Work-In-Progress: Can We Create a Model Program: Insights into the Effectiveness of a Research Experience for Undergraduates

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Abstract

This study expands on our prior work of the Research Experience for Undergraduates (REU) SITE program to provide data on participant preparation for success in graduate school and their perceptions of the program. In the first two studies from our initial cohort, we summarized that we effectively provided an independent research experience, increased participants perception of preparedness for success in the graduate application process and graduate school and increased their ability to communicate about Biomechanics and Mechanobiology (BMMB)[1]. In the follow up study we showed that by the end of the program students believed they were better prepared for success in graduate school, two students co-authored publications from their projects, and the majority were enrolled in a graduate program[2]. Here we share data across our first two cohorts which expands our outcomes associated with graduate school preparation and student perceptions of the REU SITE program. We used our site-licensed online survey tool Qualtrics to administer the surveys for data collection. We used the same pre- and post-survey data to assess changes for both ten student cohorts over the 10-week period. The data were analyzed using a paired t-test from GraphPad Prism 9.3.0 software. This study confirmed the findings from the first two studies while highlighting new information. The new analysis conducted across both cohorts showed participation in the program influenced student interest in applying to graduate school $p< 0.05$. Additionally, the data show that participants felt more prepared to conduct independent research after participating $p<0.05$. Of the twenty participants the twelve students who have graduated or will be graduating before summer 2023 are enrolled in a graduate program or have applied for admission. Six of those yet to graduate reported they plan to pursue a graduate degree after completing their BS degree. Additionally, students felt the program prepared them to find and read research articles $p<0.01$ and participate at a conference $p<0.05$, skills that will be beneficial for success in a graduate program. Ninety-five percent of the participants indicated the REU SITE met or exceeded their expectations and would recommend the program to others. Similarly, 95% were satisfied with the mentorship of their graduate ambassador and 100% indicated they were satisfied with the mentorship of their faculty. Additionally, we were excited to find that after an adjustment to our program after the first cohort, the second cohort felt prepared to contribute to the field of BMMB $p<0.05$. This was an objective of the program that was not achieved with the first cohort. Lastly, 85% of participants were from underrepresented minority (URM) backgrounds and 70% were female. Thus, the enrollment of our participants in graduate programs continues to enhance diversity in engineering and the field of BMMB. Going forward we will continue to track the progress of participants and the careers they choose after completion of their graduate degrees. We will also continue to use student feedback to improve the experience for participants.

Introduction

A fundamental value of a REU is the research experience students acquire. By participating students gain the experience many STEM graduate programs seek in their applicants. But the research experience alone is insufficient for admission. Additional professional development could be beneficial in helping students garner success in the admissions process. We set out to enhance the research experience and increase a student's likelihood of success with gaining admission and successfully completing a graduate degree by incorporating targeted professional development.

Our REU SITE has had three main objectives, to increase the number of traditionally underrepresented students pursing a graduate degree and prepare them for success in the application process and graduate school, provide hands-on scientific research experience in BMMB, and develop the participants ability to comprehend, contribute, and communicate advances in BMMB. From our first study we learned that by the end of the 10-week program participants were conducting independent research, felt prepared for success in the application process and graduate school and believed they were better able to communicate about the field of BMMB[1]. Additionally, all participants from the first cohort were from underrepresented minority backgrounds, 80% of them are now pursing graduate degrees[1].

In the absence of a REU SITE program in years two and three because of the pandemic we analyzed additional data from cohort one to better understand the effectiveness of the program. We found that students felt better positioned for success in graduate school after participating because of the professional development they received[2]. Specifically, students believed they were better able to prepare and give research presentations, write an abstract and design posters and that their knowledge of applications of BMMB work had increased[2]. Providing students with the requisite skills to be successful after they enroll in a graduate program is essential. According to the Council of Graduate Schools (CGS) PhD Completion Project from 2008, only 57% of PhD students actually complete their degree within ten years[3]. Unfortunately, students from underrepresented minority backgrounds complete PhD programs at an even lower rate. The 2008 CGS PhD Completion and Attrition study reported 36% of African American/Black and 40% of Hispanic/Latino students completed PhD programs in life science, engineering, and physical and mathematical sciences in seven years[4]. To accomplish our aim of increasing the number of URM students pursuing a graduate degree and preparing them for success in the application process and graduate school, it is imperative to begin to cultivate the skills they will need as they progress through their programs. This will include providing intentional professional development and active mentorship. To ensure our participants were entering an inclusive environment and positioned to receive support and effective mentorship, all faculty mentors completed our 8-hour mentor training workshop. This training was designed to prepare faculty to be more effective at creating inclusive environments and support student/trainee research development. Here we used the data from the first two cohorts to assess additional skills students believed they obtained that would support their success in graduate school and their perceptions of our program over two years. We also investigated whether our program influenced participants to pursue a graduate degree. Based on what we have learned we hope to create a model to facilitate success for others seeking to develop a REU.

