

Effective Mentorship and Social Wellbeing: Insights from a Biology Integration Institute

Kaggwa Asiimwe, R. J.¹, Wester, E.², Streit Krug, A.², & von Wettberg, E. B.³

¹Donald Danforth Plant Science Center, ²The Land Institute; ³University of Vermont

Mentoring is commonly defined as a formal or informal developmental relationship between a more experienced individual (mentor) and a less experienced individual (mentee), aimed at supporting both career advancement and psychosocial development. Increasingly, however, mentoring is recognized as a multidimensional practice that extends beyond the traditional dyad to include networks of mentors, such as faculty, peers and near-peers, who provide varied forms of guidance, affirmation, and support. While a substantial body of research has explored the attributes of effective mentors and the processes that underpin mentoring relationships, relatively few studies have examined how mentoring contributes to post-academic transitions, including career clarity, professional satisfaction, geographic and disciplinary mobility, and the development of a sustained professional identity. Moreover, the role of mentoring in supporting social wellbeing, particularly dimensions such as social integration and social acceptance, is often overlooked or treated as secondary to academic achievement, despite its growing significance in light of the mental health crisis affecting STEM trainees. This study investigated the role of mentoring in advancing social wellbeing, academic and career outcomes among a diverse cohort of early-career trainees affiliated with the New Roots for Restoration Biology Integration Institute (NRR BII), a multi-institutional collaborative in the biological sciences that fosters mentoring relationships and networks. Employing a mixed inductive and deductive coding approach, we analyzed semi-structured interviews in which participants reflected on their educational and professional trajectories. Findings reveal that mentoring played a critical role in shaping research interests, supporting non-linear career transitions, fostering long-term career trajectories, and enhancing social wellbeing. This work underscores the importance of responsive mentoring strategies in promoting both scientific advancement and the holistic flourishing of diverse scholars.

Keywords: Mentoring outcomes, Mentoring mechanisms, social wellbeing, biological sciences, early career trainees

Acknowledgements: This research study was funded by the National Science Foundation NSF 2120153. The authors would like to thank members of the New Roots for Restoration Biology Integration Institute for their participation in the study, and Aubree Mitchell, an undergraduate intern who assisted in data collection.

Introduction & Literature Review

Traditionally mentoring involves a senior-junior pair (a dyad) in a close, support-based relationship that fosters both career advancement and psychosocial development; the former enhances professional growth, while the latter supports personal and emotional wellbeing (Mullen and Klimaitis, 2021). These relationships can be formal or informal, vary in duration and purpose, and differ widely in mentor training, activities, and interaction modes (Lunsford et al. 2017). However, researchers contend that students gain the most from having multiple mentors such as faculty, staff, peers, family, friends, and community leaders who provide different types of support, such as advice, feedback, and academic tracking,

affirmation and friendship (D'Abate, 2009). For example, peer mentoring shifts the focus from mentor-centered hierarchies to mentee-centered peer sharing and support (Montgomery, 2018; Thomas et al. 2015); while near-peer mentors augment support by providing connection, social integration, sense of belonging and validation, and help to alleviate imposter syndrome (Curtin et al. 2016). While mentorship is known to support academic outcomes among trainees (Crisp and Cruz, 2009); Lunsford et al. 2017), the nuanced interactions and mechanisms that unfold within mentoring relationships have yet to be thoroughly investigated. Moreover, the role of mentoring in shaping long-term career trajectories and social wellbeing remains comparatively underexplored (Nabi et al. 2025; Byars-Winston et al. 2015; Eby

