

Insights from the Socioemotional Undergraduate Research Experience (SURE) Framework

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Abstract

This study examines the Socioemotional Undergraduate Research Experience (SURE), a student-led, interdisciplinary co-mentoring framework that guided 15 undergraduates as they designed and conducted their own projects. Using interviews with six alumni and the Mediation Model of Chemers and colleagues (2011), the authors identify which elements of the framework most shaped student success. Findings show that the integration of socioemotional and instrumental mentoring—within a co-mentoring, cohort-based structure—supported the development of science self-efficacy, general self-efficacy, and researcher identity. Students highlighted the value of technical guidance, emotional support, meaningful independence, and opportunities to present their work. These results suggest that small, intensive, transdisciplinary research programs like SURE can effectively cultivate strong research identities and offer a portable model for undergraduate research mentoring.

Keywords: *inquiry-based, self-efficacy, socioemotional, mentoring, qualitative research*

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Over eight years, two faculty members at the University of Oklahoma from different scholarly backgrounds collaboratively mentored 15 undergraduate students, guiding two to three students annually, while applying their Socioemotional Undergraduate Research Experience (SURE) framework. After completing this mentorship program, many students identified themselves as being researchers,

as well as having more self-efficacy, both in their academic work and in general. These outcomes are measured not only by mentees' remarks in interviews but also through their notable successes, including publication of five peer-reviewed articles with undergraduates as lead authors, 16 presentations at national and regional conferences, and receipt of many competitive grants, fellowships, awards, and recognitions, including a 2023 Pulitzer Center Campus Consortium Fellowship and a 2021 National Science Foundation Graduate Research Fellowship.

How did these faculty members achieve such results with their mentorship? This study was approved by the University of Oklahoma institutional review board (IRB) and explores students' experiences to answer the research question: What specific properties of the SURE approach are most effective in building students' self-efficacy and academic scholarly recognition? Drawing on mentee interviews and the Chemers and colleagues (2011) Mediation Model, the study illuminates how co-mentoring, socioemotional support, and transdisciplinary practices shaped students' psychological development and scholarly outcomes. The findings reveal three interrelated strategies central to the SURE approach: fostering effective teamwork, leveraging multidisciplinary expertise to challenge disciplinary norms, and prioritizing students' socioemotional well-being. Building on these insights, this study contributes to the literature by (1) qualitatively examining how co-mentoring and socioemotional practices intersect with the psychological processes in the Chemers and colleagues (2011) Mediation Model, and (2) identifying deliberate nondirectiveness as a key mechanism through which undergraduate researchers

develop self-efficacy and scientific identity in a small, transdisciplinary program.

Background Literature

Team-Based Undergraduate Research Experiences (UREs)

There are multiple examples in the literature on mentorship of successful team-based mentoring approaches (Asif, Edison, and Dolan 2023; Gill et al. 2017); however, there are few that cite two or more faculty jointly mentoring students (e.g., Miller and Walston 2010). Often, it is the case that one faculty member is either supervising a graduate student or others (e.g., Jelen et al. 2019) as a scaffolded, hierarchical group. For the mentee, team-based mentoring benefits include “solidify[ing] knowledge and research skills, and further professional connections as they help their mentee[s] network . . . increase in research productivity . . . and increased recognition and networking due to well performing mentees” (Young et al. 2015, 242). Ketcham and colleagues (2018, 155) also noted that co-mentoring not only helps students but also makes mentors and institutions stronger, as it “has the added benefit of enhancing research capacity and outputs.” Team-based Undergraduate Research Experiences (UREs), especially many-to-many groups, provide additional support to scholarly work (Levine, Hebert, and Wright 2003). Ketcham and colleagues (2018, 163) support the idea of a team approach to mentoring, as it allows for mentees to draw from a more robust pool of knowledge, in which “different mentors . . . have strength[s] in . . . different areas.”