Materials and Methods

In preparation for the program all faculty mentors completed mentor training. It was offered within our college or university and was designed to prepare faculty to be more effective at creating inclusive environments and supporting mentee development personally, professionally, and academically, so they become independent researchers. The training is based on the curriculum developed by The Center for the Improvement of Mentored Experiences in Research (CIMER) and facilitated by the REU SITE PI, co-PI, and other trainers within our college and across the university. During both summers we hosted the program we engaged ten students in each of the two cohorts for a 10-week research immersion. Each participant was matched with a faculty mentor based on their research interest. Only one participant was paired with each mentor. Participants were also assigned a graduate ambassador from their faculty mentors research group. Throughout the ten-week program participants engaged in research and professional development activities. The program was structured to expose students to the graduate student experience, how to prepare for success in graduate school, and career opportunities beyond the advanced degree. They all participated in a series of professional development activities. Some activities were integrated into their research activities and others were conducted separately. Structured and unstructured interactions with their mentors, lab members and workshops provided an opportunity for participants to learn how to identify and understand research articles, conduct independent research, prepare for conferences, and ultimately success in graduate school.

Questions
1. Please rate the extent of your interest in applying to graduate school?
2. Please rate the degree to which you feel prepared to conduct independent research?
3. Please rate the degree to which you feel prepared to find research articles?
4. Please rate the degree to which you feel prepared to read research articles?
5. Please rate the degree to which you feel prepared to participate at a conference?
6. Please rate the degree to which the REU SITE program met your expectations?
7. Would you recommend this REU SITE program to others?
8. Please rate the degree to which your graduate ambassador met your expectations?
9. Please rate the degree to which your faculty mentor met your expectations?
10. Please rate the degree to which you feel prepared to contribute to the field of BMMB?

Table 1. Shows an excerpt of the pre- and post- survey questions asked of participants.

Nineteen of the twenty students completed the pre- and post-surveys: nine in cohort one and ten in cohort two. To maintain data integrity, we only used the data from those who responded to both surveys. Since the names were not collected, we mapped the pre-and post-survey data based on the demographic and identifying questions asked in each survey. Table 1 shows the survey questions asked to assess knowledge of and comfort with research, research related activities, the ability to contribute to BMMB and student perceptions of the REU SITE program.

Nineteen students completed the pre- and post- survey. Question 1 asked participants the extent of their interest in applying to graduate school on a scale of 1 (Not at all) to 5 (High). In questions 2-5 and 10 participants were asked to rate how prepared they currently felt with doing each of the following on a scale of 1 (Not at all) to 5 (High). For questions 6-9 participants were asked to rate their perception of each item or provide a recommendation. The data was analyzed using GraphPad Prism 9.3.0 software using a parametric paired t-test.

Results

We provided the participants a ten-week research immersion with professional development opportunities embedded as well as separate sessions. The sum of these opportunities provided students insight into the graduate student experience and how to prepare for success in obtaining an advanced degree. We assessed the extent of their skill development after they engaged in research and conversations with their mentors and lab mates, journal clubs and discussions with faculty, ambassadors, and their peers, and professional development seminars. We also assessed participant satisfaction with the mentorship from the faculty and graduate ambassadors and the program overall. Because of our small sample size of 19 and normal distribution and homogeneous variation of the data we used a parametric t-test to conduct our analysis. The data from questions 1 and 2 on Table 2 indicated participation in the program influenced student interest in applying to graduate school $p< 0.05$ and students felt more prepared to conduct independent research after participating $p<0.05$. The data from questions 3 and 4 on Table 2 indicated that by the end of the program participants felt better prepared to find and read research articles $p<0.01$. The data from question 5 on Table 2 indicated that students felt better prepared to participate at a conference $p<0.05$. The first cohort of this REU did not feel as though they were prepared to contribute to the field of BMMB. On the contrary, 71% the faculty mentors from the first cohort indicated their mentee produced data that could be included in a future publication[1]. Therefore, we sought to understand whether the 2nd cohort perceived they could contribute to the field of BMMB. The data from question 6 on Table 2 indicated participants from the second cohort felt prepared to contribute to the field of BMMB $p<0.05$ despite the absence of this perception by cohort 1[1]. This was the only one of our proposal objectives for which there was a lack of concurrence between the two cohorts. Data for this question was analyzed for cohort one and published in the 2021 ASEE Illinois-Indiana regional conference proceedings.

