

Broadening Participation in Computing Plan

Background: The Emerging Scholars Program (ESP) in Columbia's CS Department. The lack of diversity in electrical engineering and computer science student bodies is a widely recognized problem [150, 42]. In 2007, the percentage of Computer Science majors at Columbia University who were women hit a rock bottom of 9% [95]. As a result, several faculty members in the CS department at Columbia created the Emerging Scholars Program (ESP) [53] to directly address the gender imbalance. ESP takes its name and model from workshops started in the 1970s by Uri Treisman [129] at the University of California, Berkeley, which aimed to improve the performance of underrepresented minority students in math classes by encouraging students to form small study groups. The study groups are led by a more senior student and foster a sense of community and a peer network.

Columbia's CS department adapted the ESP model for a computer science setting. Combining ESP with the Peer-Led Team Learning (following the example of Susan Rodger [75]), the department created a once-a-week seminar to expose students to the non-programming and collaborative aspects of computer science that typically are not a big part of introductory classes. There is no coding and no grading or homework in ESP; the focus is entirely on high-level concepts in computer science, particularly on algorithmic thinking and on application areas. Students are encouraged to enroll in ESP while taking one of the introductory computer science courses. A major determinant in whether students succeed in the CS major is whether or not they have a small peer group to turn to as they progress through higher level classes, and ESP is designed to foster these groups.

The approach has proven successful at increasing female participation. The program does not explicitly select for women, but the current groups are 60%-90% women, perhaps influenced through a combination of female group leaders (who advertise the program in the introductory courses), the positioning of the program, and word-of-mouth. Students taking ESP are three times more likely to major in computer science than the students who do not take ESP. Over the first four years of ESP being offered (2008-2012), women went from 9% to 23% of Columbia computer science majors. Today, women comprise 37% of Columbia's CS majors, much higher than the national average (20%).

Proposal: ESP for EE/CE students. The PIs have affiliations with the EE, CS, and CE programs. Electrical engineering and computer engineering majors are also required to take the introductory CS courses that ESP is designed to complement. However, the ESP program is currently only intended for CS majors. The PIs will work to make it available more broadly, to other engineering departments that still have low female representation. Following the model of the CS department, the PIs would like to design a new ESP variant for Computer Engineering and Electrical Engineering majors in Columbia.

The PIs plan to adapt the current ESP curriculum to address CE/EE topics, such that some of the material will be the same as it currently is and some will be CE/EE-specific. The idea will be to have CE/EE-specific cohort groups running in parallel with the CS ones. The PIs will work with the existing organizers of the CS ESP program to replicate the success they had. PI Katz-Bassett has already had initial discussions with this team. The PIs also plan to integrate ideas and best practices from the residential CS program for women at Rutgers [138] previously led by Rebecca Wright, who is currently the chair of CS at Barnard College, the women's liberal arts school within Columbia University. That program had similar goals and a similar target audience as the Columbia ESP program, but it was more intensive as a residential program.

These efforts are complementary to the PIs' existing involvement in growing the computer engineering and software systems side of the EE department. In fact, PI Katz-Bassett was the host and lead of hiring PI Cidon to the department. Shortly after joining as faculty, PI Cidon led the effort to create a new computer engineering research area. Both PIs designed the course flowchart for the new area and have been active in faculty and student recruiting in this area.

Proposal: ESP for BIPOC students. While ESP has increased female participation in Columbia CS, it has not yet had a comparable impact on the number of BIPOC students studying CS. The PIs plan to help pursue changes to the ESP program and how it serves the BIPOC student population. The PIs intend a two-pronged approach. First, they will pursue new channels for advertising ESP, and in particular for jointly advertising ESP and the introductory courses. Currently, ESP is primarily advertised in the introductory courses, and so enrollment in CS is a gating function for the population that can be reached. The PIs will pursue students who may not have been considering taking their first CS course, including by conveying the advantages of

taking a CS course even for students who do not intend to major. The PIs will advertise via student affinity groups. Second, they will work to understand the experience of BIPOC students in CS/CE/EE classes and majors, and in ESP. PI Katz-Bassett is participating in an October 2 forum led by current BIPOC students and recent alums to discuss their experience in Columbia CS, and he has started a small-scale mentoring pipeline to connect incoming BIPOC students with senior students and recent alums. These activities will inform modifications to ESP to tailor it to the needs of a larger set of students.

Proposal: ESP for Transfer and Combined Plan Program Students. The PIs also plan to design a complementary program for transfer students. Columbia Engineering has a **3-2 Combined Plan Program** that allows undergraduates at affiliate schools, including but not limited to those at Columbia University (Columbia College and Barnard College), which allows students to pursue three years at a liberal arts school and then join Columbia Engineering for two years, finishing with both a bachelor of arts degree from the liberal arts school and a bachelor of science degree from Columbia Engineering. This program is the major source of Columbia EE undergraduates.

The Combined Plan program is also an avenue for broadening participation. A number of the affiliate schools are women's schools, historically black colleges and universities (HBCUs) or other minority-serving institutions, or have large numbers of students from groups that are underrepresented in CS/EE/CE. They include Barnard (women), Bryn Mawr (women), Goucher (71% women), Morehouse (HBCU), Queens College (67% non-white), Sarah Lawrence (72% women), Spelman (women, HBCU), and Scripps (women).

However, anecdotally, many transfer and Combined Plan students have reported feeling lost and missing the cohort that first-year students feel, as well as feelings of "imposter syndrome" compared to students who have been at Columbia for their entire schooling. The PIs believe that a variant on the ESP program can provide them with a peer group. Transfer students from underrepresented groups can experience this lack of cohort doubly. Since ESP currently targets students in introductory courses, the PIs will explore how to design a variant for more advanced students.

Metrics. The PIs will measure success via metrics including: participation from female and BIPOC students in ESP, overall and by intended major; retention of these students in the majors; retention of female and BIPOC students in the Combined Plan; and graduation rates of these students. The ESP program has used similar metrics to track female majors in CS, and we will follow their best practices.