

The Early Research Scholars Program

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Background

Research experiences for undergraduates has shown to increase retention in scientific fields [1], and the NSF Summer REU program provides great support for such experiences. Most REUs are designed for advanced students with strong foundations in Computer Science. The Early Research Scholars Program (ERSP) was designed to provide a structured research experience for students early in their CS career (pre-data structures when they apply). The goal is to increase retention of women and under-represented minorities in CS and related disciplines.

Design

The design of ERSP is based on four pillars:

1. A course-supported apprentice model
2. A dual-mentoring framework
3. A team-based environment
4. An inclusive selection process

ERSP students work in teams under the guidance of a research faculty member, as part of an active research project. This apprenticeship is supported by a required course that introduces students to research in a structured class setting: topics, findings, how to read and evaluate a research paper, and a variety of research exercises. The students are mentored by both ERSP mentors and a member of the research project (faculty, or graduate student). The program is team-based, building a strong sense of student community and support. ERSP students typically devote 30 weeks to the program (2 semesters / 3 quarters), and earn credit towards graduation. The goal of the program is to create an inclusive community that engages students from groups that are traditionally marginalized in computing and engineering. Students are selected to participate in the program using a process that explicitly takes into account the extent to which they both understand and have experienced marginalization and how much their participation will help add to the diversity of computer science and engineering.

Current Status

The NSF-sponsored program began in 2014 at the U. of California, San Diego [2]. ERSP has now grown to include 6 institutions (in order of joining program): UC San Diego, UC Santa Barbara, Stanford, U. of Illinois Chicago, U. Mass. Amherst, and NC State University. Over 400 undergraduate students have participated in over 100 research projects, with over 70% of those students identifying as female and over 20% identifying as Latinx or African American. Projects span a wide range of Computer Science and related disciplines, including Data Science, Machine Learning, Parallel Processing, Sensors, Vision, and Wearable technologies.

A majority of students continue with research after ERSP, and ERSP students express a stronger interest in graduate school post-ERSP. Most importantly, students often graduate from the

program feeling more confident, more connected, less intimidated, with a strong sense of accomplishment. From one student:

“... a sense of accomplishment, I think. Just saying oh, we did this whole year’s worth of program. We stuck to it; we got our work done. We just did the piece by piece, all the work that we needed to do to be able to present at that conference... So that’s something that I think is really cool.”

Variation on the Original Model

The original model was designed for a three-quarter academic year at the U. of California, San Diego. The research course was offered in the fall as an upper division course which counted for elective credit in the CSE major. The culmination of this course was a proposal for a research project that was then carried out in the winter and spring quarters. As ERSP has expanded to other institutions we have adapted this original model and we discuss these variations here in the three expansion schools who have been running the program for 1-3 years.

U. of California, Santa Barbara: ERSP is currently in its third year at UCSB. The program has preserved all of the main elements of the original model. Compared to the program at UCSD, ERSP at UCSB started on a small scale which helped create an intimate community of mentors and students. Key outcomes include that the program has had no attrition so far, and more than 50% of the students continued research beyond ERSP. Building on ERSP's initial success, we are on track for a significant expansion of the program in the coming academic year. A few minor variations in UCSB's implementation are:

- (1) Using a shared messaging platform for communication among student teams and mentors.
- (2) Including other undergraduates involved in research (beyond those in ERSP) to present their work at the annual research showcase.

U. of Illinois, Chicago: ERSP runs on a semester system. The research course is offered as a 1-credit hour course in the Fall, with students assigned to research teams and attending team meetings. The Fall deliverable is a research proposal, which serves as the team's project for the Spring semester. Students register for 2-3 credit hours in the Spring, and receive technical elective credit towards graduation upon completion of the Spring semester. Students are not expected to complete the research project in just 15 weeks; the goal is a meaningful research experience. The Spring semester, and ERSP, culminates in poster presentations by each team.

Stanford University: rather than implement ERSP as a stand-alone program, Stanford integrated aspects of ERSP into their pre-existing CURIS program, a paid summer research program for students from underrepresented groups. The ERSP research course is offered in the spring quarter. Two sections are offered: one for students who will participate in CURIS and one for students who will not. For students participating in CURIS, the course is very similar to the original model. Students learn about research in the context of the project they will work on over the summer, and the final deliverable in the course is the proposal for the work they will complete over the summer. In the section for students who will not participate

in CURIS, students complete a research project within the single quarter of the course offering. In effect, this track offers a shortened version of the complete ERSP experience.

Based on the way the program has translated to our partner institutions, we believe the ERSP model can be replicated at other institutions, with minimal investment from the host department. Additional findings are discussed in [3, 4].

Essential Components/Tips for Success

We have found that although some aspects of the program are flexible, there are some key components that make the program successful that anyone who wishes to implement the program should strive to realize in their implementation.

1. Sufficient course credit (of value). Most of the ERSP partner sites implement the ERSP introductory research course as a full academic course. Where it is implemented with a smaller footprint (at UIC), students sometimes struggle to have enough time in their schedules to complete the work required to make significant progress on their projects. Positioning the course as a full course that counts for degree credit allows students to free up time in their schedules that they would otherwise have to devote to other courses needed for graduation.
2. Central mentor support over the whole program. The graduate student central mentor provides a key resource to help students stay on track with their research. (See [4] for more details). New partners sometimes inquire whether that person could be eliminated from the program to save costs. In short, our answer is a resounding no. This person is the glue that holds the teams and their research together.
3. Team-based research. Projects work best, and the program scales best, when students work in teams. We have found that teams of between 2-4 students maximize the benefits of team-based work, while still making it feasible for students to find time to coordinate and work together.
4. Mentor students on planning their course load while they participate in ERSP. At UCSB, we found that there is a tendency for students to take ERSP as an overload even though they receive elective credit that counts towards their degree requirements. We recommend mentoring students about taking an appropriate course load.

References

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[3] J. Stout, N. Burcin Tamer, C. Alvarado, “Formal Research Experiences for First Year Students: A Key to Greater Diversity in Computing?”, in *Proceedings of the 49th ACM Technical Symposium on Computer Science Education*, 2018, pp. 693 – 698.

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