Board 367: Reflections from an Interdisciplinary Team Research Project during a 10-week NSF REU Program

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Introduction

In a typical year, the Biomedical Engineering NSF Research Experiences for Undergraduates (REU) site at the University of Nebraska-Lincoln involves multiple individual projects, each consisting of a faculty adviser, a graduate student or postdoctoral mentor, and a visiting undergraduate REU participant. The goals of the REU projects include fostering independent research skills, enabling research experiences for participants from underrepresented groups and/or schools with limited research opportunities, and providing professional development. Because our REU faculty come from a wide variety of departmental affiliations and research expertise related to biomedical engineering, the REU participants are exposed to diverse interdisciplinary research programs through seminars and weekly presentations. However, the REU students generally do not have the opportunity to conduct research as a part of an interdisciplinary team. In fact, previous REU student cohorts have expressed a desire for more collaboration and team-based research projects, features which they felt were lacking from the existing REU program format.

To increase opportunities for such collaborative experiences, we conducted a pilot project involving collaboration between two labs to create a wearable ultrasound device during the 2022 summer program. One lab specialized in designing and manufacturing wearable biomedical devices and the other lab specialized in diagnostic ultrasound imaging. Two REU participants were involved in the project, with each assigned to a different faculty adviser and graduate student or postdoctoral mentor. The REU participants each had separate responsibilities but needed to collaborate extensively to attain the project goal within the 10-week REU program period. This paper will describe the outcomes of a novel pilot project involving collaboration between two labs within the University of Nebraska-Lincoln Biomedical Engineering REU.

Methods

Interdisciplinary Team Research Project

Dr. Greg Bashford's lab specializes in research and development involving diagnostic ultrasound imaging, with a particular focus on transcranial Doppler ultrasound (TCD), a type of ultrasound specialized for monitoring blood flow in the major arteries of the brain [1]. Dr. Eric Markvicka's lab specializes in designing and manufacturing stretchable electronic devices for wearable biomonitoring. The two PIs leveraged their areas of expertise to identify a cutting-edge research topic: wearable ultrasound devices [2]. The goal for the summer was to create a wearable TCD device. Before the 10-week REU program began, the two faculty mentors agreed upon how to divide the tasks necessary to create the device among two REU students. Each student was assigned to one "primary" faculty mentor at the beginning of the REU summer session. Approximately the first three weeks of the ten-week session were devoted to training the undergraduate REU participants in the relevant techniques used in their respective PI's labs. The next six weeks involved carrying out the research project, and the final week involved preparing a poster based on the results.

At weekly meetings attended by the PIs and graduate student and postdoctoral mentors from both labs, the REU participants took turns presenting their progress, and the entire group came to a consensus regarding next steps. These weekly meetings were in addition to the regular weekly meetings attended by all students in the biomedical engineering REU program, and in which each student presented every week.

Data Collection Methods

To assess changes in participants' self-efficacy due to the REU program, all REU participants were asked to complete a pre-program survey and a post-program survey. Both surveys had the same set of questions, which had Likert scale responses [3]. For example, students were asked, "How confident are you in the following skills as a scientist?" and given a list of skills along with the choices "not at all confident", "a little confident", "kind of confident", "confident", and "very confident". The survey was administered by the University of Nebraska-Lincoln's Methodology and Evaluation Research Core Facility (MERC). De-identified, aggregated results were provided to the BME REU program.

Additionally, students participated in focus groups facilitated by MERC. Focus groups were conducted at the midpoint of the program and at the endpoint of the program. Finally, faculty mentors were interviewed post-program by MERC. MERC provided de-identified summaries of important comments from all focus groups and interviews.

Results

Figure 1 shows selected survey results from the pre-program survey and post-program survey, showing that students' self-efficacy improved in working collaboratively as part of a research team.