Socioemotional Mentoring in UREs

Socioemotional mentoring is defined as the mentor’s attention to students’ social and emotional health and development when going through undergraduate research (Chemers et al. 2011). COVID-19 escalated the importance of socioemotional undergraduate research mentoring (Savić et al. 2021), including that the “higher the level of the mentorship quality, the fewer academic, career, and mental health challenges experienced by research mentees during the COVID-19 pandemic” (Chang et al. 2022, 6). However, socioemotional mentoring is not unanimously agreed upon as a mentoring factor; Syed and colleagues (2019) reported that the two studies they conducted with undergraduate and graduate students to test the mediators of research experience showed informational mentoring, but not socioemotional mentoring, to be a significant predictor of commitment to science, technology, engineering, and mathematics (STEM). This contrasts with Haeger and Fresquez (2016), who reported stronger student development when socioemotional mentoring was provided by mentors.

Broadening Participation through Building Self-Efficacy

Socioemotional mentoring can help develop other skills, including fostering self-efficacy (Beals et al. 2021).

Self-efficacy has been highly regarded as a change agent in academia. Bandura (1997, 3) defined it as “belief in one’s capabilities to organize and execute the courses of action required to produce given attainments.” Bandura (1997) also stated that verbal persuasion, or words of encouragement, is one of the ways to increase self-efficacy, a practice that the mentors modeled with their mentees in that study. However, a decrease in self-efficacy causes students to see themselves less as researchers (Ashcroft et al. 2021). This lack of belief in one’s ability is a textbook case of impostor syndrome, first defined by Clance and Imes (1978, 1) as “a strong belief that [the person believes they] are not intelligent; in fact, they are convinced that they have fooled anyone who thinks otherwise.” Building self-efficacy may be one of the most effective ways of tackling impostor syndrome (Amoa-Danquah 2022).

The social cognitive theory of Bandura and NIMH (1986) was a springboard to social career cognitive theory (Lin, Lee, and Snyder 2018). Indeed, per Petrella and Jung (2008), career path clarification is one of the benefits of UREs for students. However, another theory can explain, specifically from a URE perspective, what mechanisms can be leveraged by students to commit to a science career: the Mediation Model of the Effects of Science Support Experiences (Chemers et al. 2011).

Theoretical Framework: Chemers and Colleagues’ (2011) Mediation Model

Chemers and colleagues (2011) established a replicable Mediation Model of science support activities for undergraduate and graduate students that links the presence of specific support components and psychological processes to the increased likelihood of students’ commitment to a science career (see Chemers et al. 2011, 471, for a schematic overview of the model). This model was tested and built upon the analysis of science support experiences reported by 327 undergraduates and 338 graduate students/postdoctoral fellows. The model also easily allows for transdisciplinary mentoring, as no discipline-specific components are included. Chemers and colleagues (2011, 485) showed that science self-efficacy and personal identity have a strong influence on “motivation, commitment, and performance of underrepresented students, and all students, in the science education pipeline.” Although there are other similar models of mentoring, such as Thiry and Laursen (2011), the Chemers and colleagues (2011) model was chosen for this study because it offers a very large database (Society for the Advancement of Chicanos/Hispanics and Native Americans in Science) and a psychological foundation.

Support components of the Chemers and colleagues (2011) Mediation Model are identified as research experience, instrumental mentoring, socioemotional mentoring, and community involvement. Research experiences

might include learning scientific terminology and interpreting the results of a study or project. Instrumental mentoring can be part of a research experience and takes place when a mentor teaches or models the technical skills needed for a research project and for preparing conference presentations. Socioemotional mentoring supports a student's emotional development. For example, socioemotional mentors build trust with students and help students build confidence in their ability to carry out the research project. Community involvement might include activities such as networking with student peers and attending social events with faculty, staff, and students, helping a student feel like a member of the scientific community. Through the use of these support components, mentors—such as those in this study—can help develop self-efficacy in their mentees.

These support components influence students' psychological processes, including science self-efficacy, leadership and teamwork self-efficacy (LTSE), and identity as a scientist. Science self-efficacy is a measure of students' confidence in their scientific abilities, including tasks such as using scientific terms, explaining results, and publishing research in a peer-reviewed outlet. LTSE is a measure of students' confidence in leading and contributing to a research team, where leadership is understood as being able to motivate others to perform well, and managing conflict and teamwork is understood as cooperating and communicating with others. Identity as a scientist is a relative measure of the degree to which students conceptualize themselves as scientists—for example, the degree to which “being a scientist is an important part of their self-image” (Chemers et al. 2011, 479).

