A two-year comparative evaluation of an NSF Research Experiences for Undergraduate(R site integrating Engineering and Technology disciplines

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NSF REU: A two-year comparative evaluation of an NSF Research Experiences for Undergraduate (REU) site integrating Engineering and Technology disciplines

Abstract

Early engagement in undergraduate research has been widely shown to enhance student confidence, technical competence, and persistence in science and engineering pathways. While many studies report positive short-term outcomes from Research Experiences for Undergraduates (REU) programs, fewer examine whether these outcomes are consistent across multiple cohorts or persist beyond program completion. This paper presents a two-year comparative evaluation of an NSF-funded REU site that integrates students from engineering and engineering technology disciplines within a multidisciplinary research framework focused on human safety and smart personal protective equipment. Outcomes from two consecutive cohorts (N = 18 total) are examined using externally conducted pre-, mid-, and post-program surveys and faculty mentor evaluations. In addition, six- and twelve-month follow-up data from the first cohort are analyzed to assess longitudinal persistence of program impacts. Results show consistent gains in research confidence, technical skill development, and understanding of the research process across both cohorts, despite differences in incoming preparation. Longitudinal findings indicate that many of these gains persist beyond the program, influencing graduate school enrollment, continued research engagement, and professional identity development. The results suggest that multidisciplinary REU models integrating engineering and technology students can produce replicable and durable outcomes when supported by structured mentoring and authentic research engagement.

1 Introduction

Undergraduate research experiences are increasingly recognized as a critical mechanism for preparing students for advanced study and research-oriented careers in engineering and technology. Prior research has shown that participation in undergraduate research improves self-efficacy, enhances technical and communication skills, and strengthens student persistence in STEM disciplines [1]–[4]. The National Science Foundation's Research Experiences for Undergraduates (REU) program has played a central role in expanding access to these opportunities nationwide [5].

Although the benefits of REU participation are well documented, much of the existing literature focuses on single-cohort evaluations conducted immediately after program completion. Comparatively fewer studies investigate whether program outcomes are reproducible across multiple cohorts or whether gains in confidence and skills persist beyond the research experience. Additionally, most REU assessments focus on cohorts composed solely of engineering or science students, with limited attention given to programs that intentionally integrate engineering and engineering technology students, who often enter with different educational backgrounds and skill profiles.

This paper addresses these gaps by presenting a two-year comparative evaluation of a multidisciplinary NSF REU site that integrates students from engineering and engineering technology disciplines. The evaluation draws on externally conducted assessments from two

consecutive program years and includes longitudinal follow-up data from the first cohort. The study is guided by three research questions:

1. Are core REU outcomes consistent across two program years?
2. How do student-reported outcomes align with faculty mentor evaluations?
3. Do program impacts persist beyond the immediate conclusion of the REU?

2 Program Overview

The REU site is a collaborative effort between two universities and is centered on multidisciplinary research related to human safety and smart personal protective equipment. Each summer cohort consists of nine undergraduate students recruited nationally from science, engineering, and technology programs. Students are distributed across the two institutions and embedded within faculty-led research laboratories. The program is structured to balance foundational training with independent research. The first two weeks focus on technical skill development, research orientation, and laboratory onboarding. As the program progresses, students assume increasing responsibility for defining research questions, implementing experimental or computational methods, analyzing data, and communicating results. Faculty mentors meet regularly with participants, while graduate students from the faculty mentor's lab provide near-peer mentoring and day-to-day technical support. Cross-site meetings between two universities and student presentations promote collaboration and exposure to diverse disciplinary perspectives.

3 Assessment methods

Program outcomes were evaluated by an independent external evaluator, and surveys were conducted with anonymity. Identical assessment instruments were used across both program years, enabling direct comparison of short-term outcomes. Data sources included:

- Pre-program, mid-program, and post-program student surveys
- Faculty mentor evaluations conducted at mid-program and program completion
- Twelve-month follow-up surveys administered to the first cohort

Survey instruments measured research confidence, technical skill development, and program satisfaction and endorsement. Longitudinal surveys examined sustained skill application, graduate school trajectories, and program endorsement.

Short-term evaluation data for Year 1 and Year 2 were drawn from externally produced program evaluation reports, while longitudinal data were obtained one year after the program experience from follow-up surveys of the first cohort.

