Developing Researcher Identity, Efficacy, and Experience Through a Novice Researcher Program

Abstract

Undergraduate research is widely recognized as a high-impact learning practice that strengthens student learning, retention, and preparation for future academic and professional pathways. Yet many undergraduates struggle to form a researcher identity due to limited skills, mentorship, and science self-efficacy. This study examined how the Rural Scholars Program, a 10-week rural, community-embedded research experience, fostered the development of scientific identity, research experience, and science self-efficacy among undergraduate and graduate participants. Using validated measures of identity, experience, and self-efficacy, 20 participants completed weekly surveys analyzed with descriptive statistics, linear mixed models, and paired-sample t-tests. Results showed a significant upward trajectory in identity as a scientist across the 10 weeks, demonstrating that structured research environments with mentorship can meaningfully strengthen emerging scholars' identities. Participants also exhibited significant gains in research experience, with large effect sizes indicating substantial practical growth. Science self-efficacy increased moderately, reflecting meaningful but more variable change. Findings affirm the value of immersive, mentored undergraduate research, particularly in rural, place-based contexts, in cultivating scientific identity, confidence, and skill development. Recommendations include strengthening mentorship structures and expanding community-engaged research opportunities.

Introduction

Institutions of higher education have promoted increased research exposure for undergraduate students since the 1970s, with significant growth predominantly over the last two decades (Adebisi, 2022; Peterella & Jung, 2008; Russell et al., 2007). By 2025, undergraduate research plays "an integral part in higher education" (Brewer et al., 2012, p. 212), as it fosters enthusiasm for postgraduate study (Linn et al., 2015), enriches the undergraduate experience, and increases student retention (Kaul et al., 2016). Furthermore, it serves as a valuable educational strategy, enhancing learning outcomes while preparing students to contribute meaningfully to society and pursue further professional development and aspirations (Adebisi, 2022; Linn et al., 2015; Palmer et al., 2018; Seifan et al., 2022).

Despite these benefits, previous studies examining the relationship between undergraduate research and student success have highlighted a strong disconnect between students and the broader research culture of universities (Zamorski, 2002). This detachment often stems from barriers, such as limited research skills, a lack of mentorship, insufficient funding, and heavy workloads (Adebisi, 2022; Keast et al., 2012). Many undergraduates also struggle to develop a clear identity as a researcher, and limited self-efficacy in science can further hinder their engagement in scholarly research, sometimes diminishing interest in graduate study or academic careers (Chemers et al., 2011; Hu et al., 2022; Robnett et al., 2015; Syed et al., 2019). Reducing these barriers is vital, as researcher identity and self-efficacy underpin long-term engagement in research (Robnett et al., 2015).

In response to these barriers, researchers emphasize the importance of developing scientific identity and self-efficacy, suggesting these factors are crucial for students' integration into the research community (Robnett et al., 2015). Building on this focus, we investigated how participation in a structured undergraduate research program, Rural Scholars, supported the development of students' researcher identity and self-efficacy in rural settings.

Literature Review and Conceptual Framework

Historically, universities aimed to educate intellectuals, leaders, and statesmen (Scott, 2006). From their inception, their goal was to serve society's needs. Before the 19th century, this meant producing highly literate individuals for city-state chancelleries and leaders for emerging political arenas (Lukashchuk, 2023; Scott, 2006). In the 20th century, however, this role shifted from elite intellectual production to mass education of a nation's populace (Lukashchuk, 2023). Today, modern universities encompass research, teaching, and cultural extension (Rueda Beltrán, 2018). Essentially, institutions of higher education have evolved to serve the needs of their era, with the present one characterized by mass education of the working class (Lehmann, 2009).

In the United States, the recognition that higher education should extend beyond elites to the masses was advanced by Abraham Lincoln, who, through the Morrill Act of 1862, laid the foundation for the land-grant university system (Geiger, 2014). The Morrill Act of 1890 extended land-grant status to historically Black institutions (Craig, 1992; Geiger, 2014). These institutions served the common person, at the time, farmers, "with an education appropriate for the management of farm resources" (Sternberg, 2014, p. 5). They ensured higher education was available to those beyond traditional elites and extended beyond classical fields to practical training in agriculture, mechanics, and the applied sciences, while maintaining a civic mission to serve a democratic society (Geiger, 2014).