et al. 2013). Hardly any studies have examined how mentoring relationships influence post-academic transitions such as career clarity, satisfaction, mobility, and sustained professional identity. Additionally, while research has shown that mentoring relationships, particularly those with peers, can offer encouragement, emotional support, and a sense of belonging that enhances social wellbeing (Oddone Paolucci et al. 2020), the broader impact of mentoring on key dimensions of social wellbeing, including belonging, social integration, and life satisfaction (Keyes, 1998), is often overlooked or treated as secondary to academic outcomes. Addressing these gaps is essential for developing effective mentorship programs that support diverse trainees, amidst the ongoing mental health crisis in STEM (Evans et al. 2018; Levecque et al. 2017). Research shows that feelings of loneliness and isolation, limited opportunities for social interaction and support, poor work-life balance, and poor mentoring relationships are significant contributors to the prevalent mental health crisis in STEM graduate education (Evans et al. 2018; Barreira et al. 2018; Bekkouche et al. 2022). Further research is urgently needed to examine how and which mentoring approaches foster academic success and promote social wellbeing, ultimately shaping both professional outcomes and overall wellbeing.

- Objectives:**
- To examine the forms of mentoring that most significantly influence social wellbeing outcomes in the reflections of biological sciences trainees participating in a multi-institutional collaborative
 - To identify which mentoring strategies are most salient in supporting the academic and career outcomes of diverse trainees in their reflections, while participating in a multi-institutional collaborative

Theoretical Framework

This research study was guided by Keyes' (1998) five-dimensional model of social wellbeing which asserts that social integration (evaluation of one's connection to society), social contribution (belief in being a valuable member of society), social coherence (perception of how society functions), social actualization (belief in society's progress

and its potential being fulfilled through institutions, people) and social acceptance (trust in others' kindness), assess how individuals navigate social challenges to thrive within their communities.

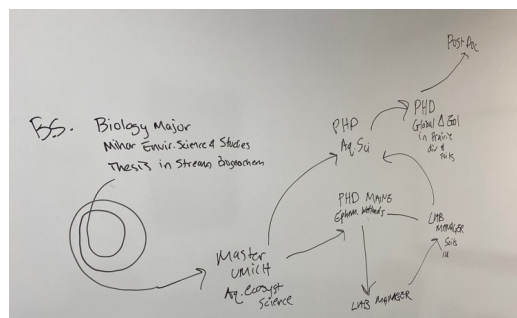
Method

Participants for this cross-institution research study comprised 11 diverse trainees and early career institute members (see Table 1 for participants demographics), from multiple academic institutions of the New Roots for Restoration Biology Integration Institute. The New Roots for Restoration Biology Integration Institute (NRR BII) is a virtual biology integration research institute founded in September 2021, which includes scientists and trainees from nine academic institutions: Chicago Botanic Garden, Northwestern University, Donald Danforth Plant Science Center, The Land Institute, Saint Louis University, Saint Louis Science Center, University of Kansas, University of Missouri, and the University of Vermont. The NRR BII, comprising around 100 members, fosters a robust culture of mentorship by fostering both near peer mentoring relationships and expansive mentoring networks that support diverse trainees across institutional, disciplinary and career stages. This study targeted early career trainees that were willing to participate and had availability for interviews from members of the NRR BII, participants were therefore recruited using convenience sampling methodologies (Etikan et al. 2016). The research was approved by the Institutional Review Board at Donald Danforth Plant Science Center Protocol # IRB_2024_02. All participants provided informed consent prior to participation, and confidentiality procedures were guided by IRB protocols.

Data Collection

Data collection involved semi-structured interviews and journey mapping artifacts (see figure 1). The semi-structured interviews were conducted using an interview protocol guided by Hallpike et al. (2022)'s decision mapping framework and Keyes (1998)'s social wellbeing framework and focused on retrospective reflections of education and career trajectories and decision-making influences. Interviews were recorded and transcribed.

Figure 1:
Sample journey map from one of the study participants



Sample questions from the interview protocol included:

- Reflect on your journey, in terms of your education and career, including your engagement with the New Roots for Restoration Biology Integration Institute:
- What were the key decisions along the way?
- How were these key decisions made? What were the most influential factors in driving these decisions?
- What factors had the greatest influence on your educational journey? For example, has it been personal interest, the influence of others, career demands, or something else?