4 Results

4.1 Participant Characteristics

Both cohorts consisted of nine participants with varied levels of prior research experience and technical preparation. In Year 1, 55.6% of participants reported prior research experience, compared to 88.9% in Year 2. In terms of initial technical skill levels, both cohorts expressed identical programming and computational skills.

Table 1: Programming and computational skills expressed by the participants

Skill level	Year 1 and Year 2
Strong	33.3 %
Moderate	44.4 %
Basic	22.2 %

4.2 Research Confidence

Both cohorts demonstrated substantial gains in research confidence by the time of program completion. In Year 1, the proportion of students reporting high confidence increased from 33.3% pre-program to 71.4% post-program. In Year 2, high confidence increased from 33.3% to 55.6%. Participants entering with medium confidence exhibited the largest gains, while those entering with low confidence showed technical growth but more varied shifts in career orientation. Faculty mentor evaluations supported these findings, frequently noting increased independence, problem-solving ability, and comfort with open-ended research tasks by the time of program completion.

Table 2: Research confidence level expressed by the participants

Confident level	**Year 1**		**Year 2**	
	Pre-program	**Post-program**	**Pre-program**	**Post-program**
High	33.3 %	71.4 %	33.3 %	55.6 %
Medium	44.4 %	28.6 %	44.4 %	22.2%
Low	22.2 %	-	22.2 %	22.2%

4.3 Technical and Research Skill Development

All participants in both cohorts reported gains in technical skills, including programming, simulation tools, and laboratory techniques. In Year 1, 89% of participants reported significant improvement in technical skills, with the remaining participants reporting moderate improvement. In Year 2, 100% of participants reported growth in both technical skills and understanding of research methodology.

Mentor evaluations further revealed progression toward independent research. In Year 2, 67% of evaluated students transitioned to requiring minimal guidance by program completion, compared to full reliance on typical guidance at mid-program. While Year 1 mentor data were more qualitative, similar trends toward increased autonomy were noted.

4.4 Program Satisfaction and Endorsement

Participant satisfaction remained high across both cohorts. In Year 1, 78% of participants reported positive experiences, while all participants indicated willingness to recommend or promote the program. In Year 2, 77.8% reported positive experiences, and 88.9% stated they would recommend the program to peers. Specific elements that participants valued are included below.

- Mentorship and guidance from faculty: Participants consistently highlighted the quality of faculty and graduate student mentorship as the program's strongest asset.
- Hands-on research experience: Direct engagement with research projects provided invaluable practical learning.

- Technical skill development: Exposure to new software, equipment, and methodologies significantly enhanced capabilities.
- Research community integration: Interaction with graduate students and faculty provided insight into academic career paths.

Across both years, dissatisfaction was primarily associated with logistical and structural issues rather than research content or mentoring quality. For example, PIs experienced challenges in terms of issuing student IDs required for free transportation around the campus.

5 Longitudinal Outcomes from Cohort 1

Twelve-month follow-up surveys administered to Year 1 participants provide evidence of sustained program impact. Half of the respondents reported a strengthened research identity, and several had enrolled in or applied to graduate programs. One participant matriculated into a graduate program within the same research laboratory where they completed their REU project.

Participants also reported continued application of technical and research skills in advanced coursework, internships, and professional presentations. Program endorsement remained strong, with five of six respondents indicating they would participate again. These findings suggest that gains in confidence and competence were not transient but contributed to longer-term academic and professional development.

6 Discussion

The two-year comparative results demonstrate that program outcomes are consistent across cohorts. Quantitative gains in research confidence, technical skill development, and increases in independent research were observed in both years. The alignment between student self-reports and mentor evaluations strengthens confidence in the validity of these findings.

Longitudinal evidence further indicates that program impacts persist beyond the immediate REU experience, influencing graduate school enrollment, continued research engagement, and professional identity formation. Together, these findings suggest that the REU site's multidisciplinary structure and mentoring model effectively support both immediate and sustained student development.

7 Conclusions

This study provides evidence that a multidisciplinary REU program in engineering and engineering technology yields consistent, measurable outcomes. Cross-cohort results demonstrate reliable gains in research confidence and technical competence, while longitudinal findings confirm sustained impact on career trajectories and professional identity. These results support the continued development of collaborative REU models as an effective mechanism for preparing undergraduates to contribute meaningfully to research, graduate education, and the broader STEM workforce.

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