# Board 259: Early Research Scholars Program Update and Reflection Study

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# Early Research Scholars Program at UIC Update and Reflection Study


## Abstract

This conference paper provides an update on the Early Research Scholars Program (ERSP) background, structure, and implementation at the University of Illinois Chicago (UIC), developed at the University of California San Diego and funded by the National Science Foundation Improving Undergraduate STEM Education program. The program aims to support retention of students from marginalized backgrounds in the fields of computer science, and electrical and computer engineering. This paper provides program updates, including data from the 2022-2023 academic year and preliminary results from a reflection study that began in Spring 2020. The reflection study examined the impact of the ERSP on a student's computing and engineering identity development based on student reflection responses. In this paper, we also discuss student demographics, retention rates, and changes made to the program's curriculum at UIC. The evaluation results from the last three years of the program are also shared, which show how students are impacted by the program, as well as areas for improvement. Preliminary results show that the program has positively impacted students' computing or engineering identity development for at least three identity dimensions: recognition, competence, and community.


## Introduction

In this paper, we provide an update for the years 2019-2023 to the implementation of the Early Research Scholars Program (ERSP), developed at the University of California San Diego, to our institution, the University of Illinois at Chicago (UIC). The program, funded by the National Science Foundation Improving Undergraduate STEM Education program, was designed to support retention of students from marginalized backgrounds in the field of computing especially during the second year of their major [1].

Currently, the project at UIC is in its fourth grant year, having served four cohorts of students since 2019. The program has served majority women or non-binary students and continues to strive for representation of minoritized students in the fields of Computer Science and Electrical and Computer Engineering. In this paper, we focus on discussing program updates, including data from the 2022-2023 academic year, and preliminary results from a reflection study that started in spring 2020.

In spring 2020, after IRB approval was obtained, we started collecting responses to student reflections done via UIC Qualtrics. These reflections focus on several topics aligned with the ERSP program and they include: computing/engineering identity, emotional response to research, teamwork, and advisor/mentor-mentee relationships. For the reflection study, we focused on the reflections about computing/engineering identity using an identity framework that incorporates performance, recognition, competence [2], [3] and community [4]. The research question for this study is: *How does ERSP impact a student's computing/engineering identity development?* Our preliminary results show that overtime a student's computing/engineering identity is impacted by the program at least along the following identity dimensions: recognition, competence, and community.

In this paper, we also share evaluation results from the last three years of the program. These reflections show the ways in which students are impacted by the program as well as areas for improvement.

## ERSP Background

The Early Research Scholars Program (ERSP) was developed at the University of California San Diego. The central components of ERSP are "1. a course-supported apprentice model in which students work on real research problems within an active research group as they learn the fundamentals of Computer Science (CS) research in a structured class setting. 2. A dual mentoring framework in which students are. co-advised by a central team of ERSP mentors and a faculty or graduate student research mentor. 3. A team-based structure that builds community and 4. student-to-student support" [1]. ERSP runs during the full academic year starting with the fall semester.

In the first half of the program, students learn basic research skills that are common in computing research, and they develop a research proposal as a team. In the second half of the program, students work on the research project proposed and are directly supervised by a faculty or graduate student research mentor. This two-semester design offloads some of the research training that faculty may have to do with undergraduate students new to their research lab.

ERSP is structured using a cohort-model so that students work in teams wherein the support is provided via class meetings, research meetings, and team meetings[1]. Aside from the faculty that oversee ERSP, there is at least one graduate student designated to ERSP who assists with goal-setting and technical advice for each team of undergraduate student researchers [5].

The implementation of ERSP at other institutions, including University of California Santa Barbara, Stanford University, and UIC was enabled by the NSF Grant (#1821501). The team has published results from this effort in [6], and [7]. Since 2020, the number of institutions has also grown to include four more institutions; namely, University of Massachusetts-Amherst (UMass Amherst), North Carolina State University (NC State), Southern Connecticut State University (SCSU), and Texas Southern University (TSU). In this paper, we focus on disseminating updates and data from the implementation of ERSP at UIC.

## ERSP at the University of Illinois Chicago

In this section, we discuss the implementation of ERSP at UIC. A thorough discussion of how we adapted the program to fit UIC is shared in [8].

The University of Illinois Chicago is a mid-tier research university, with a large diverse student population. What makes UIC a good fit in contrast to other ERSP partner institutions is that UIC is a Hispanic Serving Institution, with 40% of the student body being Pell-grant eligible. Also, as UIC is mainly a commuting school, programs like ERSP are crucial for helping students develop a sense of community on campus. In addition, the College of Engineering at UIC has a large transfer student population, which would also benefit from having access to a community on campus.

ERSP at UIC started in 2019 in the departments of Computer Science (CS) and Electrical and Computer Engineering (ECE). Table I shows a summary of student demographics for the four cohorts that have been through the program thus far.

