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INCLUSION IN COMPUTING VIA THE EARLY RESEARCH SCHOLARS PROGRAM AT UIC (PRACTICE)

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ABSTRACT

For a sustainable world, all people who aspire to be engineers should have an equitable opportunity to achieve their engineering education. In the United States, groups of individuals continue to be minoritized in engineering and computing

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specifically. This practice paper addresses inclusion and diversity efforts in the computing field, within two departments of a college of engineering, to 1) increase the number of minoritized students in computing, 2) introduce research as a career path to undergraduates early on in their education, and 3) nurture a sense of community (within the department and the computing field) for students. These efforts are being furthered through the Early Research Scholars Program, which is a program to engage students with research within their first 3-4 semesters in their undergraduate careers. In this paper, we will review aspects of this program that make it inclusive and harness diversity, share preliminary results from the last two years on community building within the program, and provide implications for other institutions to implement inclusive and community-building practices in their curricula or programming.

1 INTRODUCTION

1.1 Inclusion and Diversity in Computing

Inclusion and diversity efforts in STEM fields in the United States are ongoing and have been a focus of discussion for many years (Tsui 2007; Museus et al. 2011), with a multitude of national reports addressing or highlighting this issue. While other fields within STEM have made some strides in improving diversity, computing fields, and especially in industry, have not (Johnson and Miller 2002). Within computing specifically, which includes fields of Computer Science, Computer Engineering, Data Science, and Software Engineering, inclusion and diversity efforts are crucial given the heightened and relatively recent interest in these fields. This interest paired with the underrepresentation of women and racial/ethnic minoritized students (i.e., Black, Latinx, and Indigenous) in computing makes it necessary to address this issue. Inclusion and diversity efforts targeted toward undergraduate students in computing generally address the following areas: harnessing a sense of belonging (Lewis et al. 2019; Gates et al. 1999), addressing structural needs such as financial aid and career-building support (Bego and Nwokeji 2021), connecting their major and career to personal values (Brinkman and Diekman 2016).

To address inclusion and diversity in computing, efforts to improve upon these areas have sprouted in the form of curricular changes, extracurricular engagement, and support, as well as some policy changes. In this paper, we discuss efforts to improve upon inclusion and diversity within computing fields via curricular changes through an undergraduate research program completed in the early years of undergraduate education. This program was started at the University of California San Diego (Barrow, Thomas, and Alvarado 2016) and recently implemented at various institutions across the United States (Alvarado et al. 2022).

1.2 Institutional Context

The University of Illinois, Chicago is located in an urban setting, the university is a research-intensive Minority Serving Institution. Although the university is diverse and there is no racial/ethnic majority group, diversity within computing majors (i.e., Computer Science, Data Science, Computer Engineering) does not fully reflect the institution's diversity. Similarly, women and non-binary students are underrepresented in computing majors. The majority of students in the College of Engineering at the University of Illinois, Chicago are non-residential students with a significant percentage (almost half) being transfer students.

The Early Research Scholars Program started at the institution in 2019 and is currently in its fifth year running. The program is split into two semesters: in the first semester, students take an introduction to research course, and in the second semester, students work on their research program directly with their research mentor. Every year, there have been ~25 undergraduates in the program. There has been steady participation from faculty in both departments housing the program over the years, with an increased interest in Computer Science and most recently Data Science. Table 1 provides an overview of the student demographics that this program has served since 2019.

Table 1. *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%

2 METHODOLOGY

2.1 Program Components that Promote Inclusion and Diversity

While more in-depth details of the entire program are provided elsewhere (Alvarado et al. 2022), in this section we will review program components that are specifically incorporated to promote inclusion and diversity in computing. This program's components include:

- **Application Components:** Students have to apply to the program by providing some demographical information, as well as writing three short essays. Two of these short essays are specifically instituted to elicit reflection about diversity and hardship.
- **Targeted Recruitment:** While acceptance to the program is open to any student eligible for the program, we emphasize targeted recruitment via inclusion-drive entities within the College of Engineering to ensure a diverse pool of applicants. These entities include retention and recruitment programs, women in engineering programs, women-focused student organizations, and ethnic student organizations in computing. Additionally, targeted communications are sent to minoritized students in computing who are encouraged to apply.
- **Recruitment of Central Mentors:** Central mentors are critical to the success and feeling of inclusion in the program. As a result, there is targeted recruitment and selection of central mentors. Central mentors are selected from one of the two departments that house this program, which includes computing majors. The central mentors are identified by the program directors and sometimes with the help of other faculty in the departments. Central mentors help undergraduates not just succeed in their respective research projects, but also feel a sense of belonging within the fields. Central mentors have a fundamental understanding of research in computing, strong communication skills, an understanding of the need for inclusion and diversity and computing, and an ability to advise and guide using an ethic of care (Noddings 1988).
- **Recruitment of Faculty Mentors:** Similar to the recruitment of central mentors, faculty mentors are purposefully recruited. Program directors make concerted efforts to identify faculty mentors who have a track record of a) working with undergraduates on research, b) understanding and supporting the need for inclusion and diversity in computing, and c) are committed to the goals of the program.
- **Class-Based Reinforcements:** In the fall semester introduction to research class, in-class activities that reinforce inclusion and diversity in the form of