Commitment to a science career is a measure of students' plans to pursue work in a scientific field, in response to the statement: “I intend to work in a field of scientific research” (Chemers et al. 2011, 480). Chemers and colleagues (2011) establish that the above psychological processes—science self-efficacy, LTSE, and identity as a scientist—are strong predictors of commitment to a science career; for undergraduate students, they find that science self-efficacy and identity as a scientist are particularly important factors. It is important to note that Chemers and colleagues (2011, 485) find that undergraduate students in their study likely did not have sufficient experiences with LTSE for it to register as a predictive factor in committing to a science career.

The SURE Framework

The SURE framework is a transdisciplinary co-mentoring model developed by Angela Person and Randy Peppler in 2017. The co-mentors have diverse training. Although both have PhDs in cultural geography, Person also holds degrees in environmental design and museum studies, whereas Peppler holds degrees in atmospheric science and

industrial engineering. They drew on their broad interdisciplinary backgrounds in designing and implementing the SURE framework.

The SURE program integrates instrumental mentoring, socioemotional support, and cohort-based community building to cultivate student-led research that leads to measurable scholarly outcomes. The model rests on the premise that undergraduate researchers thrive when given both structured guidance and meaningful autonomy, and when situated within a supportive peer community that reinforces their emerging identity as researchers. Across multiple cohorts, students worked with two faculty mentors for a minimum of two years per student, allowing time for substantial project development, public presentation, and, in many cases, publication or digital dissemination. Figure 1 illustrates the overarching components of the SURE framework—co-mentoring, personalized student research, psychological processes, and scholarly outcomes—each of which is detailed below.

Fifteen students participated in the 10-week paid summer program from 2017 to 2024: 14 female students and one male student. Fourteen of the participants were traditional, college-aged students (ages 18–22), and one was nontraditional, over the age of 30. The most common majors were environmental sustainability and environmental studies (13 students). Four of these 13 participants with environment-related majors double-majored in psychology, political science, constitutional studies, or creative media production. The remaining two students majored in international studies and computer science.

Of the 14 who have graduated, eight have pursued master's degrees, including a law degree, and three are currently doctoral candidates in STEM fields. National educational attainment data suggest that approximately 32 percent of bachelor's degree holders go on to earn a master's degree, and about 5 percent complete a PhD (EducationData.org 2023; U.S. Census Bureau 2022). In contrast, 57 percent of SURE program mentees have pursued master's degrees, and 21 percent entered doctoral programs—rates that far exceed these national estimates. The range of career paths for SURE program participants who have completed their studies and entered the workforce is highly variable, including a graphics developer, university outreach program manager, university health program manager, environmental philanthropy program specialist, and hazard mitigation specialist.

SURE Framework Design

SURE was intentionally structured to balance rigor, autonomy, and socioemotional support. Students entered the program through a paid 10-week summer research and professional development sequence, which introduced them to the expectations of independent research while

also building a cohesive research cohort. Each week, each student was paid for 40 hours of work on their research project.

From the outset, the program positioned students as the primary drivers of their projects. During the first week, students identified intellectual interests, articulated summer goals, and began generating initial research questions. Mentors acted as advisers rather than supervisors, offering guidance on feasibility, research design, and ethical considerations without dictating project direction. By the second and third weeks, students refined their proposed research questions and developed preliminary study plans, supported by structured feedback during the weekly cohort meetings.

The cohort meetings formed the backbone of the SURE experience. Each one-to-two-hour meeting followed a consistent pattern: students presented brief progress reports, discussed accomplishments and challenges, collaboratively troubleshoot obstacles in one another's projects, and articulated goals for the coming week (see Table 1). To prepare for these discussions, students posted informal weekly updates on a dedicated Canvas site; these short, work-in-progress reflections helped them gather their thoughts, track incremental progress, and identify questions to bring to the cohort. In parallel, students maintained more formal, image-rich research blogs during the 10-week summer sequence—typically three posts per student—that documented their project design decisions, early findings, and evolving research processes for an external-facing audience. These blogs allowed mentors to follow the development of each student's methodological thinking, while providing students with an additional structured opportunity to narrate their research trajectories in real time.

