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Associations among REU student characteristics, REU program design, and Quality of REU Student Presentations

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This **Work in Progress Empirical Research paper** will examine whether and to what extent the quality of final presentations for Research Experiences for Undergraduates (REU) students was related to their perceptions of professional skills, sense of belonging, mentoring quality, satisfaction, and self-efficacy. Participation in REU programming and other undergraduate research experiences has been widely documented as a high-impact educational practice that supports student development and long-term persistence in STEM disciplines [1]. REU programs are vital for cultivating the next generation of engineers and scientists by providing hands-on research opportunities that build technical skills, foster mentorship, and offer pathways into advanced study and STEM careers [1].

Professional skills, including time management, communication, and problem-solving, are important goals for REU participation. Undergraduate research experiences have been shown to enhance students' professional capabilities [2]. Students who engage in undergraduate research often report gains in scientific communication, data analysis, and disciplinary problem-solving, outcomes that are strongly linked with academic performance and career readiness [2]. A growing literature also highlights the importance of a sense of belonging within the research environment. Students who feel connected to their research teams, departmental communities, and the broader scientific network are more likely to engage deeply with research activities and report positive outcomes [3], [4]. In undergraduate research contexts, a strong sense of belonging can help students transition from peripheral participants to fully engaged members of the scientific community, enhancing both retention and commitment to research pathways.

Mentorship quality is a consistently documented predictor of REU success. High-quality mentoring practices, characterized by clear communication, constructive feedback, and support, are associated with stronger student outcomes [5], [6]. For example, Rodriguez Amaya et al. [6] found that research mentoring not only supported students' problem solving and independence but also fostered confidence and academic development. Similarly, a study by Moon et al. [5] found that high-quality mentoring is associated with higher mentor satisfaction, stronger science identity, and greater self-efficacy. Satisfaction with the research experience itself is both an outcome and a contributor to program success. Student reports of higher satisfaction with mentoring, research tasks, and the program structure are associated with better performance [7]. Finally, self-efficacy, or students' belief in their ability to successfully perform research tasks, emerges across the literature as a critical determinant of REU success. Rooted in social cognitive theory, self-efficacy influences effort, persistence, and resilience in challenging research environments [8]. Previous research has shown that REU participants reported increased confidence in their research abilities, which is linked to stronger science identity and intentions to pursue scientific careers [9].

Research aims. Given the extant research on constructs most closely related to REU student success, we aimed to examine the associations between students' perceptions of their professional skills, sense of belonging, quality of mentorship, satisfaction, and self-efficacy, and the quality of their final presentations. We hypothesized that each of these constructs would be significantly and positively correlated with students' final presentations.

Methodology

Our REU program provided undergraduate students (n = 8) with an intensive, full-time summer research experience that emphasized both technical skill development and professional growth. Each student was paired with a faculty mentor and a graduate or postdoctoral researcher to conduct a well-defined, original research project aligned with the goals of the engineering research center (ERC). In addition to their research projects, students engaged in a coordinated cohort experience that included weekly technical and professional development seminars. The REU program concluded with a formal Research Presentation. Each student prepared a professional-quality research poster and a brief oral summary of their work, demonstrating their ability to communicate scientific findings to both technical and non-technical audiences. This comprehensive structure was designed to develop each student's research competency, science identity, and confidence in pursuing future academic and career pathways in STEM. This study was determined to be exempt from IRB review by The Ohio State University Institutional Review Board (Protocol #STUDY20252184), under categories 1 and 4.

Participants. We implemented a proactive recruitment strategy designed to attract a diverse, talented pool of undergraduate students from across the United States. We received applications via Handshake, an online job-posting platform, and the NSF Education & Training Application (ETAP) platform. ETAP allowed students to submit standardized materials and was used to confirm participant eligibility, as undergraduate students supported with NSF funds in REU Sites must be U.S. citizens, U.S. nationals, or U.S. permanent residents. Application deadlines, eligibility criteria, and program details were widely disseminated through institutional listservs and newsletters, as well as targeted emails to faculty and advisors. Through our recruitment efforts, a significant fraction of student participants in our REU program came from outside the host institution or organization; approximately 38% of the 2025 REU cohort enrolled at institutions outside the ERC. The 2025 cohort of REU students was 63% female, with 50% identifying as white, 50% identifying as Hispanic or Latino/a/x, and 25% were first-generation college students.

Measures. At the conclusion of the program, REU participants completed a survey on their perceptions of the program. This survey was based on the Multi-ERC Instrument Inventory (MERCII) [10]. The domains used in the final analyses were professional skills, sense of belonging, quality of mentorship, satisfaction, and self-efficacy. Professional skills were assessed to determine the extent to which participation in the ERC improved students' professional skills (e.g., communicating, networking, leadership) using 11 items on a 5-point Likert scale (ranging from none at all to a great deal). A Sense of Belonging was assessed to determine the extent to which the ERC promotes a sense of belonging among participants (e.g., I feel valued, my voice is heard, I am respected) using 10 items on a 5-point Likert scale (ranging from none at all to a great deal). Quality of Mentorship was assessed by asking REU students to rate the overall quality of mentoring they received (e.g., sharing knowledge, providing feedback, and supporting independent work) using 8 items on a 5-point Likert scale (ranging from poor to excellent). REU Satisfaction was assessed to determine the extent to which students were satisfied with their REU experience (e.g., seminars, research experience, lab equipment) using 7 items on a 5-point Likert scale (ranging from very dissatisfied to very satisfied). An additional section on REU self-efficacy [11] included 18 items on a 5-point Likert scale (ranging from strongly disagree to