Data Analysis

Interview transcripts were analyzed using a hybrid inductive-deductive approach (Saldaña, 2016). Initial open coding identified emergent themes, which were then structured using Keyes' (1998) social wellbeing framework (integration, acceptance, contribution, actualization, coherence) and Eby et al. (2013)'s process-oriented mentoring model. Themes reflect how the eleven participants conceptualized their educational and career trajectories, with interpretive coding emphasizing their lived experiences and perceptions. As qualitative researchers we acknowledge that these findings are not generalizable to all biological sciences trainees; however, they provide foundational insights into how mentoring shapes career pathways within specific institutional and disciplinary contexts, in the context of a multi-institutional biology collaborative.

Results

Objective I

The objective was to examine the forms of mentoring that most significantly influence social wellbeing outcomes in the reflections of biological sciences trainees participating in a multi-institutional collaborative. This study explored how mentoring experiences across career stages support the social wellbeing of diverse trainees in academic contexts, aligning with Keyes' (1998) five-dimensional model of social wellbeing.

Social Integration

Social integration refers to the degree to which individuals feel connected to and part of their communities or social groups (Keyes, 1998). From this study, Annie, a first generation and early career professional of racially minoritized ethnicity, reflected on the sense of meaningful connection and shared identity with a mentor, that fostered a feeling of belonging in the academic and research community:

"My undergraduate advisor, he's a Mexican American man in the US and felt there's a lot of lessons that he learned being a part of Academia which does have a white dominant culture. I feel there were lessons he imparted

to me, like how I can make it through and reach the angles that I'm looking for, but making sure that I take care of myself. How do you play the game to get what you need? And we're not often taught you about those kinds of cultures and systems."

While Meena, a Caucasian female graduate student, benefited from her advisor's willingness to learn alongside her:

"I'm studying mycorrhizal fungi on tree seedlings, and my advisor has a much more plants-heavy background but had said to me 'well I don't know much about mycorrhizal fungi right now, but I can learn with you.'"

By validating her topic and offering to engage with it together, the advisor's supportive and reciprocal interaction helped Meena feel socially and intellectually integrated into her research environment.

Social Acceptance

Social acceptance refers to the perception that others are kind, trustworthy, and capable of good (Keyes, 1998). Participants in this study reflected on several experiences of social acceptance during their mentorship relationships; for example, Meena recalled:

"I remember I had asked one of my professors for a letter of [recommendation] for I think it was an REU program in my sophomore year for the upcoming summer and he's like 'yeah, sure I can write you a letter but I also am looking for a student to do research would you be interested?' "And kind of, you think i'm good enough to do research? Okay."

Additionally, Polly, a female Caucasian post-doctoral scholar, reflected on how faculty outside her direct supervisory relationship provided support, guidance, and encouragement, and a willingness to engage in honest conversations about her future. These affirming interactions reflect a broader sense of belonging and acceptance within the academic community and signaled that she was valued and respected as illustrated below:

"I remember going and talking to some of the other faculty members deciding whether or not this was right for me. Obviously, that's not a conversation you can really have with the person who you're working directly for. And they were incredibly helpful to help me basically figure out what that list was and what I needed and whether or not I was going to get there. And they were also really encouraging; they would tell me that they thought I could be successful in other institutions."

Social Contribution

Social contribution refers to the belief that one's activities are useful to society and that one plays a valuable social role (Keyes, 1998). Charles, a Black, male international graduate student, reflected on mentor-provided opportunities to engage with a broader research community where

he participated in shaping and strengthening the community of practice around perennial grain research. His involvement helped build collective knowledge and foster collaboration within the field as he recalled below:

“Through NRRBII also, I was able to get invited to the early career perennial grain researchers’ program, where I had the opportunity to speak with other young researchers within Midwest, and that has been a huge opportunity for me to build a network in this space, meeting other grad students working in this space”

Furthermore, Zach reflected on his own challenging experience, taking a financial risk to pursue an academic path, to inform and improve support for others, which has shaped how he advocates for current students, especially around issues of equity, time valuation, and institutional treatment. By actively working to make the system better for others, particularly those in their program, he is contributing to a more supportive and just academic environment. He reflected:

“I wasn’t as informed as I would have liked to have been and that has guided how I advise people who are thinking about these types of programs. To take that risk and shoulder the financial burden to do what i wanted to do, it will hopefully work out for me but it’s a big decision that I made that informs a lot of the way that I advocate for particularly students in our program and how students are treated and how their time is valued or not valued which i feel very strongly about.”