Each weekly cohort meeting also incorporated a dedicated professional development discussion grounded in assigned readings and facilitated dialogue. The professional development curriculum unfolded in a purposeful sequence: students began with strategies for making time for research, then moved into a two-part series on career planning that included specific, measurable, achievable, relevant, and time-bound (SMART) goal setting, career inventories, and personal reflections. Midway through the summer, the workshops emphasized analytical skill development, project management, and navigating workplace norms, whereas the final sessions focused on networking, preparing a one-minute professional introduction, and wage negotiation. In the final week, students synthesized their summer work through a 10-minute research presentation and an Esri Story Map, which served as an initial dissemination milestone toward later conference presentations or publications.

The scaffolding provided by the summer sequence extended into the academic year. After the initial paid research

period, all but one student continued their projects through independent study courses or to fulfill capstone research requirements. They maintained momentum through periodic blog post updates that documented key project milestones, including conference participation, journal publications, and other activities. Throughout this extended period, the co-mentors provided individualized instrumental mentoring on data analysis, interpretation, writing, visualization, and the preparation of scholarly products. Students were encouraged to submit abstracts to on-campus symposia and external conferences; all but one ultimately presented at an external, peer-reviewed venue. Students developed their abstracts, posters, and presentation slides independently, receiving iterative feedback from both mentors and peers, and they delivered practice talks to the cohort before every public presentation. For students pursuing humanities-oriented projects, mentors provided equivalent support, helping them develop digital humanities or film outputs, seek external expert review, and, where possible, publish the final work in the university's open-access institutional repository with assigned DOIs.

Socioemotional mentoring was woven throughout these activities. Mentors consistently emphasized that uncertainty, iteration, and early-stage “failure” are normal dimensions of the research process. Cohort meetings cultivated a supportive climate in which students could express concerns, compare experiences, and build confidence in their ability to lead and complete independent research. Students were also encouraged to teach and support one another across projects—sharing skills in ArcGIS and Esri Story Maps, offering guidance on Qualtrics survey design, co-mentoring peers through IRB submissions, and assisting with graphic preparation and visualization. Through these collaborative practices, students learned not only how to advance their own work but also how to function as contributing members of a research community. Together, these structures—co-mentoring, student-led research design, structured professional development, and a cohesive cohort environment—directly operationalize the components of SURE (Figure 1).

Methods

Interview of Past Participants

To understand which facets of the SURE mentoring program most influenced students' success, six past mentees (40 percent of all participants) from five different cohorts were interviewed by the first author, Miloš Savić, who was not one of the co-mentors. Participation was voluntary; however, the resulting group reflected substantial diversity across the cohort year, research topic, disciplinary background, research products, and postgraduation trajectories (see Table 2). Because this diversity aligned with the study's goal of capturing a broad range of student experiences, the final group was treated as a *maximum variation*