As higher education expanded from educating elite men to educating ordinary farmers (Geiger, 2014), the focus on practical, high-quality instruction intensified. The challenge became ensuring that larger student populations engaged meaningfully with the curriculum. This new model emphasized that pedagogical approaches, often from underrepresented or working-class backgrounds, could be understood and applied in their communities to serve the state (Geiger, 2014; Trow, 1973). Thinkers and education reformers such as John Dewey championed this approach, advocating for learning that connects classroom experiences to real-world applications rather than rote memorization (Dewey, 1938). In the 1960s and 1970s, pedagogical practices such as service learning emerged, tying academic knowledge to civic engagement and workplace practices (Eyler & Giles, 1999; Kuh, 2008). However, as these methods spread, many students struggled academically and failed to graduate (Chen, 2012).

By the early 2000s, research increasingly showed that student persistence and development were shaped by multiple factors, including student involvement and engagement (Astin, 1993), effective leadership and active learning (Chickering & Gamson, 1987), and integrative applied experiences (Pascarella & Terenzini, 2005). This recognition laid the foundation for "High-Impact Learning" (HIL) as a central and effective practice in modern higher education (Kilgo et al., 2015; Kuh, 2008). HIL promotes deep, active learning by fostering student engagement (Kuh, 2008; Kuh & O'Donnell, 2013) and has moved from

individual scholarship to systematic documentation and widespread use (Lopatto, 2004, 2010). These practices represent the culmination of a centuries-long transformation, from cultivating elites to developing engaged citizens.

Recent scholarship shows that HIL opportunities, such as research, internships, and service learning, foster greater academic interest (Miller et al., 2011; Zydney et al., 2002) and are often described as among the most transformative experiences of university life (Lopatto, 2010). Among these, undergraduate research is repeatedly identified as one of the most transformative for student development (Hunter et al., 2007). Studies have shown its far-reaching, positive effects on the learning outcomes (Lopatto, 2004, 2010; Russell et al., 2007), fostering persistence, self-efficacy, and identity as scholars (Kardash, 2000; Seymour et al., 2004).

Identity as a Scientist

Undergraduate research provides a development practice in which students build self-efficacy and begin to see themselves as scientists (Chemers et al., 2011; Hunter et al., 2007; Linn et al., 2015). As put by Zydney et al. (2002):

> [Students] who participated in undergraduate research reported significantly greater enhancement of … important cognitive and personal skills … and … were also more likely to pursue graduate degrees … [and] to have reported that they had a faculty member play an important role in their career choice (p. 156).

Given the transformative power of undergraduate research, scholars have focused on measuring its impact on student growth. Chemers et al. (2011) addressed this by creating three validated scales that assess: research experience, science self-efficacy, and identity as a scientist (Robnett et al., 2015, 2018). The first scale, the Identity as a Scientist Scale (ISS), measures how strongly students perceive themselves as scientists (Carlone & Johnson, 2007; Chemers et al., 2011; Estrada et al., 2018; Stets et al., 2017). First developed by Chemers et al. (2011) and validated by Robnett et al. (2015), ISS reflects the idea that success in science requires internalizing a scientific identity, seeing oneself as a lifelong member of the scientific community (Robnett et al., 2015). ISS captures dimensions such as technical skill, collaboration, leadership, and identity (Robnett et al., 2015), enabling researchers to trace development from experience to confidence to independence (Chemers et al., 2011).

Scientific identity, or how individuals see themselves as scientists, is additionally closely linked to self-efficacy. Using the ISS, Robnett et al. (2015) found research participation predicts gains in both scientific identity and self-efficacy. Further, Robnett et al. (2015) proposed a staged developmental process in which research involvement increases self-efficacy, therefore increasing the recognition as an emerging scientist. Moreover, Robnett et al.'s (2015) longitudinal findings show sustained research engagement guides students along this trajectory. Robnett et al. (2018) further highlight mentorship as critical for strengthening scientific identity. Instrumental and socioemotional mentoring supports a stronger scientific identity, and negative mentoring behaviors inhibited it (Robnett et al., 2015). Together, these studies underscore that structured research experiences and meaningful mentorship are essential for fostering scientific identity.

