

Increasing Access to Undergraduate Research: Housing Student Research in the Engineering Diversity Office

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Abstract

Research shows groups traditionally underrepresented in engineering (e.g., underrepresented minorities, women, veterans, students with disabilities, LGBTQ+ students, and first-generation college students) are less likely to pursue undergraduate research opportunities. As a result, these students are also less likely to enter the pipeline for graduate school. One barrier for students to trying research is the lack of access to these programs. Many students are unaware that the programs exist or the benefits of participating. To heighten the visibility of research opportunities in the College of Engineering at Penn State, the unit that focuses on undergraduate research experiences is located in the College's diversity office, the Center for Engineering Outreach and Inclusion (CEOI). This non-traditional organizational structure places the research program in the same space as the other student retention programs dedicated to women, multicultural students, and students transitioning from other Penn State campuses. The association gives the undergraduate research programs an intentionality and sensitivity to issues around diversity, and it gives all students in the College of Engineering visible access to the services facilitated by CEOI. In addition, CEOI is well-positioned to promote undergraduate research programs to targeted populations, especially centrally-funded opportunities. Preliminary evidence has indicated a positive effect on the number of underrepresented student participants, retention and graduation rates, as well as enrollment in graduate school.

Introduction

Participation in undergraduate research programs is a proven high impact strategy for increasing student retention and graduation rates, as well as the likelihood that undergraduate students will enroll in graduate school [1, 2, 3, 4]. Undergraduate research opportunities have been particularly successful for improving these metrics for underrepresented populations [5, 6, 7]. As a result, several nationally-recognized programs have focused on increasing the number of traditionally underrepresented groups in engineering to try research as undergraduate students. For example, the Meyerhoff Program at the University of Maryland, Baltimore County (UMBC) is a four-year undergraduate program that attracts top high school students and prepares them for graduate school. Admission preference is given to students "who are interested in the advancement of minorities" and those who already plan to pursue a PhD in STEM [8]. Meyerhoff Scholars are prepared for graduate school through research opportunities, mentoring and community building programs [9]. As a result, Meyerhoff Scholars are almost 5 times as likely to graduate or be enrolled in a STEM PhD or MD/PhD program compared to students who declined their offer to join the Meyerhoff Scholars Program and attended school elsewhere [10]. The success of the Meyerhoff program has been replicated at other universities, including Penn State's Millennium Scholars Program (MSP) and the University of North Carolina's Chancellors Science Scholars Program (CSS). In a recent comparison [11], CSS and MSP cohort students had at least, if not greater, entrance rates to STEM PhD and MD/PhD programs after 4 years as those of the Meyerhoff cohort.

The National Science Foundation (NSF) funds hundreds of undergraduate research programs every year, with about 150 programs in the field of engineering [12]. A goal of these Research Experiences for Undergraduates (REU) programs is to broaden participation of students historically underrepresented in STEM and put them on a path to graduate school. Several studies have demonstrated the positive impact NSF REU programs have had on the recruitment and retention of women and minority students [13]. In addition, NSF typically requires REU host institutions to populate their programs with external students. This strategy appears to be working, as surveys show a larger percentage of African-American students and Hispanic students participating in REU programs outside their home institution compared to their Caucasian and AsianAmerican counterparts [14].

Despite the success of these high profile programs geared toward high-achieving students, there are still significant barriers for underrepresented students to participate in undergraduate research, especially “average” engineering students [15]. For example, Russell and Dye [16] outlined several factors preventing underrepresented student participation in REUs, including lack of high school preparation, limited support to navigate the application process, and misconceptions about REUs being unpaid. Similarly, Bangera and Brownell [17] reported several barriers hindering underrepresented students from pursuing undergraduate research, including:

- *Awareness of existing research opportunities*
- *Awareness of the possible benefits of research experiences*
- *Awareness of cultural norms associated with scientific research*
- *Perceived barriers to interactions with faculty*
- *Financial and personal barriers*
- *Assessment of mentorship and preferences for the “best” students*
- *Unconscious societal bias*

To help reduce these barriers, many universities have created undergraduate research offices dedicated to helping students find research opportunities. Typically, you will find engineering student research offices in spaces near the Career Services Center, Office of Research, in the individual Engineering Departments, or students are referred to a centralized university office. However, to break down barriers even further and benefit those who need it most, a more visible location for the student research office is in the same space as the diversity programs.