TABLE 1. 10-Week SURE Summer Research and Professional Development Sequence

Week & theme	Focus & core activities / professional development topic
1. Kickoff meeting	Introduction to SURE research culture; discussion of individual interests and long-term goals; project brainstorming. Reporting expectations introduced (weekly Canvas work plans and verbal updates); overview of summer blog; introduction to final presentation and Esri Story Map; goal setting for week two.
2. Making time for research	Weekly progress reports (accomplishments, challenges, goals); cohort-based troubleshooting. Professional development: strategies for protecting research time (preassigned reading). Students draft individualized work plans.
3. Career planning, Part I	Progress reports and peer problem-solving. Professional development: professional goal setting (prereadings on career pathways); initial reflection on strengths, interests, and future trajectories.
4. Career planning, Part II	Progress reports and planning. Professional development: SMART goal setting; personality and strengths inventories (University Career Services tools; Myers-Briggs assessment); discussion of aligning personal values with research and career goals.
5. Enhancing analytical research skills	Progress reports with peer support. Professional development: analytic skill-building using resources shared on Canvas; discussion of methodological options, interpreting data, and refining research design.
6. Workplace politics & professional etiquette	Progress reports and collaborative troubleshooting. Professional development: norms of workplace culture, navigating professional relationships, communication expectations, and organizational awareness (assigned readings).
7. Project management & prioritization	Progress reports and cohort-based planning. Professional development: task prioritization, timeline development, managing multiple deadlines, and frameworks for organizing independent research.
8. Negotiating fair compensation	Progress reports and peer feedback. Professional development: strategies for negotiating fair compensation, understanding labor value, and preparing for professional advancement (prework resources on Canvas).
9. Networking skills	Progress reports; refresher on final presentation and Story Map expectations. Professional development: networking strategies; practicing a “one-minute professional introduction”; discussion of scholarly and professional networking opportunities (prereadings and draft elevator pitch).
10. Concluding the summer	Synthesis of project findings. Professional development: finalizing Esri Story Map project overview and 10-minute final presentation (prework: guidelines review); final presentations practiced and delivered to mentors and cohort; celebratory lunch and reflection on next steps.

Note: SMART, specific, measurable, achievable, relevant, and time-bound; SURE, Socioemotional Undergraduate Research Experience.

purposive sample (Patton 2015), a qualitative sampling approach used to illuminate common themes that emerge across heterogeneous cases.

Each participant completed a semistructured interview following Kallio and colleagues (2016). Three questions asked students to describe their undergraduate research project and its outcomes, whereas the remaining three focused on the psychological processes in the Chemers and colleagues (2011) Mediation Model—science self-efficacy, leadership/teamwork self-efficacy, and identity as a scientist. Students were also prompted to identify specific mentor actions or SURE program elements that contributed to these psychological processes. The full list of interview questions is provided in Table 3.

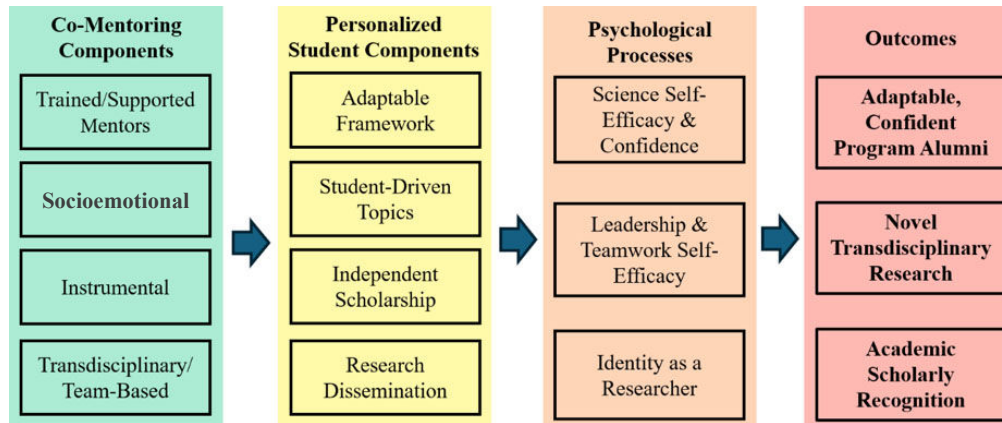
Analysis of Interview Responses

Interview transcripts were analyzed using *provisional coding* (Saldña 2009), with the initial code list drawn directly from the four support components in the Chemers and colleagues (2011) Mediation Model: research experience, instrumental mentoring, socioemotional mentoring, and community involvement. Each transcript was reviewed

to identify segments describing these forms of support. In a second analytic pass, the research team examined how each support component aligned with students’ descriptions of the three psychological processes—science self-efficacy, leadership/teamwork self-efficacy, and identity as a scientist—as well as their broader reflections on career development and long-term impact.