	BUCKEYE REU OUTCOMES ASSESTMENT				Mean Diff.	Sig. Diff.[2]	N
	Pre		Post				
	Mean	S.D.	Mean	S.D.			
Question 1	3.38	1.12	4.12	0.56	0.74	p<0.05	19
Question 2	3.19	1.35	4.45	0.53	1.26	p<0.05	19
Question 3	3.37	1.11	4.11	0.52	0.74	p<0.01	19
Question 4	3.58	1.34	4.3	0.93	0.72	p<0.01	19
Question 5	2.41	1.14	3.88	0.62	1.47	p<0.05	19
Question 6	3.22	1.21	4.64	0.51	1.42	p<0.05	10*

Table 2. The data analyzed from the pre- and post- surveys, from Table 1, administered to participants. Sig Diff = significant difference. *Only data for the 10 students from cohort two were analyzed.

In addition to skill development, participants also had positive views of the program with 95% of them indicating the REU SITE met or exceeded expectations, and they would recommend the program to others (Figures 1 and 2). Similarly, 95% of participants were satisfied with the mentorship they received from their graduate ambassador and 100% indicated they were satisfied with faculty mentorship (Figures 3 and 4). We have also had success with recruiting students

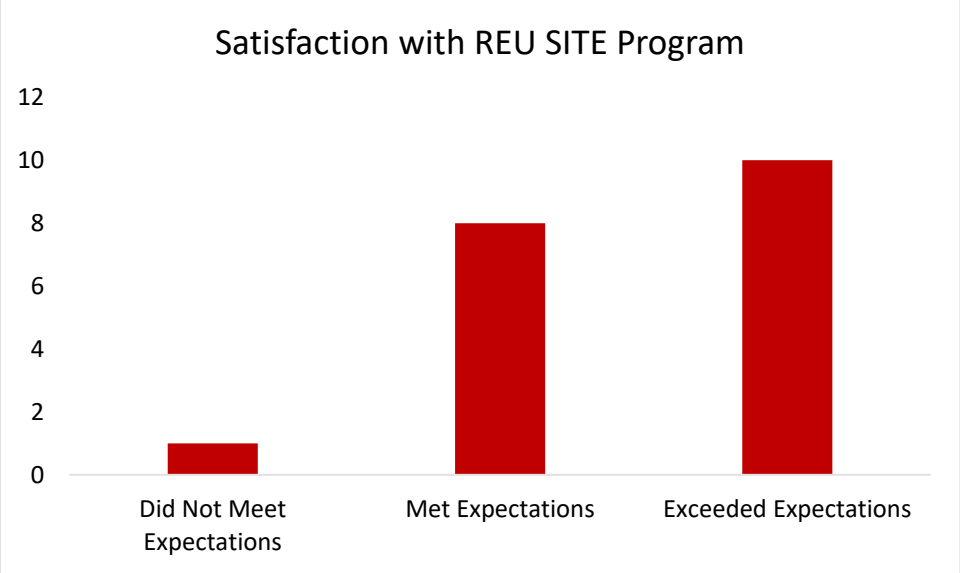

Figure 1. Shows participants perception of our REU SITE program.