Social actualization:

Social actualization refers to the perception of society’s potential and the belief in its capacity for growth and improvement (Keyes, 1998). Meena’s reflections below illustrate a clear belief in the potential for individual and societal growth through learning, experimentation, and adaptability:

“Hopefully in any profession if you already know everything, that sounds boring. Where we grow is where we’re not sure, but say, let’s take a stab at it.”

Additionally, Winnie expressed optimism about future change in agriculture, education, and land access below:

“Am hoping that my next career steps will help scientists and researchers like everybody, to collaborate more with farmers and vice versa but It’s also gotten me into a lot of really interesting questions about who has access to land and how can we get more young people on the landscape who have knowledge of conservation and regenerative farming practices and how can we pair them up with people who with landowners who might be interested in seeing those types of projects and management on their landscapes.”

Social Coherence

Social coherence refers to the degree to which

the social world is perceived as intelligible, logical, and predictable (Keyes, 1998). Polly, who attended a self-described “small college,” reflected on how her academic path became meaningfully aligned with broader societal challenges, specifically climate change. The experience of reading and discussing a pivotal article in a course setting catalyzed a sense of purpose and direction. This moment helped her make sense of their place in the world and shaped a coherent identity around contributing to solutions for urgent global issues, reflecting a deep integration of personal goals with societal needs. She recalled;

“When I started college I had to take a non-honors environmental science class and so we did and we read this article in the *New Yorker* called “The Climate of Man” and I just remember reading that article and I hadn’t heard about climate change before. And I was like, oh, this is going to be what’s going to change the world. And I just remember feeling compelled that I was like, oh, okay. I should do something related to this. This is going to be the biggest thing facing our generation. So I just started, I changed majors. I ended up as a biology major.”

Additionally, Charles illustrated social coherence in his recollection of motivating factors for seeking out his doctoral program below.

“These situations really motivated me to go for a PhD program where I could gain skills, knowledge and research skills that could be used to, you know, contribute to a world where we provide food while also sustaining our environment.”

Collectively, these narratives illustrate how effective mentoring can cultivate a holistic sense of belonging, purpose, and contribution, especially when attuned to the cultural, social, and structural contexts that shape diverse trainees’ academic journeys. These findings highlight the importance of intentional, context-sensitive mentoring practices in supporting the social wellbeing and professional development of trainees and early career professionals.

Objective II

Objective two was to identify which mentoring strategies are most salient in supporting the academic and career outcomes of diverse trainees in their reflections, while participating in a multi-institutional collaborative. Through our analysis of interview transcripts, five salient and interrelated themes emerged (Table 2), each illuminating key mentoring strategies that effectively supported the educational and career trajectories of diverse participants;

- Relational Support & Identity Formation: Mentorship as a relationship that shapes STEM identity, motivation, and belonging.
- Skill Development, Research Autonomy & Career Progression: Mentorship that builds practical expertise, self-efficacy, and helps navigate career transitions.

- Mentorship Networks & Peer/Community Supports: Mentorship as access to a broader ecosystem and peer learning.
- Structural & Programmatic Mentoring Approaches: Mentoring enabled or limited by institutional structures and intentional systems.
- Culturally Responsive Mentoring, Normalizing Vulnerability, Fostering Resilience and Transparency: Mentoring that affirms identity, encourages openness about challenges, and builds trust, supporting resilience and psychological safety for diverse trainees.

These themes not only highlight what forms of mentorship were impactful, but also elucidate the underlying mechanisms, through which these strategies fostered identity development, professional growth, and sustained engagement in scientific pathways. Across career stages, effective mentoring played a critical role in cultivating STEM identities (Table 2.1), research skills (Table 2.2), building resilience (Table 2.5), expanding professional networks (Table 2.3), and fostering a sense of belonging in academia (Table 2.5) and social wellbeing (Figure 2).