community building and boosting self-belonging are included. These activities include team-building exercises, dialogue about research and being researchers, 1-1 chats with students about their journey in computing, and peer-feedback activities to reinforce community building.

- **Research in a Team:** Akin to the affinity-group model (Gates et al. 1999), the Early Research Scholars Program aims to promote community-building by establishing research work via teams. Students are teamed up by project interest as well as availability. Different from other undergraduate research programs, working on a research program as part of a team encourages students to build connections and avoid feeling isolated or alone in doing research. Throughout the program, the central mentor and program director support the teams through any challenges or conflicts that might arise to ensure that community building can be prioritized.

2.2 Reflection Study

To assess the impact of the program on students, we collected ~monthly reflections throughout the academic year. In this paper, we share preliminary results from the reflections surrounding the sense of belonging and feeling supported. The reflection prompts for these questions were: In what ways does your team help or hinder your feeling of belonging in your field?

The reflections were collected via Qualtrics and are currently being analyzed using MAXQDA software. The guiding research question for this analysis is: How does the Early Research Scholars Program impact a student's feeling of inclusion in computing? We performed a thematic analysis of the students' reflections to answer the research question.

A major limitation of this reflection study is that the reflections were purposefully not graded or given class credit therefore those who completed the reflection did so very lightly. As a result, we have a number of reflections that consist of only a couple of sentences per question/prompt.

3 PRELIMINARY RESULTS

3.1 Student Reflections

The thematic analysis is not yet finalized; as a result, in this paper, we share our preliminary results. What we are finding so far is that the team aspects of the Early Research Scholars Program help students feel connected not just to one another, but also to the computing field. In addition, as can be noted by some of the quotations below, some students feel connected to their team not just because of computing, but also because of the shared gendered experiences.

My team consisted of all girls that supported one another and always made me feel like I belonged in Computer Science. They celebrated and were proud of my achievements, and thus they made us feel like I really belonged to be a part of Computer Science. Spring 2020

Students in the program generally feel supported in computing by others in their teams. This support is sometimes personal and academic and sometimes in the process of doing research.

They are incredibly talented in computer science and sometimes I feel imposter syndrome but they never bash me or make me feel less than despite being behind or different. Spring 2021

3.2 Evaluation Results

The initial evaluation findings revealed that students demonstrate a strong comprehension of research after their first semester in the program. In keeping with the program's objectives, the majority of participants in the Early Research Scholars Program possess no prior experience in conducting research, despite harboring a strong interest. Students evinced an understanding of the scope and nature of research, distinguishing it from other classes from their curriculum, while some have even gained insight into the research process itself. We attribute this success to students' competence and attitudes in engineering; that understanding the research process is a crucial step towards developing the ability to conduct research and ultimately gaining proficiency as engineers or computer scientists.

The Center for Evaluating the Research Pipeline, an arm of the Computing Research Association, conducts an annual assessment of the Early Research Scholars Program. The first evaluation of the Early Research Scholars Program at UIC indicated that students in the program exhibited increased levels of experience with research, collaborating with colleagues on research projects, data analysis, and presenting research findings, six months following their completion of the Early Research Scholars Program. Nearly all students reported a favorable impact of the Early Research Scholars Program on their identity as an engineer, computer scientist, or researcher; however, measures such as student self-efficacy and sense of belonging did not show significant statistical differences in the evaluation report. Nonetheless, personal, academic, and professional reflections submitted by students during the program demonstrated that their sense of belonging and identity have been positively impacted by the program.

Some student reflections indicated a desire for improved coordination with research mentors and a more evenly distributed workload in the research methods course, which will be addressed in the program's fifth iteration.

4 SUMMARY AND ACKNOWLEDGMENTS

The Early Research Scholars Program is focused on improving diversity in computing by promoting community building and an enhanced sense of belonging through engagement in undergraduate research. This program provides undergraduates an opportunity to engage with peers, graduate students, and faculty early on in their undergraduate years in a meaningful way that affirms students' belonging in computing and promotes inclusion. We believe the aspects of the program that harvest diversity and inclusion can be translated to other institutions as well as other types of activities within higher education such as curricular and extracurricular activities.

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