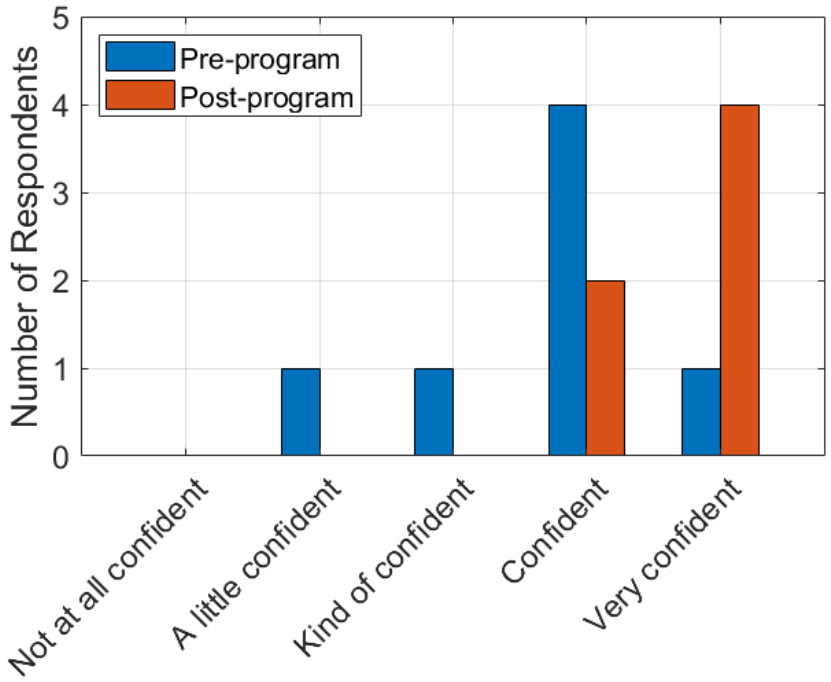

Figure 1. Pre-program survey (N=7) and post-program survey (N=6) results for the question, "How are you in the following skills as a scientist: working collaboratively as part of a research team?" One student did not complete the post-program survey.

Discussion

Survey Results

A comparison of pre-program and post-program survey results suggest that the collaborative project produced positive outcomes in students. For example, when comparing the pre-program survey to the post-program survey, undergraduates showed an improvement in their confidence in their ability to work collaboratively as part of a research team (Figure 1). However, this improvement appeared in more than just the two undergraduates involved in the collaborative project (since the number of students responding "very confident" increased by three), suggesting that it may also have been driven by other undergraduates who experienced other types of collaboration (e.g., working alongside a graduate student mentor on a project).

Benefits of Collaborative Projects

Engaging in a team research project between two labs with different areas of expertise afforded multiple benefits. First, this team research project allowed REU participants to obtain a broad understanding of different aspects of this interdisciplinary research project while focusing on their own area of expertise, a skill necessary in many real-world engineering applications. Second, the REU participants were able to develop problem solving skills through interactions with their peers, rather than requiring assistance from their faculty adviser or graduate student mentor whenever a problem was encountered, providing an opportunity to develop students'

self-efficacy related to independent problem-solving in research. Students in past REU cohorts have indicated that learning to be independent researchers is important to them [4].

Difficulties Encountered

Several difficulties arose during the collaborative project. In agreement with previous studies [5], it was found that direct communication between the undergraduate REU participants and mentors/advisers was essential to make progress during the short time frame offered by the 10-week REU program. However, not all information that was communicated between the two collaborating REU participants was relayed to the graduate mentors or faculty advisers. In addition, although students began with well-defined roles in the project, the constantly evolving nature of the research project made it difficult to define each undergraduate's roles and responsibilities throughout the program. Finally, the two collaborators' labs were located several miles apart on two different campuses, making frequent face-to-face meetings difficult.

Future collaborative team research projects will contain modifications to address these challenges, such as starting weekly meetings of the collaborative team (PIs, graduate student and postdoctoral mentors) several weeks before the start of the REU program, instead of waiting several weeks after the start of the program to begin weekly meetings. This would allow everyone to begin the REU program with a clear set of goals and objectives for the undergraduates and would help establish a regular meeting time before other demands of the summer fill out team members' schedules. Additionally, placing a high priority on regularly scheduled meetings would allow for improved communication of information from the REU participants to faculty and graduate student or postdoctoral mentors. Finally, the convenience of virtual meetings could be leveraged for some of the meetings, allowing the team to stay in close communication while not spending excessive time commuting between campuses.

Limitations

A limitation of the current work is that results in this study are based on the outcome of a single interdisciplinary REU project involving two undergraduate students, their graduate student and postdoctoral mentors, and their faculty mentors. Further experience with multiple interdisciplinary, collaborative REU projects will allow further insight into the benefits and drawbacks of this style of research experience.

Conclusions

The first year of a novel collaborative research project showed promising increases in student self-efficacy. For example, students expressed an increase in confidence in working collaboratively at the conclusion of the session compared to prior to the session. Some challenges were also encountered, such as difficulties establishing communication between the two participating labs and defining the individual research responsibilities of the REU students. Overall, the collaborative research project proved to be successful based on student survey responses and research outcomes, including a patent application generated from the work, peer-reviewed conference publication [6], and the opportunity for both participants to present the results of their work at a national conference. Results in this preliminary study are based on the

outcome of a single interdisciplinary REU project. In future REU cohorts, we hope to have more collaborative partnerships between different disciplines within biomedical engineering.

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