To enhance analytic rigor, three authors independently coded the transcripts and then met to reconcile discrepancies. Following Harry and colleagues (Harry, Sturges, and Klingner 2005, 6; as cited in Saldña 2009, 28), the team used *consensus coding* rather than calculating interrater reliability statistics such as Cohen’s Kappa. Through deliberation and negotiated agreement, the authors developed a shared interpretation of how specific mentoring practices and cohort interactions shaped students’ psychological development. This approach aligns with qualitative traditions that prioritize meaning-making and collective judgment over quantification of coder agreement.

Because two of the authors served as co-mentors in the SURE program, the research team engaged in ongoing

FIGURE 1. Socioemotional Undergraduate Research Experience (SURE) framework**TABLE 2. An Overview of Interviewees**

Summer cohort	Student	Major	Research product	Postgraduation
2017	Allyson	Environmental sustainability	Peer-reviewed journal article; conference paper presented at a national conference	University program manager
2017	Sonia	Environmental sustainability	Peer-reviewed journal article; conference paper presented at a national conference	Graphic development manager
2018	Marie	Environmental sustainability	Conference paper presented at a national conference	Master's student in regional & city planning
2019	Madeline	Environmental studies & psychology (<i>double major</i>)	Peer-reviewed journal article; conference paper presented at a national conference	PhD candidate in geography
2020	Attie	Environmental sustainability	Conference paper presented at a national conference	Philanthropy program specialist
2021	Julia	Environmental sustainability & creative media (<i>double major</i>)	Documentary film screened in a professional setting	Freelance multimedia documentarian

reflexive discussion about their positionality, potential biases, and interpretive assumptions. The approach to collaborative, consensus-based coding across authors who varied in their proximity to the program served as a partial safeguard against overidealized interpretations.

Results

Research Experience

The support component *Research Experience* was most connected by the interviewees to the psychological processes “Science Self-Efficacy” and “Identity as a Scientist,” and in some cases to “Leadership and Teamwork.” Sonia said that the effects of this undergraduate research experience have lingered since 2018: “I’ve really, really doubled down on critical thinking, checking sources, how to research in general . . . not just accepting information as it’s widely thrown about. And to be curious.” Critical

thinking, a skill that many universities regard highly in terms of its importance in education (Davies 2011), was gained, as well as the self-efficacy of a scientist to check sources in day-to-day situations. Marie said, “The fact that I had to design the whole research project, I’d say from the IRB on . . . I got the bird’s-eye view and a comprehensive view.” On confidence gained, Marie said, “I was very confident that I was the expert in this specific thing . . . I don’t know if I’d classify this necessarily a leadership skill, but the first thing that comes to mind is like the confidence to do this project. Because it was pretty empowering.” Marie’s self-efficacy and identity as a scientist are apparent in this description of empowerment.

Instrumental Mentoring

The support component *Instrumental Mentoring* mapped directly to “Science Self-Efficacy,” “Self-Efficacy,” and

TABLE 3. Interview Questions

Question	Chemers et al. 2011 component
1. Can you describe your undergraduate research project?	N/A
2. How did you feel during the process, including the professional development activities during the summer?	N/A
3. Did you present or produce anything from your undergraduate research? If so, how did you feel about that? If not, would you want to?	N/A
4. Through the process, how confident were you in carrying out your project? If you were starting another project, what would you do, and how would you feel about starting anew?	Science self-efficacy
5. In your undergraduate research project, how did you work with others? What were some leadership skills that you employed or learned?	Leadership/teamwork self-efficacy
6. Do you feel like a scientist or a part of the research field? What contributed to that feeling? What career are you pursuing, and what did your undergraduate research experience contribute to that career path?	Identity as a scientist

“Leadership and Teamwork” among the interviewees. Allyson appreciated the mentors reinforcing that “we’re just going to help you accomplish this and open doors for you that you might not know exist . . . I don’t think I ever would have submitted to AAG [American Association of Geographers].” Allyson’s eventual STEM graduate degree was also credited to that community involvement in AAG. Madeline also pointed out the affordances this mentorship allowed: “I think undergraduates aren’t always given that freedom that we are given in this group. And it was absolutely life-changing to have the opportunity and the trust to have a lot of freedom with my research. . . . [The co-mentors are] here as a resource if [I] need [them], but this is [my] show.”