This paper presents a non-traditional organizational structure in the College of Engineering at Penn State designed to help broaden access to undergraduate research programs. The integration of the Student Research Unit with the Center for Engineering Outreach and Inclusion (CEOI) addresses many of the barriers outlined by others [16, 17] and is validated by participation, retention, graduation and graduate school enrollment data for an internal centrally-funded undergraduate research program.

Background

The mission of the Center for Engineering Outreach and Inclusion (CEOI) in the College of Engineering at Penn State is to assist all students in the pursuit of their undergraduate and graduate degrees. It was founded to serve students from groups traditionally underrepresented in engineering (women, underrepresented minorities (URM), LGBTQ+ students, first-generation college students, individuals with disabilities, and veterans) and has grown to assist all students, faculty and staff in the College with their engagement in equity and inclusion. To assist with this mission, CEOI includes several success programs for students, including those targeting women and underrepresented minorities.

To increase research opportunities for engineering students who attend Penn State, the Engineering Dean established a centrally-funded undergraduate research program. At the time of the program foundation in 2014, the College provided research experiences to students from external universities, but opportunities for Penn State undergraduate students to become involved in research were limited. The initial goals of the undergraduate research program were to 1) promote undergraduate students participating in research early in their academic career to broaden their education; and 2) increase the likelihood of undergraduate participants to enter graduate school. At the direction of the Assistant Dean of Engineering Outreach and Inclusion, the undergraduate research program and its administrative staff were strategically placed in CEOI. As a result, the program goals expanded to include broadening research participation for students historically underrepresented in engineering (e.g., women and underrepresented minorities); increasing retention of populations traditionally most at risk for degree completion; and exposing majority students looking for research opportunities to CEOI.

Reducing Barriers

A centrally-funded undergraduate research program run through a diversity office can make access to student research more equitable on many fronts. For example, the presence of research staff inside the CEOI office space heightens our visibility to students who enter the office and leads to their awareness of research opportunities. Within a few feet of entering the office, students will see posters advertising research opportunities. The office of the Student Research Director is located between the Directors of the Multicultural Engineering Program (MEP) and the Women in Engineering Program (WEP). As a result, Student Research staff are in close contact with MEP and WEP staff, who are frequently meeting with students in search of co-curricular activities. MEP and WEP Directors facilitate many introductions every week, which increases our credibility with the students and makes the Student Research staff more approachable. Not only does Student Research have a presence inside the office, but we are also part of the standard College welcome programs with a timeslot in the Engineering Dean's Welcome, prospective student visits, student organization meetings, and first year seminar classes. The Student Research Unit is on the front page of the CEOI website (<https://inclusion.engr.psu.edu/>) and our listing of undergraduate research opportunities is provided in the same drop-down menu as CEOI's other academic success programs. As participation grows, several undergraduate research alumni have shared the opportunity while working as mentors in various diversity programs.

In a welcoming and inclusive environment, there are more opportunities to actively share the benefits of undergraduate research and demystify the process of finding a research opportunity. When meeting with students, staff address common misconceptions about undergraduate research, including the need to have a certain level of achievement to get started or know how to work in a laboratory. Marginalized groups are less likely to know that many research opportunities are paid, the existence of academic year opportunities, flexibility in schedules, that it is appropriate to email faculty about their research, and the overall value of the experience toward their future career. To help students connect with faculty, we often facilitate introductions, especially to those we know to be excellent mentors. It is also common to introduce students to faculty in a different department than their intended major, often opening up more interesting opportunities and career exploration.

Perhaps most importantly, a centrally-funded research program in the diversity office has the agency to ensure underrepresented students are being considered for faculty research opportunities and properly supported. In collaboration with MEP and WEP Directors, training is offered on best practices for mentoring underrepresented students and addressing faculty prejudices toward only working with top students and other societal biases. Diversity, equity and inclusion is further encouraged through central messages from the Engineering Dean and funding selection processes that encourage applications from underrepresented groups. A centrally-funded undergraduate research program also allows for professional development sessions to build a student's "soft" research skills and foster community.