Science Self-Efficacy

The Science Self-Efficacy Scale (SSES), grounded in Bandura's (1997) theory of self-efficacy, serves as a critical instrument for assessing confidence in authentic scientific practices, such as understanding disciplinary concepts and frameworks (Kardash, 2000; Seymour et al., 2004), experimental design (Lopatto, 2004, 2010), data analysis, and writing a research publication (Bandura, 1997; Chemers et al., 2011).

Self-efficacy, an individual's belief in their ability to succeed at specific tasks, has been shown to be associated with higher levels of achievement and persistence (Bandura, 1997). The SSES implements this concept by focusing on disciplinary understanding, experimental design, data analysis, and scholarly communication through writing. Disciplinary understanding is essential for engaging with research questions and developing a scientific identity (Kardash, 2000; Seymour et al., 2004). Without disciplinary understanding, students may struggle to contextualize their work within other frameworks. Another critical component, experimental design, emphasizes creativity and higher-order thinking in the construction of methods (Lopatto, 2004, 2010). Not only does designing experiments require technical skill, but it is also a deep engagement with scientific reasoning. Data analysis is central to interpreting results and drawing evidence-based conclusions. Confidence in analyzing data is one signal of readiness for independent research. Lastly, scientific writing is essential for disseminating findings and participating in scholarly communities (Bandura, 1997; Chemers et al., 2011). Writing a research publication is a key indicator of scholarly development, given the demand for precision and clarity. The SSES can highlight students' technical competency and their development as scholars (Tas et al., 2023). By capturing where students are, the SSES offers insights into where they may need additional support. Subsequent research has confirmed the strong reliability of science self-efficacy instruments, often adapted or modified from the SSES, across education levels and disciplines.

Research Experience

The Research Experience Scale (RES) was built upon Bandura's (1997) social-cognitive theory, which proposes that individuals develop self-efficacy and professional identity through participation in professional communities. The RES was developed to measure undergraduate student engagement in research by assessing self-reported involvement in specific components of scientific research (Robnett et al., 2015). Instead of asking if students participated in research, Robnett et al. (2015) aimed to measure the depth, intensity, and developmental qualities of those experiences. By emphasizing what students do in research, rather than if they only participate, the scale supports evaluations of course-based undergraduate research experiences and mentoring models (Brownell & Kloser, 2015; Corwin et al., 2015). Research experiences are critical for fostering science self-efficacy and the development of a scientific identity, therefore allowing them to engage in authentic practices of scientific communities (Robnett et al., 2015). Psychometric analyses indicate that the RES functions similarly across gender and ethnic groups and demonstrates strong internal consistency and contrast validity, indicating that the RES measures constructs meaningfully distinct from the ISS and SSES (Robnett et al., 2015).

Identity is shaped by experience, and experience, in turn, shapes our efficacy. The RES aligns closely with the core principles of experiential learning (Kolb, 1984) by measuring students' engagement in concrete research activities. Specifically, RES captures concrete experience, active experimentation, and professional practice directly—corresponding to Kolb's (1984) experiential learning cycle. Higher scores on the RES indicate a deeper immersion in experiential learning.

Together, the SSES, RES, and ISS allow researchers to trace development pathways from experience to confidence to identity. Studies show how these measures work in tandem, forming stages of a developmental process where research builds self-efficacy, which supports identity formation (Robnett et al., 2015; Robnett et al., 2018; Syed et al., 2019).

One program pursuing this goal is the Rural Scholars Program, which places undergraduates and graduates in rural communities for collaborative, faculty-guided research addressing real-world challenges. Each fall, students join a faculty member at a U.S. land-grant university and a rural community mentor. Participants typically take a 16-week spring course on rural engagement, research methods, and science communication. Students from other universities complete an intensive one-week course before the 10-week Rural Scholars Program. During the program, participants design and implement service projects and conduct applied research under faculty supervision. This program concludes with findings, data analysis, interpretation of results, and a public presentation at the annual U.S. land-grant university rurality symposium.

