

UNL Summer REU Program in Biomedical Devices

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Abstract

We report results of a multi-year summer undergraduate research program (REU) focused on diagnostic and therapeutic biomedical devices. The goals of the project include fostering independent research skills, recruitment from underrepresented groups and/or schools with limited research opportunities, and professional development particularly targeting entrepreneurship and innovation. Pre/post surveys and focus group interviews were conducted to collect data from participants. Students strongly indicated that the program was an important bridge between their undergraduate and graduate careers and that important knowledge, skills, and interests were developed as a result. One of the main self-perceived deficiencies of students entering the program was technical communication, and gains were achieved in this area by structuring biweekly program-wide meetings around developing relevant skills. We found that one of the key indicators of a successful summer research experience is early contact between the student and the faculty mentor and/or graduate student mentor prior to the start of the research experience, and regular contact thereafter. We also determined that for purposes of engagement, it is important to provide hands-on activities from the beginning (in parallel with research training that supports the later phases of the summer project), even if these hands-on activities do not bear directly on the longer-term research goals. Finally, we found that exposure to professional development activities involving industry and technology transfer themes resulted in increased self-efficacy related to the ability to innovate in students' chosen field. A mixture of quantitative and qualitative survey results are presented to support these findings.

Introduction

Undergraduate research experience has been shown in many cases to enhance preparation for graduate programs and to increase self-efficacy in related skills. These may involve international components [1,2], K-12 outreach [3], various aspects of professional development [4], and any number of discipline-specific focus areas. In this paper we describe the outcomes and lessons learned from a three-year summer undergraduate research site.

Methods

A research experiences for undergraduates (REU) site was held at the University of Nebraska-Lincoln during the summers of 2013-2015. This 10-week program involved an average of nine undergraduate student participants each year, spending approximately 40 hours per week on research and professional development activities. A smaller-scale follow-up program (fewer students) was also carried out in the summer of 2016. Faculty mentors paired with students, along with graduate student mentorship, to guide research projects in the area of biomedical devices, culminating in a research poster session at the end of the summer. Although many of the supplemental professional development activities focused on preparation for graduate study (GRE preparation, graduate school applications, professional skills, research ethics), seminars and field trips designed to promote understanding of intellectual property, entrepreneurship, and industry careers were also included as special emphasis areas.

Several data collection modalities were used to provide formative feedback and overall assessment for the REU site. These included pre-program, post-program, and one-year follow-up surveys, student focus groups held at the midpoint and at the end of the 10-week program, and interviews with faculty and graduate student mentors. Results and interpretation of these assessments follow.

Results

One of the recruitment goals of the program was to attract underrepresented applicants. Our pre-program survey, which included demographic information, indicated that we were able to draw from female and non-Caucasian groups to a much greater extent compared to regional averages (in part, by recruiting nationally), as shown in Table 1. In particular, recruitment of female students improved significantly each year.

Table 1. Recruitment demographics.

	2013	2014	2015
White	75%	57%	90%
Female	29%	57%	80%

The remainder of the statistics presented pertain to the 2015 cohort, taking these as typical of the three-year program.

The pre-program survey indicated that this was the first structured research experience for almost half of the participants. Prior to arrival, 70% were unfamiliar with the steps for admission to graduate school, and 60% were unfamiliar with graduate programs in their discipline. They provided self-efficacy ratings for a number of science-related skills, and confidence was lowest for skills related to technical writing and written expression of research outcomes.

The mid-program focus group discussion revealed that two of the most positive aspects of the program were perceived as being frequent contact with mentors (faculty and graduate students) and independence to conduct research and design/carry out experiments at their own pace. Students also indicated a preference for increased mentor contact. This suggests that although students appreciate frequent contact, the nature of the contact is important (it should guide students to function relatively independently as researchers).

The post-program survey indicated significant gains. Students reported that their knowledge increased in various areas and that important skills were also gained (see Table 2). It should be noted that the greatest perceived science skills weakness from the pre-program survey (technical communication) was addressed both orally (Table 2, “skill at presenting”) and in written form via the (roughly a dozen) articles published by students from the 2013-2015 cohorts. The targeted gains relative to technology commercialization and entrepreneurship were also achieved.

Table 2. Self-reported increases in knowledge and skills/interest (% responding positively).

Knowledge		Skills/interest	
Lab/research techniques	88%	Ability to conduct research independently	100%
Expectations for graduate students	100%	Lab skills	100%
Steps for graduate school applications	100%	Time management	100%
Current research trends	88%	Confidence	100%
Graduate programs	63%	Ability to navigate problems in research design	100%
Careers	50%	Skill at presenting	100%
		Comprehension of primary literature	88%
		Interpreting experiment results	88%
		Understanding and interest in interdisciplinary research	100%
		Interest in commercialization of ideas/tech	88%
		Professional development and entrepreneurship skills	75%

Focus group feedback from students as they completed the program showed a general recognition that the REU program was a valuable bridge between their undergraduate and graduate careers. Furthermore, students from the 2014 cohort responding to the 1-year follow-up survey overwhelmingly indicated that the program helped prepare them to select a graduate program (100% responding positively) and contributed to their development as a scholar (83% responding positively).

Although not presented in detail here, similar data were collected for the 2013 and 2014 cohorts. This feedback led faculty to focus on ensuring plenty of information flow and contact with their selected students prior to the program, in order to ensure that the project topic and scope would be appropriate for the particular student in the 10-week time frame and consistent with the amount of time a particular faculty mentor expects to be able to devote throughout the program. A skills survey is recommended to assist in this assessment. Based on the desire to improve students' technical communication skills, biweekly program-wide meetings were also revamped to provide a more structured approach to developing technical presentation skills and map research progress towards the end-of-program goal of the research poster presentation.

Conclusions

A 10-week summer REU program in biomedical devices demonstrated impact on students' skills, knowledge, interests, and preparation for graduate study. Important factors included early and frequent contact with mentors, focus on technical communication, and stimulating supplementary professional development activities. Based on lack of evidence to the contrary, it appears that this approach could lead to similar successes regardless of the research theme of the REU program.

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