Table 1
*ERSP Student Demographics & Retention*

| Year | # of Students | # of Women and Non-Binary | # of Black, Latinx, Indigenous | Program Retention (Fall to Spring) |
|---|---|---|---|---|
| 2019-2020 | 28 | 22 | 5 | 93% |
| 2020-2021 | 29 | 21 | 7 | 97% |
| 2021-2022 | 30 | 17 | 9 | 90% |
| 2022-2023 | 25 | 11 | 7 | 84% |

## ERSP Changes for Implementation at UIC: reduced hours per week

The ERSP program is composed of the research methods course followed by independent research. In this section, we discuss the impact of the reduced hours per week for the research methods course. Adjusting the ERSP curriculum for the research methods course from 4 credit hours (one full upper division course) to 1 credit hour took two iterations. The 4 credit hour curriculum (10 weeks, 2 sessions per week of 80 minutes each), including a detailed syllabus, can be reviewed in the ERSP start up guide [9]. There were two critical considerations in condensing the curriculum to 1 credit hour (15 weeks, 1 session per week of 50 minutes each): in-class activities and weekly assignments. Given the semester format at UIC, students are expected to spend 3 hours outside of class for every 1 hour of credit. As a result, we needed to optimize in-class activities and weekly assignments to ensure that the curriculum included core research methods components as well as time for students to build team rapport.

In conversation with ERSP directors at other institutions part of the project, we removed three topics in our implementation of ERSP at UIC due to time restrictions. These topics were Independent Learning, Machine Learning, and Research in the Real World. The rest of the topics, as shown in Table 2, were spread out in the 15-week semester. The major assignments in the ERSP model were maintained in the course; namely, the proposal, peer review, teaching presentation, and final presentation.

In-class time is limited in a 1 credit hour course; as a result, we decided to structure in-class activities and time, outside of covering content presented in Table 2, to allow students to build rapport with their teams and to develop their research proposal. Every class session includes in-class activities for students to engage in discussion and preparation for their research proposal. Allowing students to use in-class time to work on their proposal and collaborate with their team is an essential part of the 1 credit hour curriculum because it provides the students with dedicated team time that they may not budget for outside of class.

Table 2
*ERSP at UIC Curriculum*

| Week | Topic |
|---|---|
| 1 | What is Research? |
| 2 | What is Research pt. 2 & Graduate School? |
| 3 | Research Talks |
| 4 | Teamwork |
| 5 | Reading a Research Paper |
| 6 | Evaluating a Research Paper |
| 7 | Literature Search |
| 8 | Research Paper Difficult Concepts |
| 9 | Teaching Presentations |
| 10 | Experiments in CS/ECE and Data Visualization |
| 11 | Ethics |
| 12 | Giving Clear Talks |
| 13 | Teamwork |
| 14 | Proposal Peer Reviews |
| 15 | Final Lightning Presentations |

Aside from the major assignments, individual and group logging is also done on a weekly basis by students and graded by the central mentor. When grading the major assignments, the focus is placed on providing feedback and it is done by the course instructors. Along the same lines, when grading the logs, the central mentor focuses on identifying any issues (individual or team) that may deter students from making progress in their research proposal. In other words, given that the course is a 1 credit hour course, we focus on supporting the students academically, professionally, and personally rather than emphasizing a grading rubric.

## Reflection Study

In Spring 2020, after IRB approval, we began to collect reflections for research. The reflections were developed by the PI team across institutions. These reflections allow for an understanding of how the project is progressing, how teams are working together, how advisors are impacting teams, and how students identify within computing fields (i.e., Computer Science, Computer Engineering, Data Science, and Electrical Engineering). These reflections are distributed to the students using UIC Qualtrics throughout the academic year. In this paper, we review preliminary results from the reflections given to students that focus on engineering and computing identity development. This reflection is distributed to students early on in the fall and spring semesters.

## Data Source and Analysis

The data used in this study includes reflections from three different cohorts of ERSP scholars starting with Spring 2020 until Spring 2022. The reflections prompted students to think about how they identified with the field of engineering and computer science and how they identified as researchers within that field.

Table 3
*Scholars and Study Participants by Year*

| Academic Year | # of Scholars | # of Study Participants |
|---|---|---|
| 2019-2020 | 28 | 16 |
| 2020-2021 | 29 | 15 |
| 2021-2022 | 30 | 8 |

The reflection data was analyzed using MAXQDA software. In the first cycle of coding, two of the authors engaged in individual analysis of data, using deductive coding. The coding was based on a working codebook provided by the ERSP UCSD site where the same study took place the year before ours. The codebook included dimensions of engineering/computing identity (i.e., performance, competence, interest, recognition). In the second cycle of coding, we engaged in group analysis of data, seeking to agree on our individual codes. We utilized an agreement method for group coding, where we accepted codes where there was agreement, and discussed codes where there was disagreement to take an action to either include a code (wherein we had agreement via discussion) or to exclude a code (wherein we did not have agreement after a discussion).