Purpose and Research Objectives

The Rural Scholars Program, administered at a U.S. land-grant university, is a 10-week summer research program that places undergraduate and graduate students in rural communities to work with faculty and local mentors on applied research projects addressing real-world challenges. Since little is known about the impact of structured programs intentionally designed to boost science self-efficacy among college students, such as the Rural Scholars Program, this study explored how participants' identities as scientists, their research experiences, and science self-efficacy developed over a 10-week summer research program. The following objectives guided this research study:

1. Describe the participants' identity as a scientist scores over the 10-week program.
2. Examine the variance in undergraduate participants' researcher identity development over time in the program, measured weekly.
3. Examine the change in participants' research experience and science self-efficacy, measured pre- and post-program.

Methods

This exploratory study employed a repeated measures survey design to assess researcher identity development and a within-subjects pretest-posttest design to assess science self-efficacy and researcher experience (Dillman et al., 2014; Privitera, 2020). Participants were all students ($N = 20$) enrolled in the Rural Scholars Program in the summer of 2025. The Rural Scholars

Program connects research mentors (i.e., university faculty) with undergraduate and graduate students who are novices in research. Of the 20 participants, 16 were undergraduate students, and four were graduate students. Over the 10-week summer program, participants were placed in rural communities across Oklahoma with local community partners to assist in implementing a research project designed to strengthen these communities.

Instrumentation

Prior work has validated the three measures used in the study to assess research experience, science self-efficacy, and identity as a scientist (Chemers et al., 2011; Deemer et al., 2022; Syed et al., 2012, 2019). Researcher identity was measured using the five-item identity as a scientist scale developed by Robnett et al. (2015), which assessed students' perceived growth in their identity as scientists over the 10-week program. This measure addressed research objectives one and two concerning changes in researcher identity. The scale demonstrated strong internal consistency in prior research ($\alpha = .96$; Robnett et al., 2015) and showed similarly high reliability in the current sample ($\alpha = .93$). Research Experience and Science Self-Efficacy were measured using scales adapted from Robnett et al. (2015), which demonstrated excellent internal consistency in their study (Research Experience: $\alpha = .96$; Science Self-Efficacy: $\alpha = .95$) and in our sample ($\alpha = .93$ for pre-program and $\alpha = .93$ for post-program). These measures were used to address research objectives three and four regarding changes in research experience and science self-efficacy.

The ISS scale consisted of five items and was administered weekly via a Qualtrics questionnaire; items were rated on a 4-point Likert-type scale ranging from 1 (*not at all/a little*) to 4 (*a lot*). The SSES consisted of seven items, each rated on the same 4-point, Likert-type scale ranging from 1 (*not at all/a little*) to 4 (*a lot*). The RES consisted of eight items, each rated on a 4-point, Likert-type scale ranging from 1 (*not at all/a little*) to 4 (*a lot*). The three scales and accompanying items are presented in Table 1.

Table 1

Instrument Scales, Accompanying Items, and Response Rate by Scale (Robnett et al., 2015)

Identity as a Scientist Scale (ISS $n = 20$)
In general, being a scientist is an important part of my self-image.
Being a scientist is an important reflection of who I am
I feel like I belong in the field of science.
I have a strong sense of belonging to the community of scientists.
I am a scientist.
Science Self-Efficacy Scale (SSES $n = 11$)
Relate results and explanations to the work of others.
Generate a research question to answer.
Use scientific literature to guide research.
Create explanations for the results of the study.
Develop theories (integrate results from multiple studies).
Use scientific language and terminology.

Use technical skills.
Research Experience Scale (RES *n = 11*)
I worked on a research project in which I figured out what data to collect and how to collect it.
I reported my research results in an oral presentation or written report.
I learned scientific language and terminology.
I related my research results and explanations to the work of others.
I used scientific literature to guide a research project.
I had the opportunity to generate my own research question to answer.
I learned technical science skills.
I took a leadership role in a scientific research team.

Data Collection

Data on identity as a scientist were collected longitudinally across the 10-week research scholar experience. Participants ($N = 20$) completed a brief online questionnaire once per week, administered midweek via Qualtrics, beginning in the first week of the program and continuing through the final week.