Discussion

Our findings suggest that effective mentorship characterized by cultural responsiveness, encouragement, and access to resources fosters key dimensions of social wellbeing such as integration and contribution. Our study adds to the scholarship on STEM identity support, specifically, mentoring as a process that affirms diverse identities, fosters a sense of belonging in STEM, and explicitly supports the development of a research self-concept. Although previous researchers discuss psychosocial support and role modeling, they are less explicit about how mentoring relationships actively shape scientific identity, belonging, and motivation over time (Crisp & Cruz, 2009; Pfund et al. 2016; Eby et al. 2013).

Furthermore, our findings emphasize relational support and identity formation mentorship that actively affirms unique thinking, normalizes vulnerability, and fosters a sense of belonging in STEM. This extends recent scholarship on identity-affirming mentoring (Estrada et al. 2018) by situating it within non-linear, cross-disciplinary trajectories. Most mentoring models, including Pfund et al. (2016) and Eby et al. (2013), do not deeply explore how mentoring that normalizes vulnerability, builds resilience, and explicitly engages with cultural identity representation. This study's findings provide a richer lens of culturally responsive practices, showing how mentors can foster transparency, normalize struggle, and model resilience for mentees. This echoes and extends calls for culturally aware mentoring (Byars-Winston et al. 2015). Additionally, our findings show how mentors help mentees navigate transitional

moments, side projects, and interdisciplinary interests by scaffolding both practical expertise and identity shifts. Findings also provide support for mentoring that actively supports navigating pivots, re-entry points, and flexible career paths. This adds nuance beyond current mentoring models e.g. Eby et al. 2013 by foregrounding trajectory flexibility. Prior research (Pfund et al. 2016; Lunsford et al. 2017) does not highlight mentoring as a scaffold for increasing autonomy or as a bridge through nonlinear career transitions and rarely addresses how mentoring supports career pivots or re-engagement after detours. Moreover our study also introduces programmatic and structural levers as active elements of mentoring effectiveness, showing that institutional design, funding models, and intentional systems enable or constrain mentoring impact. Earlier frameworks such as Pfund et al. (2016); Crisp & Cruz (2009) acknowledge institutional context and individual competencies but do not specify how structures (flexible pathways, role carving, financial policies) shape mentoring effectiveness.

Limitations

This study acknowledges several methodological limitations. First, the participant sample may be subject to selection bias as it was a convenience sample. Participants who chose to engage in this research may have had particularly strong mentorship experiences whether positive or negative that motivated them to participate, potentially limiting the diversity of perspectives captured. Second, the study relies on self-reported data, which may introduce bias related to memory recall, personal interpretation, or social desirability. Participants' reflections on their mentorship experiences are shaped by their own positionality and subjective perspectives, which may not fully capture all relational dynamics or broader structural factors. Additionally, this study's focus on participants from a single virtual institute reflects the use of a bounded context, in which the primary goal is not to generalize widely but to develop theoretical insights and analytic depth that can inform similar contexts (Stake, 1995; Tracy, 2010). While these limitations are inherent in qualitative, interview-based research, they are mitigated through careful thematic analysis, efforts to triangulate across multiple participants, and attention to context in interpreting findings. Nonetheless, caution should be exercised in generalizing the findings beyond the specific sample and settings studied. In qualitative research, the aim is not statistical generalizability, but rather rich, contextually grounded insights that illuminate how individuals interpret their experiences (Patton, 2015; Merriam & Tisdell, 2016). As this study is based on a sample of participants from a single virtual institute, its purpose is an in-depth exploration of mentoring strategies that support persistence in the biological sciences.