Julia related this aspect of mentoring to increasing self-assurance, “Like the fact that like no idea is a bad idea. No question is a bad question.” On teamwork, Julia found the co-mentoring approach invaluable: “I think [Mentor A] has the big ideas, but [Mentor B] wants to make sure that I stayed on the little things. . . . And so, they thought differently about planning. . . . I think it’s very important that we had those different perspectives because that’s important to any sort of research study.”

Socioemotional Mentoring

For responses to the support component *Socioemotional Mentoring*, nearly all the interviewees mapped directly to “Self-Efficacy” and “Science Self-Efficacy,” and this component may have had the most powerful impact on the students. Several related how this mentoring helped them alleviate feelings of “impostor syndrome,” which was brought up unprompted in five of the six interviews. Allyson said, “I did have a little bit of impostor syndrome when I was there. But I think once I got up and I did it, it was really to feel accomplished after that. . . . You know, they believed in me. And that’s what I think made

a difference.” This mentoring gave the students a sense of empowerment and confidence, both markers of self-efficacy. Attie said the mentors’ assurances aided in making a difference, as well, describing them as saying, “‘You are very capable person, and we will do literally whatever we can to help you succeed in whatever you want to do.’ That’s not a relationship I’ve ever had with adults in a field that I want to be in before.”

Madeline had a lot to say about this aspect of mentoring, stating, “I felt extremely valued and supported during the undergraduate research process . . . so I felt very empowered. . . . And ultimately, I was able to publish a paper as an undergraduate. And that was a huge accomplishment for me.” Madeline then spoke importantly about the timeline of the research experience and gaining confidence along the way: “Their constant encouragement, I felt more and more capable . . . I would be able to take on this challenge of designing an education initiative. I knew that I could work with the mayor [of the city] and hold my own. I knew that I belonged there and that it was valuable research.”

Community Involvement

For the support component *Community Involvement*, there was a heavy connection to “Teamwork and Leadership,” mapping directly to valuing the teamwork or interacting with their respective cohorts. Madeline said, “We were all studying very different things, but we would do research updates all the time and provide suggestions, help each other. . . . I think one of the biggest benefits was the camaraderie and the collaboration between the cohort.” Marie said, “In those meetings, it was more of the students talking, and the professors were there to also be there, but it was more like they wanted us to help each other.” Sonia added, “We would also just kind of pep each other up.”

Julia addressed valuable connections beyond the research group dynamic, with others on campus and off campus: “They [mentors] had different people to connect you to on campus and outside of campus. . . . They had different networks.” Madeline gave an example of that off-campus connection: “We worked with [the mayor] at the time and organized three tours of the [city] reclamation facility, which is the wastewater treatment plant here in [city]. And those tours were led by staff at the reclamation plants.” Finally, community involvement included conference attendance that helped their “Identity as a Scientist.” Madeline said, “I definitely feel like a geographer, and I feel like it was really that moment at SWAAG [conference], where people were telling me this belongs, and this is valid. That was probably the moment where you’re feeling like a scientist.” Allyson summed up the feelings on how this aspect of mentoring helped the mentees, stating, “People respected what I had to say.”

Discussion

This research finds that a combination of socioemotional and instrumental mentoring appeared to be the main benefit expressed by the mentees in fostering both scientific self-efficacy and general self-efficacy, as well as identity as a researcher. Students also emphasized the value of being part of a cohort and knowing they were not doing the work alone. Realizing that they could conduct meaningful research beyond the classroom—and be positively supported along the way, in ways that positioned them as the “experts” with results to share—was deeply empowering. The opportunities to disseminate their work at regional and national meetings further reinforced this sense of legitimacy and gave them the confidence to pursue future scholarly and professional endeavors, whether in graduate school or beyond.