Data for Research Experience and Science Self-Efficacy were collected pre- and post-program. A pre-program survey was administered during orientation, and the post-program survey was administered at program completion. In some instances, data quality was compromised by incomplete responses, incorrect entries, and other errors. As a result, only 11 participants provided complete and valid pre- and post-program data on Research Experience and Science Self-Efficacy, which were used for analysis. This analysis was considered exploratory due to the small sample size ($n = 11$).

Data Analysis

All analyses were conducted using IBM SPSS Statistics 29. Descriptive statistics were calculated for all study variables. Responses to the identity as a scientist scale were analyzed using descriptive statistics and a linear mixed model (LMM; West et al., 2014) to account for the repeated-measures structure of the data (i.e., one observation per week per participant). The LMM approach was selected because it is robust to missing data. Although the proportion of missing data was small (1.6%; Schafer, 1999; Schafer & Graham, 2002), alternative approaches such as repeated-measures ANOVA would have required complete-case analysis, thereby excluding participants. Accordingly, analyses were conducted using restricted maximum likelihood (REML) estimation.

Research Experience and Science Self-Efficacy were examined using pre- and post-program composite scores. Descriptive statistics, including means, medians, standard deviations, and ranges, were calculated, and normality was assessed using the Shapiro–Wilk test, supplemented by visual inspection of boxplots and stem-and-leaf plots. Changes over time were evaluated using paired-samples *t*-tests. Effect sizes, measured with Cohen's *d*, were calculated to estimate the effect sizes of observed differences (small = 0.2, medium = 0.5, and large = 0.8;

Field, 2018). Although these data are useful for program development, findings cannot be generalized beyond the study sample.

Results/Findings

Identity as a Scientist

Means and standard deviations for the *identity as scientist* construct across the 10-week experience are presented in Table 1. The repeated measures model included fixed effects for the identity construct and time (in weeks), with random intercepts for participants. The overall model was significant, $F(1, 19.27) = 243.81$, $p < .001$, with measures of model fit reported as AIC = 231.18 and BIC = 266.67. This indicates a significant increase in participants' perceived *identity as scientist*s over the 10-week research scholar experience.

Table 2

Means and Standard Deviations for the Identity-as-Scientist Scale Over the 10-Week Program

Week	*M*	*SD*
1	3.13	0.80
2	3.38	0.97
3	3.38	1.02
4	3.47	1.04
5	3.41	1.03
6	3.52	0.92
7	3.42	1.08
8	3.52	1.05
9	3.67	0.99
10	3.78	1.02

Research Experience

A paired-samples *t*-test was conducted to evaluate changes in research experience from pre-program to post-program. There was a statistically significant increase in research experience scores from pre-test ($M = 3.12$, $SD = 0.64$) to post-test ($M = 3.65$, $SD = 0.42$). The mean difference was −0.53, with a 95% confidence interval ranging from −0.80 to −0.26, indicating that, on average, participants showed an increase in research experience after the program compared with before. Tests of normality showed that the difference scores were approximately normally distributed, as assessed by the Shapiro–Wilk test ($W = .95$, $p = .58$), which supports the use of a paired-samples *t*-test.

Using a paired-samples *t*-test, the difference between pre- and post-scores was statistically significant, $t(10) = -4.45$, $p = .001$ (two-tailed), indicating that the likelihood of observing such an improvement by chance is extremely low. In practical terms, this suggests the program had a substantial positive impact on participants' research experience. The effect size

was large (d = 1.34), reinforcing that the observed change is not only statistically meaningful but also meaningful in practical terms.