Conclusion

Findings from this study suggest that mentoring plays a vital role in supporting social wellbeing, educational and career outcomes in the biological sciences. Effective mentorship characterized by cultural responsiveness, encouragement, and access to resources fosters key dimensions of social wellbeing such as belonging and contribution. Findings from this study suggest that effective mentoring is not only about skill transfer and psychosocial support but also about structural conditions, community ecosystems, and identity-affirming strategies that sustain diverse mentees through nonlinear STEM pathways. Mentoring strategies identified such as identity-congruent mentoring, identity-affirming advising, and mentoring through identity representation that helped normalize difficulty, built resilience, may resonate with other programs that are interdisciplinary, virtual, or designed to serve diverse individuals, particularly those underrepresented in STEM. Our findings fill research gaps by embedding mentoring within systems, networks, cultural contexts, and identity development processes, dimensions that classic models do not explicitly address. Furthermore, our study findings broaden existing frameworks by integrating identity development, networked and systemic perspectives, and culturally responsive practices, areas underemphasized in previous literature on mentoring. These findings may also inform mentoring practices that aim to broaden the STEM pipeline. We offer these themes as potential points of reflection for programs seeking to strengthen mentoring structures, while recognizing that local adaptation is necessary.

References

- Barreira, P., Basilico, M., Bolotnyy, V. (2018). Graduate student mental health: Lessons from American economics departments. In working paper. https://scholar.harvard.edu/files/bolotnyy/files/bbb_mentalhealth_paper.pdf
- Bekkouche, N. S., Schmid, R. F., & Carliner, S. (2022). "Simmering pressure": How systemic stress impacts graduate student mental health. *Performance Improvement Quarterly*, 34(4), 547-572. <https://doi.org/10.1002/piq.21365>
- Byars-Winston, A., Branchaw, J., Pfund, C., Lev-erett, P., & Newton, J. (2015). Culturally diverse research mentoring relationships: An undergraduate-graduate-faculty triad. *CBE—Life Sciences Education*, 14(2), ar13.
- Crisp, G., & Cruz, I. Mentoring college students: A critical review of the literature between 1990 and 2007. *Research in Higher Education*, 50, 525-545 (2009). <https://doi.org/10.1007/s11162-009-9130-2>
- Curtin, N., Malley, J., & Stewart, A. J. (2016). Mentoring the next generation of faculty: Supporting academic career aspirations among doctoral students. *Research in Higher Education*, 57(6), 714-738. DOI: 10.1007/s11162-015-9403-x
- D'Abate, C. (2009). Defining mentoring in the first-year experience: One institution's approach to clarifying the meaning of mentoring first-year students. *Journal of the First-Year Experience & Students in Transition*, 21(1), 65-91.
- Eby, L. T. D. T., Allen, T. D., Hoffman, B. J., Baranik, L. E., Sauer, J. B., Baldwin, S., ... & Evans, S. C. (2013). An interdisciplinary meta-analysis of the potential antecedents, correlates, and consequences of protégé perceptions of mentoring. *Psychological bulletin*, 139(2), 441-476 DOI: 10.1037/a0029279
- Estrada, M., Hernandez, P. R., & Schultz, P. W. (2018). A longitudinal study of how quality mentorship and research experience integrate underrepresented minorities into STEM careers. *CBE—Life Sciences Education*, 17(1), ar9. <https://doi.org/10.1187/cbe.17-04-0066>
- Etikan, I., Musa, S. A., & Alkassim, R. S. (2016). Comparison of convenience sampling and purposive sampling. *American Journal of Theoretical and Applied Statistics*, 5(1), 1-4. doi: 10.11648/j.ajtas.20160501.11
- Evans, T. M., Bira, L., Gastelum, J. B., Weiss, L. T., & Vanderford, N. L. (2018). Evidence for a mental health crisis in graduate education. *Nature Biotechnology*, 36(3), 282-284. DOI: 10.1038/nbt.4089
- Hallpike, H., Vallée-Tourangeau, G., & Van der Heijden, B. (2022). A distributed interactive decision-making framework for sustainable career development. *Frontiers in Psychology*, 12, 790533. doi.org/10.3389/fpsyg.2021.790533
- Keyes, C. L. M. (1998). Social well-being. *Social Psychology Quarterly*, 121-140. <https://doi.org/10.2307/2787065>
- Levecque, K., Anseel, F., Beuckelaer, A. D., Van der Heyden, J., & Gisle, L. (2017). Work organization and mental health problems in PhD students. *Research Policy*, 46(4), 868-879. DOI: 10.1016/j.respol.2017.02.008
- Lunsford, L. G., Crisp, G., Dolan, E. L., & Wuetherick, B. (2017). Mentoring in higher education. *The SAGE Handbook of Mentoring*, 20, 316-334.
- Merriam, S. B., & Tisdell, E. J. (2016). *Qualitative research: A guide to design and implementation* (4th ed.). Jossey-Bass.
- Montgomery, B. L. (2017). Mapping a mentoring roadmap and developing a supportive network for strategic career advance-