Hosting the student research program and its academic success programs in the Diversity Office allows all engineering students to see a clear resource for them in the College. This transparency not only allows all students a presence in the space, but also is often a gateway for students who have not previously accessed services to be connected to other Diversity Office resources and units.

Student Research Academic Success Program Results

We have not tracked the number of students we have helped find external research opportunities and apply to graduate school, but we can share data for one of our centrally-funded internal research programs. This Engineering undergraduate research program started as an 8-week summer program and was later converted to a 15-week research experience for engineering students during the fall and spring semesters. In the academic year model, the paid program requires a 10 hour per week commitment of research from undergraduate students. In addition to research hours, students are required to attend monthly professional development sessions focused on best practices in research, program deliverables, and community building. Example topics include maximizing your research experience, communication, research ethics, academic writing, poster design, and an overview to graduate school. At the conclusion of the program, students are required to present their research as a poster and write an associated research abstract.

To apply for the program, students connect with a faculty member and write a short 1 to 2 page research proposal describing the type of work they will be doing, the importance of the research, and a timeline. Proposals are then reviewed by Student Research staff. To serve the maximum number of students, students new to research receive preference during the selection process. As noted earlier, program staff are able to leverage their position in CEOI to recruit students from traditionally underserved populations to apply.

Through the Fall 2019 semester, over 400 College of Engineering students have participated in the undergraduate research program during its 12-semester tenure. Table 1 shows the demographics for the program. It is common for underrepresented students to engage in research at rates slightly lower than their proportion in the general population [15, 18, 19]. However, as shown in Figure 1, female participants in the undergraduate research program are represented at rates typically well above the overall college population of women (average of 22%) and URM students are participating at a rate at least equivalent to the overall college population of URM students (average of 9%). As our programs are relatively new, and many participants are still undergraduate students, the program enrollment numbers show a promising upward trend (see Figure 1).

Table 1. Demographics of Centrally-Funded Undergraduate Research Program

| Semester Cohort | Total Head Count | Gender | | URM | 1 st & 2 nd Year* |
|-----------------|------------------|------------|------------|------------|---|
| | | F | M | | |
| SU14 | 59 | 22% | 78% | 24% | 32% |
| FA14/SP15 | 31 | 29% | 71% | 19% | 3% |
| SU15 | 47 | 34% | 66% | 19% | 35% |
| SP16 | 35 | 26% | 74% | 14% | 17% |
| FA16 | 28 | 36% | 64% | 7.1% | 14% |
| SP17 | 40 | 28% | 72% | 10% | 18% |
| FA17 | 33 | 33% | 67% | 9.1% | 9.1% |
| SP18 | 51 | 31% | 69% | 14% | 49% |
| FA18 | 24 | 33% | 67% | 8.3% | 21% |
| SP19 | 29 | 35% | 65% | 28% | 52% |
| FA19 | 31 | 36% | 64% | 23% | 35% |
| Total | 408 | 31% | 69% | 16% | 26% |

*Class standing at time of application to the research program.

Of the 124 women who have participated, 29% applied when seniors, 33% applied when juniors, 25% applied when sophomores, and 13% applied when first year students. Of the 67 URM students who have participated, 39% applied when seniors, 12% applied when juniors, 17% applied when sophomores, and 10% applied when first year students. Table 1 also shows a recent shift in the cohort demographics to more first and second year students, which has the potential to positively impact retention and likelihood of attending graduate school [20].