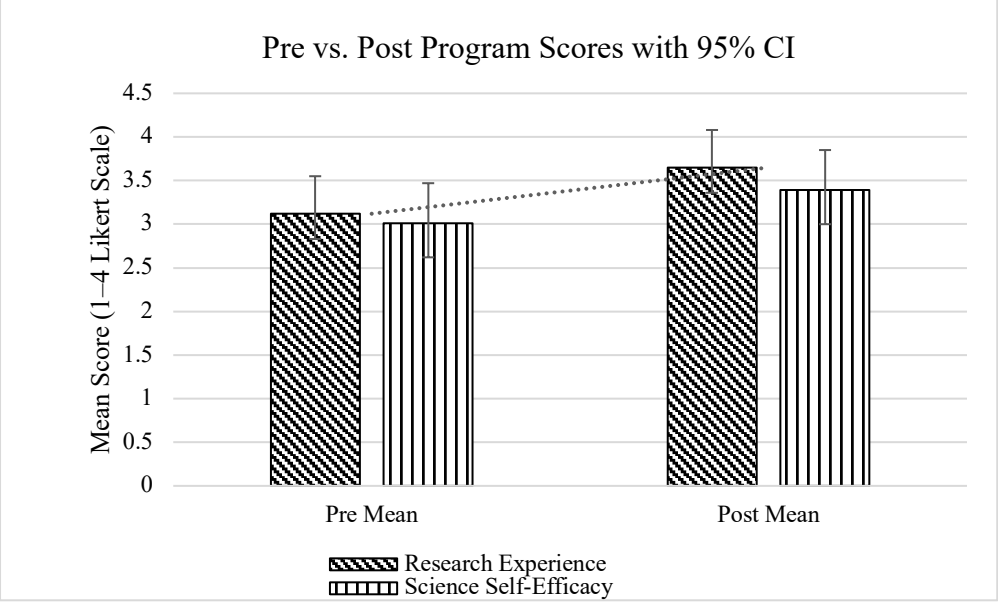
Science Self-Efficacy

Baseline science self-efficacy was moderate, with participants pre-experience average of 3.01 (SD = 0.69). After the program, scores increased to an average of 3.39 (SD = 0.58). This increase indicates that participants reported greater confidence in their science abilities following the intervention. Tests of normality showed that the difference scores were normally distributed (W = .97, p = .87).

The mean gain in science self-efficacy from pre-test to post-test was 0.38 points (SD = 0.57), with a 95% confidence interval of −0.01 to 0.76. While this result indicates increased confidence after the 10-week program, the paired-samples t-test did not achieve statistical significance, $t(10) = -2.19$, p = .054 (two-tailed). Descriptively, however, Cohen's d was .65, a medium effect size. Figure 1 visualizes the pre- and post-test scores for the SSES and RES.

Figure 1

Mean Pre- and Post-Program Scores for Research Experience and Science Self-Efficacy with 95% Confidence Intervals



Conclusions and Implications

The findings of this study provide strong evidence that structured community-engagement research experiences, such as the Rural Scholars Program, can significantly contribute to the development of novice researchers' identities, such as undergraduate students, as scientists (Chemers et al., 2011; Robnett et al., 2018). Moreover, student participation in

hands-on, applied research projects within communities appears to enhance undergraduate and graduate students' practical research experience, thereby building confidence and competence in scientific inquiry. While improvements in students' science self-efficacy were observed, they were modest, suggesting that additional targeted support or extended engagement with researchers may be necessary to further strengthen students' confidence in their scientific abilities. Additionally, these results underscore the importance of, as a package, mentorship, structured reflection, and immersive research opportunities in preparing novice researchers for potential scientific endeavors in the workforce.

Further, these findings extend existing scholarship on university students' research, demonstrating that structured undergraduate research experiences foster persistence, confidence, and identity formation (Chemers et al., 2011; Hu et al., 2022; Robnett et al., 2018). Furthermore, the gains in research experience demonstrated by participants are consistent with prior literature highlighting the benefits of undergraduate research for developing technical skills and cognitive growth (Seymour et al., 2004; Russell et al., 2007). This increasing capability indicates that engaging in applied research in community settings offers valuable opportunities for students to bridge the gap between the knowledge they have acquired and real-world applications (Zydney et al., 2002).

Participants in the Rural Scholars Program demonstrated significant, measurable growth in identity as a scientist over the 10-week program, suggesting that immersive research experiences can effectively bridge the gap between novice students and the broader research community in academia, referring to students' historically limited exposure, skills, and sense of belonging in research (Hu et al., 2022; Syed et al., 2019; Tas et al., 2023; Zamorski, 2002)). Findings further align with research showing identity formation emerges through participation in research opportunities (Hu et al., 2022). The participants' growth provides evidence that undergraduate research is a transformative educational experience (Hunter et al., 2007; Lopatto, 2004, 2010). For novice researchers with limited prior exposure to academic research, community-engaged research experiences, such as the Rural Scholars Program, may be particularly influential in helping students view themselves as capable contributors to science by highlighting the relevance and real-world impact of their work beyond the university setting. The rural context of the program may have further strengthened these effects by offering smaller, more intimate research environments that foster closer mentorship, sustained interaction, and a stronger sense of belonging. Rural versus urban contexts need to be examined to determine if this assertion is true.

