

# THE ROLE OF GRADUATE STUDENTS IN RESEARCH EXPERIENCE FOR UNDERGRADUATES PROGRAMS

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**ABSTRACT.** In this article, we consider the the role of graduate students as mentors in Research Experience for Undergraduates (REU) programs, as reflected by a breakout session at the TURMS conference. We consider the benefits of using graduate students to the institution running the program and to the participating undergraduates. We also consider the benefits that the graduate students themselves gain from working in an REU, and we warn of potential problems that can arise when employing graduate students in this context. We discuss the role of post-doctoral fellows and other undergraduates in REU programs and conclude with questions about graduate student mentors that merit further discussion.

## 1. INTRODUCTION

At the TURMS conference, there was a breakout session that discussed the role of undergraduate students, graduate students, and post-docs as mentors in undergraduate research. The discussion focused primarily on the role of graduate student mentors, so that will be the primary focus of this article as well. We begin by considering the role of graduate mentors in undergraduate research and the benefits that they provide to both the research program and the undergraduate participants. Next we consider the benefits to the graduate students in being mentors. After this we discuss some concerns and possible problems with using graduate students in a research program. We then turn to the roles of other undergraduates and post-doctoral fellows in the undergraduate research experience. Finally, we conclude with some additional questions regarding the use of graduate students in Research Experience for Undergraduates (REU) programs.

## 2. THE ROLE OF GRADUATE STUDENTS

Graduate students have two broad roles in an REU setting: the first is administrative, and the second is mathematical and technical support. In their administrative role, graduate students plan and attend social events, spot potential compatibility problems, and are often available when faculty members are not accessible. During our breakout session, many REU organizers cited examples of graduate students planning lunches and weekend outings when the faculty do not have time. Since the graduate students are closer in age to the undergraduates and, in many cases, live with the undergraduates during the program, graduate students are more likely to spot potential personal problems that a student may have. Graduate students may also be able to detect compatibility problems within the group work environment. A distinct advantage of having the graduate students live with the undergraduates is that the graduate students are more likely to be accessible at times when the faculty member is not available. Occasionally, some REU directors in our session will have to leave their program for a couple of days, during which time graduate students are able to keep the program running smoothly.

In their mathematical and technical support role, graduate students perform many functions that are vital to the success of an REU. Graduate students help provide the undergraduates with mathematical background and guide them in their research projects. In most programs graduate students provide computer training for the undergraduates. For example, many REU directors have

their graduate students teach the participants LaTeX, Beamer, or any other computer programming skills that are needed to complete the project.

Some REU mentors in our session stated that the research area of the graduate students is less important than the ability of the graduate mentors to teach the technical aspects of the project, such as LaTeX. At the conclusion of an REU, graduate students can help train the undergraduates in presenting their work, listen to practice talks, and give feedback. This is particularly valuable at large REUs, where faculty members might not be able to listen to every practice talk. If the undergraduates need to present their work outside of the REU, graduate students can show them how to create and edit posters. In addition, graduate students can assist with the writing and editing of REU papers. Since this process may take a significant amount of time (up to a year, or longer, in some outstanding cases), having graduate assistance for an extended period of time is invaluable.

We conclude this section by noting that graduate students do not need to stay at the REU for the full length of the program in order to have a positive effect. In particular, at the University of Minnesota-Duluth, Joe Gallian has some graduate students come to his program as one-week visitors. The task of the visiting graduate student is to make a personal connection with one or two of the undergraduate participants.

### 3. BENEFITS FOR THE GRADUATE STUDENTS

In a session populated with REU directors, it is not surprising that the first potential benefit mentioned for graduate students is that they will be more prepared to direct REUs themselves in the future. While this is certainly true, there are many other benefits for a graduate student participating in an REU. In a job market that seems only to get more competitive, participation as an REU mentor provides graduate students with practical experience that enhances their standing as a job candidate. As more colleges and universities stress undergraduate research, any experience with undergraduate research (such as participating in an REU as a mentor) will help a candidate immensely. As a short term benefit to a graduate student, participating in a research project can help jumpstart a Master's thesis or a dissertation. In short, the experience that graduate students gain in advising undergraduates can only help them in their future careers.

### 4. CONCERNS AND POTENTIAL PROBLEMS

While the use of graduate students has many benefits for everyone involved, our session did address some concerns and potential problems with using graduate students as mentors in an REU. In order to begin their work, graduate students must receive proper training beforehand. In particular, graduate students should have their roles clearly defined by the faculty members who are directing the REU. Faculty directors need to describe explicitly what is expected of the graduate students during the program. Here are some examples of expectations for graduate students that were mentioned: do not dominate a project, assist undergraduates with work on a project but don't solve it completely, and make sure this work is treated as a priority. The REU director should clearly specify the role of the graduate mentors, whether they are meant to be a coauthor or just part of a student support system. Finally, if possible, graduate assistants should be chosen who are not under pressure to study for qualifying exams or finish a dissertation, as these students may be too distracted to fulfill their role as a graduate mentor.

### 5. POST-DOCTORAL FELLOWS AND OTHER UNDERGRADUATE STUDENTS

In addition to graduate students, our session also briefly discussed the roles of post-doctoral fellows and other undergraduates as mentors in REUs. The REU directors in our session said that postdocs generally act in a role closer to faculty than graduate student. Both the Iowa State and DIMACS REUs have used post-docs in this way as project mentors. However, there was a range

of other experiences with postdoc involvement in REUs. For example, one former postdoc in our session participated in the MSRI-UP REU where his role was more that of a graduate student mentor than a faculty member. It seems that the greatest benefit of involving postdocs in REUs is that they are able to give graduate students the necessary training that was mentioned previously.

Participants in our session had varying opinions on the use of undergraduates as mentors at REUs. Most said that they would use undergraduates only in an administrative role and not in a mathematical mentoring role. While some REU directors do involve undergraduates in administrative work, other directors think that it is better for undergraduates to participate in another REU. One director said that he invites undergraduates who have already participated in his REU back to serve in an unofficial mentoring role. He does this for two reasons: first, if the student did not finish a paper for the previous REU, then bringing the student back can be an effective way to motivate them to finish their work. Second, this director sees value in bringing exceptional participants back, as this can be part of a grooming process to prepare these students to direct future REUs.

## 6. CONCLUDING QUESTIONS

We conclude this article by asking some questions that our session did not have time to address in detail.

- (1) If an REU site does not have graduate students, what is the best way to choose graduate students from other institutions? It seemed that most directors in our session use alumni from their own programs (as Joe Gallian from the University of Minnesota-Duluth put it, his alumni have an “institutional memory” that he does not have to teach). However, the Denison and Valparaiso REUs have experimented with recruiting graduate students from nearby larger universities.
- (2) What is the best way to train graduate students for their participation in an REU? We discussed the goals that should arise from the training, but we did not discuss technical issues, such as how early the graduate students should arrive before the program.
- (3) In our session, our discussion focused on REUs. What roles can graduate students have in other methods of undergraduate research? In particular, do graduate students ever formally mentor undergraduate research during the academic year?

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