The 10-week implementation of the SURE framework, especially components related to project management and networking, was cited repeatedly in interviews as having ongoing relevance to students’ academic and career trajectories. The Mediation Model of Chemers and colleagues (2011) provided a productive lens for unpacking how these experiences contributed to the development of self-efficacy and science identity, particularly as students overcame early uncertainties about their ability to conduct independent research. Notably, the notion of impostor syndrome—raised unprompted by five of the six mentees—appeared to diminish over the course of their participation, a shift they attributed to their interactions with mentors and peers and to the repeated affirmation of their growing competence.

A defining feature of the SURE experience, according to mentees, was the independence they were granted. Students consistently described how mentors refrained from prescribing next steps and instead encouraged them

to explore their own interests within the broader boundaries of environmental sustainability. These *deliberate nonactions*—asking probing questions, offering resources, and allowing students to make decisions—emerged as powerful mechanisms for cultivating autonomy and self-efficacy. This dynamic echoes but also extends the existing literature: whereas Syed and colleagues (2019) found socioemotional mentoring to be a nonsignificant predictor of STEM commitment in their quantitative analyses, our findings suggest that in a small, intensive, multiyear program such as SURE, socioemotional mentoring may be especially impactful because it is embedded in co-mentoring, cohort-based support, and repeated cycles of independent decision-making. The sustained duration, dual-mentor model, and psychologically safe cohort culture may create conditions under which socioemotional support becomes a more salient mechanism than what might be observed in larger, shorter-term UREs.

Mentees also valued the teamwork inherent in being part of a cohort and the opportunity to support, challenge, and learn from one another. They appreciated the co-mentoring structure as well, particularly the balance between mentors’ differing expertise, perspectives, and mentoring styles. Students noted that there was no single prescribed “right way” to design or conduct a project; instead, they encountered flexibility and multiple ways of thinking, which helped them conceptualize research problems beyond the boundaries of disciplinary silos.

Taken together, these findings highlight several contributions to the literature on undergraduate research. First, they demonstrate how a co-mentoring, socioemotional, and cohort-based framework can strongly support science self-efficacy and identity formation, even in a small program. Second, they draw attention to the role of intentional non-directiveness as an underexamined yet influential mechanism for building autonomy and confidence in novice researchers. Third, they illustrate the potential portability of the SURE framework across disciplinary contexts, given its emphasis on psychological processes rather than discipline-specific content. These insights collectively suggest that socioemotional and instrumental mentoring are not parallel or competing strategies but mutually reinforcing elements that can significantly enhance undergraduate research experiences, especially for students developing early scientific identities.

Conclusion

This study suggests that undergraduate researchers benefit significantly when instrumental mentoring, socioemotional support, and cohort-based community building are intentionally intertwined within a co-mentoring framework. Across different cohorts and project types, students consistently described significant gains in scientific self-efficacy, general self-efficacy, and identity as researchers—gains

supported both by their reflections and by their substantial scholarly outputs. The sustained, multiyear nature of the SURE program, coupled with deliberate nondirectiveness and a psychologically supportive cohort environment, appeared to reduce impostor syndrome while empowering students to take ownership of their research trajectories.

Although the scale of this study is necessarily modest, the depth of qualitative insight reveals processes that can inform undergraduate research programs more broadly. In particular, the findings underscore the value of co-mentoring models that balance differing mentoring styles and expertise; socioemotional practices that normalize uncertainty and affirm students' growing competence; and cohort structures that foster collaboration, accountability, and belonging. Together, these components constitute a portable, adaptable framework that aligns with the psychological processes outlined in the Chemers and colleagues (2011) Mediation Model and can be applied across disciplinary settings.

Future expansion of the SURE framework at the institutional level will allow for continued evaluation of how these mentoring practices shape long-term academic and professional outcomes. By formalizing and scaling this model, institutions can support more students in developing robust research identities, sustaining motivation, and accessing broader scholarly and career pathways.

Data Availability Statement

The data underlying this study are not publicly available due to student privacy concerns. They are available from the corresponding author upon reasonable request.

Institutional Review Board

This study protocol was reviewed and approved by the University of Oklahoma IRB (#15762).

Conflict of Interest

No conflicts of interest to declare.

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