## Limitations

The reflections collected were not mandatory for the student's grade, therefore some of the reflections are only a couple of sentences long. While these were still coded and included in the study; the depth that students were able to express in their answers was very limited. In the spring semester, the reflection was given out early in the program, as a result, we may not be capturing how identification with the field develops over the span of the semester, when the project is closer to completion. While we had a reasonable response rate in the first two cohorts, the third cohort, we did not have a lot of students consent to participate in the research study.

## Preliminary Results

Our preliminary results show that students have a strong understanding of what it means to do research after the first semester in the program. By design, most of the students joining ERSP do not have any experience with research although they may have high interest in doing research. Students share what research entails, how it is different from other courses that they have taken or are taking, and, in some cases, their understanding of the process to do research. We attribute this to a competence in engineering, that understanding the research process is a step towards knowing how to do research and, hopefully in the future, feeling competent as an engineer/computer scientist.

> Currently, I view engineering research as a group effort in applying engineering knowledge to answer questions, solve problems, and build upon existing knowledge rather than just reaffirming it. Sometimes this effort is among a group and mentors and sometimes it's far more individual. Earlier, I viewed engineering research as more data and observation oriented, like a lab one would conduct in class. *Fall 2021*

As expected, we found that students reported limited experience and knowledge in research before starting the program. Due to the nature of the study design, we have two data points, one before

the semester starts and one after they have completed at least half of the program. Because of this, we can see that while students are interested in engaging with research, they have limited experience and knowledge (low competence). Again, in future reflections, we expect to survey students after they have completed their project with this question to see if this low competence has changed after they have completed their research project.

> I don't have much of a background with research besides previous English class papers. ESRP has shown me that there is another side of research than that of what I did in English class. *Fall 2021*

Almost all students in the program report a positive impact of ERSP on their identity as an engineer or computer scientist or as a researcher.

> ERSP has exposed me to biomedical engineering research as well as engineering research whose potential applications can provide a life-changing impact to people's lives, particularly those of the broader disabled community. This experience has sparked my passion towards helping develop technology that has a meaningful real-world application, and further solidified my intention to pursue bioinformatics or computational biology in grad school and as a career. *Spring 2022*

**Evaluation Results**

The Center for Evaluating the Research Pipeline part of the Computing Research Association evaluates the ERSP program every year. Their first evaluation of ERSP at UIC [6], showed that ERSP students had increased levels of experience with research, working with colleagues on research, analyzing data, and presenting research reports, six months after completing ERSP. Other student measures such as self-efficacy and sense of belonging did not show a statistical difference in the evaluation report. However, the student reflections completed during the program show that students are personally, academically, and professionally impacted by the program. Below, we share some students' reflections collected and approved by the Institutional Review Board at UIC.

> I feel like ERSP has made me feel more confident that I can accomplish a role as a computer scientist and a computer science student in general. I feel like the people surrounding me want me to succeed and make me feel like I can. As a computer scientist I have grown in languages, knowledge, and interest in the different fields and especially with being able to explore with ERSP. *Spring 2021*

> I think it is a possibility for me to become a researcher. I feel like the process of research is not foreign to me. I would feel more confident now to start a research than before ERSP. The idea of research is still scary, because what is being researched is new. Someone has to know how to ask the right questions. *Fall 2021*

Some of the changes that students want to see in the program, as evident in the reflection, is better coordination with the research mentor, and a lessened/more distributed workload in the research methods course. Both will be addressed in the fifth iteration of this program.

## Future Work

ERSP at UIC has served four cohorts of Computer Science, Data Science, Electrical Engineering, Computer Engineering, and Engineering Physics students. The implementation at UIC so far has been successful, but there are improvements we plan to make. In the next improved iteration of the ERSP course, we will change the grading structure (previously graded on a grade A, B, C, D scale) to one of Satisfactory/Unsatisfactory. Given that the course is only a 1-credit hour course, the pressure of obtaining an A can overshadow the ERSP experience as we have anecdotally experienced with some students in the past two cohorts. In the next two years, we plan to focus on institutionalization of the program in the CS and ECE departments. We also strive to utilize ERSP as a recruitment tool for minoritized students in CS and ECE by promoting the program through student professional organizations such as SWE, NSBE, SHPE, WICS. We also plan to pay more attention to the mentoring aspect of student-professor relationships. For faculty mentors, we will ask to describe, in addition to their research projects, their expectations from ERSP scholars and how they work with undergraduate students. For students, we will add questions about student – mentor relationships to the reflection prompts.

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