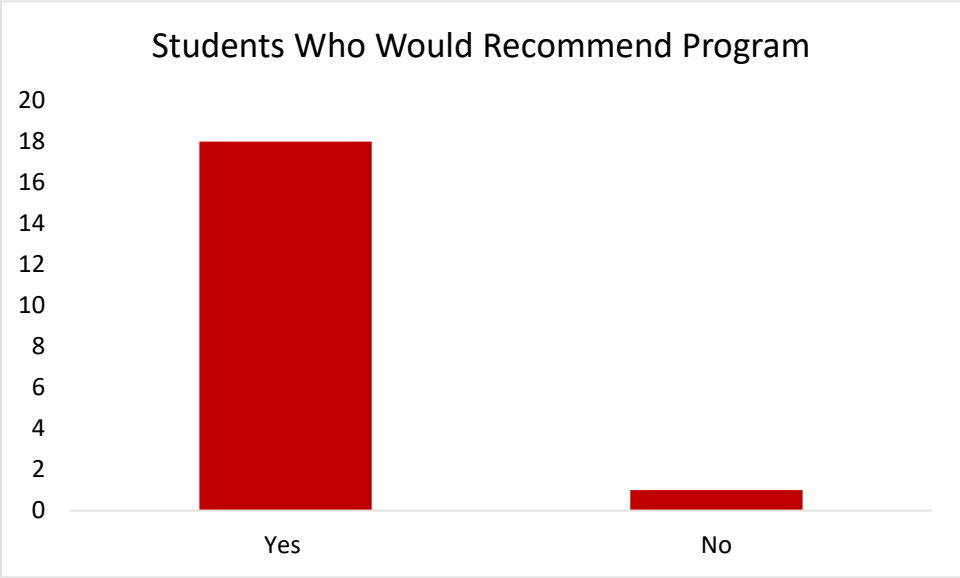

Figure 2. Shows whether participants are likely to recommend our REU SITE program to other students.

from underrepresented backgrounds in STEM. Eighty-five percent of participants were URM's and 70% were females. So far, 92% of those participants who are now in graduate school or have applied are URM and 75% are female.

Figure 3. Shows participant satisfaction with graduate ambassador mentorship.

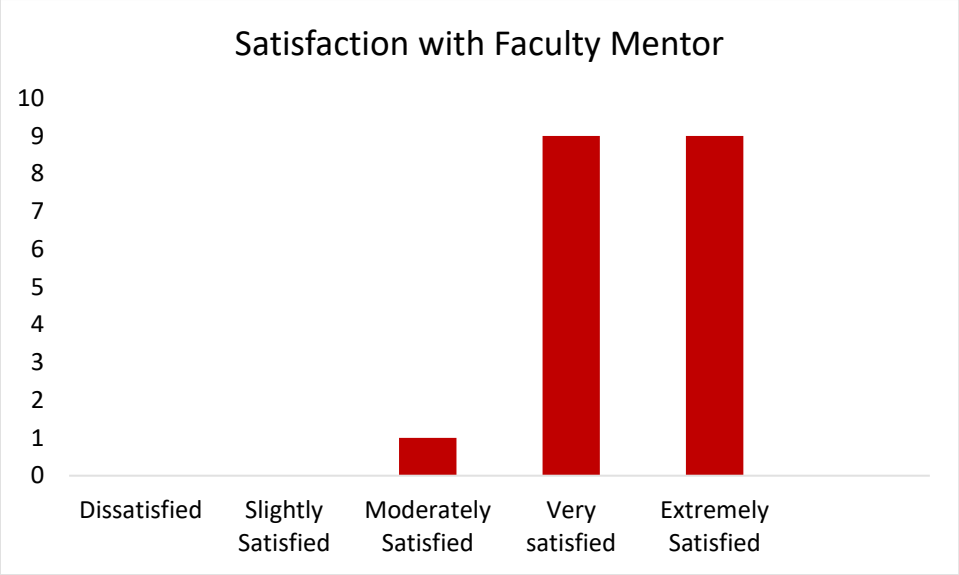

Figure 4. Shows participant satisfaction with faculty mentorship.

Conclusion

In summary, we have been able to influence our participants decision to pursue a graduate degree. The combination of research immersion and structured and unstructured professional development has helped our eligible students garner admission to graduate programs. We have continued to make progress on increasing the representation of underrepresented minorities and women in BMMB. Since participants felt better prepared to conduct activities necessary for success in graduate school, we believe they are better positioned for success. It is our hope that they will complete their graduate degrees at a higher rate than currently observed. Moreover, we have been successful in meeting or exceeding the expectations the participants have had regarding the faculty mentors and graduate ambassadors. Strong mentorship is a fundamental necessity for fostering research success and development. We believe we have the foundation for a model REU SITE program and look forward to sharing our best practices with others.

Future work

We recognize the number of students in each cohort is small and aim to strengthen the statistical validity as more cohorts complete the program. We will continue to track student decisions related to pursuing a graduate degree. We will also continue to track their progress and completion of their graduate degrees. As our program continues, we will constantly improve based on feedback from our participants. Though we have provided graduate ambassador training in the past, we aim to provide formalized mentor training to our ambassadors going forward.

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References

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