. J. Coyle, L. H. Jamieson, W. C. Oakes, and others, "EPICS: Engineering projects in community service," *Int. J. Eng. Educ.*, vol. 21, no. 1, pp. 139–150, 2005.

[5] H. Darabi, P. C. Nelson, R. Nazempour, R. A. Revelo, L. C. Nitsche, and J. Abiade, "Board 35: An Integrated Program for Recruitment, Retention, and Graduation of Academically Talented Low-income Engineering Students," in *2019 ASEE Annual Conference & Exposition*, 2019.

[6] R. Nazempour, H. Darabi, P. Nelson, , R. Revelo, Y. Siow, J. Abiade, "Execution Details and Assessment Results of a Summer Bridge Program for Engineering Freshmen," in *ASEE Annual Conference & Exposition*, 2019.

[7] R. Nazempour, H. Darabi, R. Revelo, P. Nelson, A. Felder, D. Ozevin, J. Abiade., "Implementation of an introductory engineering course and its impact on students' academic success and retention," *ASEE Annu. Conf. Expo. Conf. Proc.*, vol. 2020-June, 2020.

[8] H. Darabi, R. Nazempour, S. Reckinger, P. Nelson, R. Revelo, J. Abiade, D. Ozevin, A. Felder, B. Bilgin, Y. Siow, "An Integrated Program for Recruitment, Retention, and Graduation of Academically Talented Low-Income Engineering Students," in *2020 ASEE Annual Conference & Exposition*, 2020.

[9] R. A. Revelo, J. Omitoyin, M. Cardona, R. Nazempour, and H. Darabi, "Engineering Identity Profiles of Low-SES, High-Achieving Incoming Engineering Students," *Proc. - Front. Educ. Conf. FIE*, vol. 2019-Octob, pp. 2019–2022, 2019.