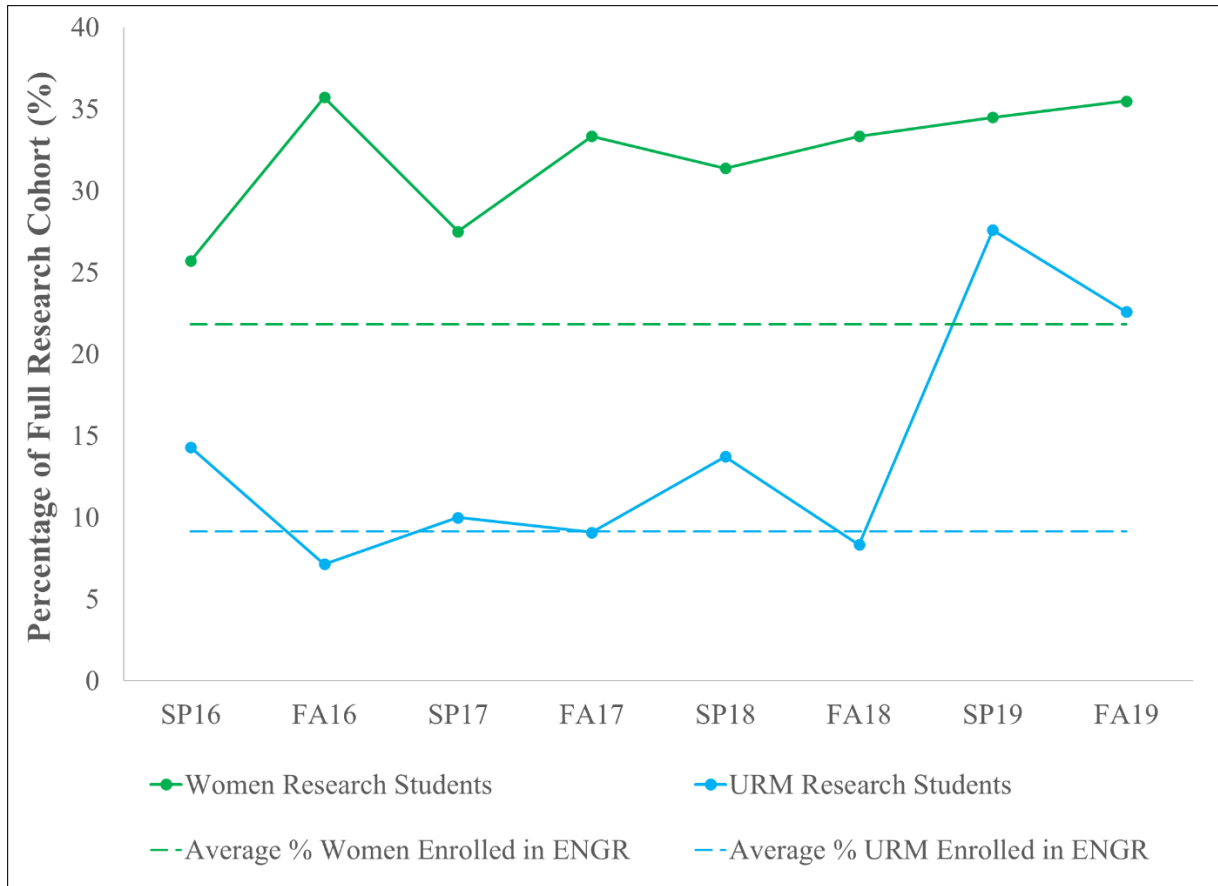


Figure 1. Participation of Women and URM students in academic year centrally-funded undergraduate research program.

Additional metrics used to evaluate the success of an undergraduate research program include student retention, graduation, and enrollment in graduate school. To date, all 67 URM research program participants have either graduated or are still enrolled as undergraduate students at the University. For the students who identify as women, only one student withdrew from the university before completing their degree. The remaining 123 women have either graduated or are still enrolled as undergraduate students.

To determine the number of underrepresented research participants who have enrolled in graduate school, an extensive search of social media sites (e.g., LinkedIn, etc.) was completed. The resulting status of the underrepresented research participants is shown in Figure 2. For the students who have graduated, at least 31% of the URM students have enrolled in graduate school and at least 40% of the women. Not all students were located during the search, resulting in missing data for 16% of the URM students and 14% of the women. These enrollment numbers are higher than the average enrollment numbers of 25% for typical engineering schools [21].