The modest increase in science self-efficacy observed in this study is consistent with Bandura's (1997) conceptualization of self-efficacy as an experiential construct in which involvement enhances students' confidence in their abilities (Chemers et al., 2011; Kardash, 2000). Although the change did not reach statistical significance, the program may still have had practical value for participants' efficacy development. However, this supports the notion that extended time and engagement with multiple research experiences, beyond this introductory experience, may be necessary to realize significant gains in efficacy. Actually, however, a larger sample size would have established a statistical significance—all other things unchanged. A medium effect size for the difference in self-efficacy pre- and post-program is practically significant.

This pattern aligns with research showing that undergraduate research and hands-on experiential learning can contribute to gains in confidence and scientific identity (Chemers et al., 2011; Hunter et al., 2007; Kardash, 2000). Moreover, by situating emerging scientists in rural communities and engaging them in applied research, the Rural Scholars Program operationalizes Dewey's (1938) vision of learning through real-world experiences while advancing contemporary pedagogical strategies. Such modern approaches, such as undergraduate research, could support the development of engaged citizens and emerging professionals through programs like the Rural Scholars Program.

Recommendations

Several recommendations arise from these findings. First, institutions of higher education should continue to prioritize HIL practices, such as undergraduate research, particularly in contexts that combine faculty mentorship, community engagement, and extended time. Equally important is ensuring that faculty mentorship is both present and intentionally structured. These recommendations derive from observed increases in identity and research experience, supported by large effect sizes, as well as alignment with established literature on the role of mentorship and structured experiences in student development (Hunter et al., 2007; Robnett et al., 2018). Practical and supportive faculty guidance can provide students with the feedback and emotional support necessary to develop confidence and identity as emerging scholars. When mentors actively build students' skills and foster respectful relationships, these experiences can become transformative rather than transactional.

The design of undergraduate research programs should integrate mentoring structures that provide both scientific training and guidance, reinforcing students' identities as emerging scholars. Moreover, routine assessment of identity development should be integrated into these undergraduate research programs, as validated scales (e.g., Chemers et al., 2011; Robnett et al., 2018) offer reliable measures of student growth. Future research should incorporate and continue using other validated scales, either individually or in combination, and ideally track students longitudinally across programs. Although limited by a small sample size, the results suggest structured, community-engaged research can play a vital role in retaining undergraduate students, particularly those from underrepresented backgrounds. Future research should examine whether structured, community-engaged research experiences contribute to undergraduate retention, particularly among underrepresented groups.

This study has also created several avenues for future research. Variations in program structure, discipline, and mentorship models influence the development of scientific identity and warrant in-depth exploration in future studies. Furthermore, longitudinal studies tracking students into graduate programs or even professional careers could provide much-needed insights into the sustained impact of undergraduate research.

The Rural Scholars Program shows the benefits of university-community partnerships. Students gained scientific identity, research experience, and science self-efficacy through research, while immersing themselves in the communities. Strengthening and expanding these

partnerships can enhance both educational outcomes and community collaboration. This further affirms the value of undergraduate, experiential, place-based research.

Discussion

This study is subject to several limitations, the first being a small, exploratory sample size that limits the scope of the findings. Although 20 students participated in the Rural Scholars Program, only 11 provided complete and valid pre- and post-program data for RES and SSES. Even with complete data, results would not be generalized beyond this study sample.

Furthermore, the results regarding SSES were modest and did not reach statistical significance. The lack of statistical strength means the results must be interpreted cautiously, as the evidence is insufficient to rule out chance variation under strict criteria. The relatively short 10-week program may have been a contributing factor, suggesting that students might require extended engagement.

Lastly, the study lacks longitudinal data over program years and with participants' follow-up experiences, making it difficult to determine if the observed gains in researcher identity and experience persist as students move into graduate school or professional careers. Future studies should aim to track students over extended time periods and incorporate larger, more diverse samples to better understand the sustained impact of the program.

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