

Opportunities for eliminating equity gaps in computer science gateway courses

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Carmen Robinson (left) and Narges Norouzi, who are leading research into gateways in introductory engineering courses, at the 2019 Celebration of Diversity in Computing Conference. Credit: University of California - Santa Cruz

Addressing "gateways within gateway courses," specific factors that hold able students back from success in introductory courses, may provide a path forward for closing equity gaps for students pursuing engineering degrees.

Introductory engineering courses often serve as barriers to students' success in pursuing their chosen degrees, causing attrition rates that are

disproportionately high amongst students of color, women, first-generation students, and students who have experienced inequitable systems financially, educationally, and socially.

New studies led by Director of Student Excellence, Engagement, and Inclusion at the Baskin School of Engineering Carmen Robinson and Computer Science Assistant Teaching Professor Narges Norouzi identify Computing Assembly, a required course for most UCSC engineering students typically taken in the first year, as the main gateway course with wide and persistent equity gaps. As an increasing number of incoming students at UC Santa Cruz are choosing to study [computer science](#), the new research reveals how motivation and a sense of belonging within the engineering community vary among students and are often tied to academic measures of success.

"We have students who are super talented, who have these great abilities, but they are being held back in some space," Robinson said. "So, how do we fix that? How do we make sure that we move them all the way through to get a degree?"

Years of research and programming

In 2019, Robinson conducted a [student](#) experience study, including a survey among all Baskin Engineering students, to investigate factors that are influencing students' ability to declare and complete an engineering degree. The study included one-on-one interviews, focus groups, and institutional data. The survey asked about students' demographics, concerns about their daily lives, if and how much the students were working, what support they might be getting from family, and how much academic preparation they had coming into introductory courses.

"We essentially looked into the [survey data](#), particularly pre-college mathematics and programming preparation as well as science

motivation and growth mindset indicators," said Norouzi. "What we noticed was a disproportionate pre-college preparation gap between students from different demographic groups. Inspired by the data, we got interested in bridging that preparation gap."

The results led Robinson and Norouzi to establish a summer program to review math and programming concepts for incoming students identified as having varied preparation. The program, called Baskin Engineering Excellence Scholars (BEES) and with Norouzi as the faculty lead, was run virtually during the summer of 2020 and 2021, and in 2022 will be held in person for the first time.

The 50 incoming students in this year's program will attend programming and mathematics lectures, participate in problem-solving sessions, and end their days with team-building activities. They will also be introduced to on-campus resources such as Counseling and Psychological Services (CAPS) and the Disability Resource Center (DRC) and participate in activities to build confidence and a sense of belonging.

A paper presented at the 2021 IEEE Frontiers in Education Conference details BEES program's curriculum and daily schedule, citing data that the program is effective in preparing students for engineering coursework. This paper analyzed the success of the program in providing students with academic self-competency in programming and mathematics concepts as well as supporting students' sense of belonging on campus, science motivation, and science identity.

BEES students also received targeted tutoring for first-year courses, mentorship, and advising that supported their learning experiences throughout their first year at UCSC. To enhance the cohort-based model of the program, the UCSC Committee on Education Policy approved first-year priority enrollment for BEES students so they can be enrolled in the same discussion section of courses and receive more targeted tutoring from the program.

Gateways and opportunities in intro courses

In evaluating student performance alongside this

earlier work, Robinson and Norouzi noticed that Computing Assembly (CSE 12) was particularly difficult for students. Institutional data showed that students across the board were struggling with the course, with passing rates and grades of B or better lower for underrepresented students. Starting in spring 2021, the researchers worked with CSE 12 instructors and the Institutional Research, Assessment, and Policy Studies (IRAPS) unit to collect data on why students were falling behind.

Pre- and post-surveys for the course gathered data about students' science motivation and sense of belonging to determine how these indicators are connected to students' lack of confidence and attrition from engineering. Bi-weekly surveys kept track of how students learned and progressed through the course materials to determine if any particular topics tend to lead to students' failure. Identifying these specific areas can help the instructors and mentors give more targeted preparation and tutoring to increase student success.

"We want to see if we can identify any gateway topic in the course that contributes to the overall failure," Norouzi said. "Or if there are any specific set of topics that, if emphasized more, can improve the students' grade and passing rate while also improving students' non-academic indicators."

Robinson and Norouzi hope similar analysis can be done for other gateway introductory engineering courses. Additionally, they want to increase the number of students of color who transfer to UCSC to study engineering and provide more support for their specific challenges through a bridge program tailored to their transition.

By presenting and discussing these papers with the community of computer science educators, Robinson and Norouzi hope to identify "gateways within gateway courses." They hope to target future interventions to build community and increase a sense of belonging.

To this end, this work [will be presented](#) at the 2022 ACM Conference on International Computing Education Research (ICER 2022) on Saturday, August 7. The team will also present a workshop

session at the 2022 Society for Advancement of Chicanos/Hispanics & Native Americans in Science (SACNAS) National Diversity in STEM conference titled "How to make most of your transition to a 4-year institution and beyond!" to discuss ideas for bridge programs for transfer students.

"We have our work ahead of us, but there are multiple ways to help [students](#) believe that they can succeed," Robinson said. "I think our faculty are very open to those things, and we do the work we can on the front end."

More information: Narges Norouzi et al, Baskin Engineering Excellence Scholars Bridge Program: Planning, Implementation, and Evaluation, 2021 IEEE Frontiers in Education Conference (FIE) (2021). [DOI: 10.1109/FIE49875.2021.9637267](https://doi.org/10.1109/FIE49875.2021.9637267)

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