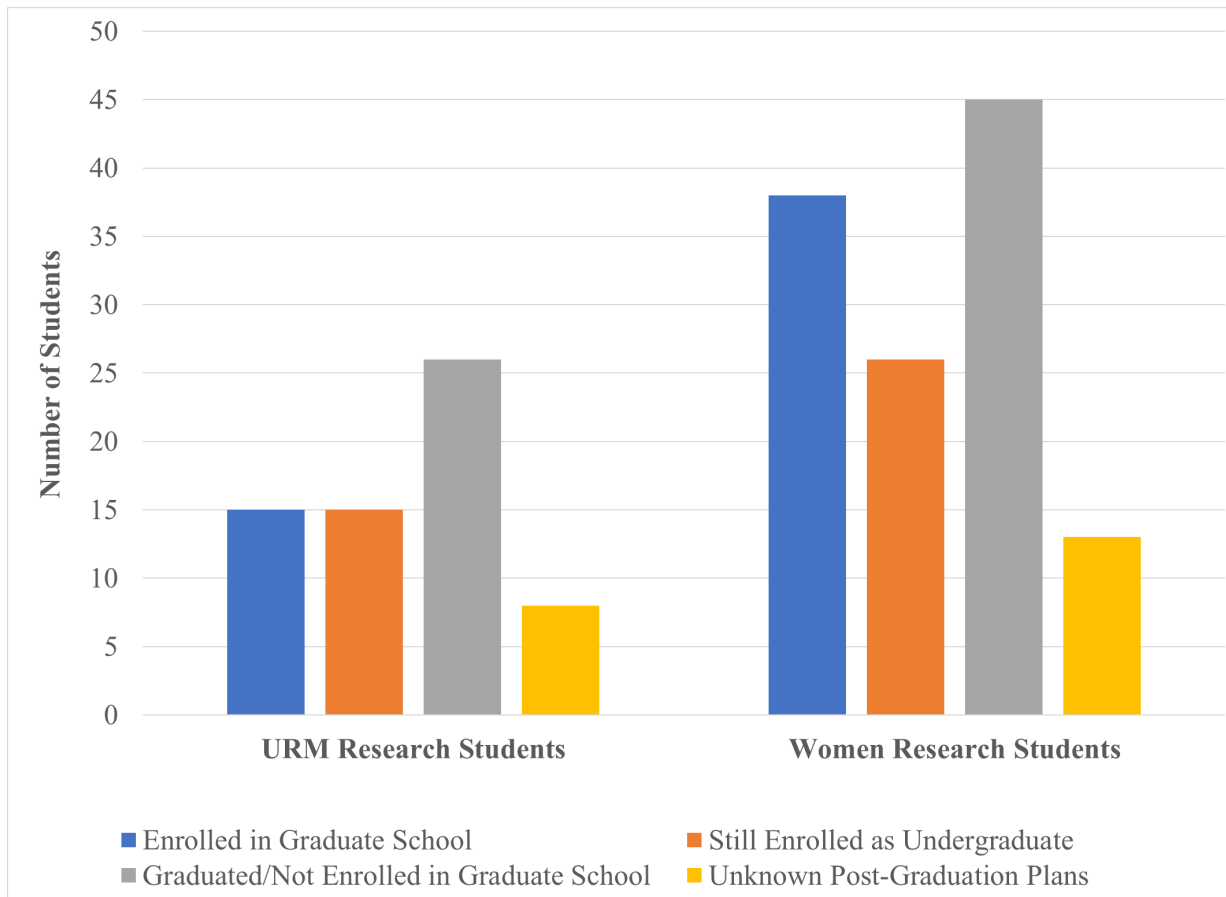


Figure 2. Number of participants in centrally-funded undergraduate research program from underrepresented groups who enrolled in graduate school.

Conclusion

A centrally-funded student research program located in a university's diversity office has the potential to break down a number of the barriers discouraging underrepresented students from trying research as undergraduate students. Co-locating Student Research and Diversity Program staff, provides an inclusive environment where students can learn about research opportunities and find support to navigate the process. Increasing the numbers of students who try research, particularly of those who might not have otherwise, positively impacts retention rates, graduation rates and graduate school enrollment. Furthermore, there has been an increase in all students visiting the Center for Engineering Outreach and Inclusion, increased collaboration within the office, better student referral to resources such as funding, and an increase in students participating in research across all demographics.

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