strongly agree) assessing whether participation in the REU increased their confidence in research skills. Students' final presentations were assessed using the Multi-ERC Instrument Inventory Presentation Rubric as an observational measure of their presentation quality. Students were evaluated on their research and verbal elements, including the research problem, findings, and conclusions; their verbal presentation, focusing on clarity and conciseness; and their ability to answer questions for a total of 20 points. Students were also evaluated on the visual and written elements of the research poster, including font-size readability, use of space, concise content, and compelling visuals, for a total of 16 points. Total scores ranged from 0 to 36.

Results

To investigate the research aim of exploring the associations among students' perceptions of their professional skills, sense of belonging, quality of mentorship, satisfaction, and self-efficacy with the quality of their final presentations, we first examined the descriptive statistics for each construct of interest (See Table 1) using SPSS 31. Overall, students reported moderate to high perceptions of their professional skills, sense of belonging, quality of mentorship, satisfaction, and self-efficacy. Observational scores for the students' final presentations also indicated high overall quality (M = 34.25, SD = 1.39, Range = 32-36).

Table 1. Descriptives for Constructs of Interest

Construct	*M*	*SD*	Min	Max
Professional Skills	3.50	1.08	2.36	5.00
Sense of Belonging	4.14	0.59	3.40	5.00
Quality of Mentorship	4.08	1.05	2.38	5.00
REU Satisfaction	3.82	0.89	2.71	5.00
Self-efficacy	3.71	0.58	3.06	4.50
Presentations	34.25	1.39	32	36

Next, we examined bivariate Pearson correlations between the constructs of interest, applying a two-tailed test for significance. There were several significant, positive correlations among students' perceptions of their professional skills, sense of belonging, quality of mentorship, satisfaction, and self-efficacy (See Table 2). Specifically, the only correlation that was not significant was between professional skills and quality of mentorship (r = .70, p = .052). Interestingly, there were no significant correlations among any of the constructs and the students' final presentations. However, the correlation between self-efficacy and students' final presentations may be approaching significance (r = .72, p = .068).

Table 2. Bivariate Correlations Among Constructs of Interest

Construct	1.	2.	3.	4.	5.	6.
1. Professional Skills	--	.95**	.70	.90**	.90**	.09
2. Sense of Belonging		--	.82*	.95**	.97**	.06
3. Quality of Mentorship			--	.93**	.81*	.18
4. REU Satisfaction				--	.96**	.20
5. Self-efficacy					--	.72
6. Presentations						--

Note. *p < .05, **p < .01.

Discussion

The purpose of this study was to examine whether students' perceptions of their professional skills, sense of belonging, quality of mentorship, satisfaction, and self-efficacy were associated with the quality of their final presentations in an REU program. Overall, the descriptive findings indicate that students reported moderate-to-high levels across all constructs and that their final presentations were rated as high quality, with little variability. These results suggest that, at the programmatic level, the REU experience successfully supported both students' perceived development and their demonstrated performance outcomes.

Consistent with prior literature, the significant positive correlations among professional skills, sense of belonging, mentorship quality, satisfaction, and self-efficacy suggest that these constructs are closely interconnected within the undergraduate research context. The lack of a statistically significant association between professional skills and mentorship quality, despite a large effect size ($r = .70$) that narrowly missed conventional significance thresholds, likely reflects limited statistical power due to sample size rather than the absence of a meaningful association. Contrary to our hypotheses, none of the constructs were significantly associated with the quality of students' final presentations. One plausible explanation is a ceiling effect in the presentation scores. Students received scores with a high mean and a very narrow range (32–36 out of a possible 36). Therefore, there may have been insufficient variability to detect meaningful associations.

Notably, the correlation between self-efficacy and presentation quality approached statistical significance and demonstrated a strong effect size ($r = .72$). This finding is theoretically consistent with social cognitive theory [8], which posits that self-efficacy is a key predictor of performance, persistence, and task engagement. These findings have implications for program refinement. For example, program changes targeting the quality of mentorship and students' sense of belonging may have cascading effects on students' confidence and perceived skill development. Moreover, the strong relationship between self-efficacy and presentation quality, consistent with social cognitive theory [8], highlights self-efficacy as a promising mechanism linking REU programs to observable student outcomes and suggests that self-efficacy should be intentionally cultivated and rigorously measured in future iterations of the program.

Taken together, these findings suggest that while students' perceptions of their experience are meaningfully interrelated, high-quality performance outcomes in an REU context may be influenced by additional factors not captured in the current study, such as prior research experience, disciplinary background, mentor expectations, or the structure of the presentation evaluation rubric. This study included a limited number of participants, which constrains statistical power and limits the generalizability of the findings beyond the specific context and cohort examined. As a result, the results should be interpreted as preliminary and descriptive, intended to identify patterns and inform program refinement rather than to support broad causal claims. Future research with larger samples, more sensitive outcome measures, and longitudinal designs may provide a clearer understanding of how development during REU programs translates into demonstrable research performance.

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