- ment. *SAGE Open*, 7(2). <https://doi.org/10.1177/2158244017710288>
- Montgomery, B. L. (2018). From deficits to possibilities: Mentoring lessons from plants on cultivating individual growth through environmental assessment and optimization. *Public Philosophy Journal*, 1(1), doi:10.25335/M5/PPJ.1.1.
- Mullen, C. A., & Klimaitis, C. C. (2021). Defining mentoring: a literature review of issues, types, and applications. *Annals of the New York Academy of Sciences*, 1483(1), 19-35. <https://doi.org.10.1111/nyas.14176>
- Nabi, G., Walmsley, A., Mir, M., & Osman, S. (2025). The impact of mentoring in higher education on student career development: a systematic review and research agenda. *Studies in Higher Education*, 50(4), 739-755. <https://doi.org/10.1080/03075079.2024.2354894>
- Oddone Paolucci, E., Jacobsen, M., Nowell, L., Freeman, G., Lorenzetti, L., Clancy, T., Paolucci, A., Pethrick, H., and Lorenzetti, D.L. (2021). An exploration of graduate student peer mentorship, social connectedness and well-being across four disciplines of study. *Studies in Graduate and Postdoctoral Education*, 12(1), 73-88. DOI:10.1108/SGPE-07-2020-0041
- Patton, M. Q. (2015). *Qualitative research & evaluation methods* (4th ed.). Sage.
- Pfund C, Byars-Winston A, Branchaw J, Hurtado S, Eagan K. 2016 Defining Attributes and Metrics of Effective Research Mentoring Relationships. *AIDS Behavior*, 2016 Sep;20 Suppl 2(Suppl 2):238-48. doi: 10.1007/s10461-016-1384-z.
- Saldaña, J. (2016). *The coding manual for qualitative researchers* (3rd ed.). Sage.
- take, R. E. (1995). *The art of case study research*. Sage.
- Thomas, N., Bystydzienski, J., & Desai, A. (2015). Changing institutional culture through peer mentoring of women STEM faculty. *Innovative Higher Education*, 40, 143-157. DOI:10.1007/s10755-014-9300-9
- Tracy, S. J. (2010). Qualitative quality: Eight "big-tent" criteria for excellent qualitative research. *Qualitative Inquiry*, 16(10), 837-851. <https://doi.org/10.1177/1077800410383121>

Appendix

Table 1:
Participants demographic information

Pseudonym	Gender	Ethnicity	Role	Institution [Pseudonym]
Zach	male	Caucasian	Doctoral graduate student	Bahamas University
Meena	female	Caucasian	Masters graduate student	University of Excellence
Charles	male	Black / African American	Doctoral graduate student	St Kitts University
Polly	female	Caucasian	Postdoctoral scholar	University of Knowledge
Annie	female	Black / African American	Early career scientist	Bahamas University
Brandy	female	Caucasian	Masters graduate student	The Fancy Center
Thomas	male	Caucasian	Doctoral graduate student	St Kitts University
Quinn	female	Mixed [Asian, Caucasian]	Doctoral graduate student	Bahamas University
Shaya	female	Asian	Masters graduate student	University of Knowledge
Moses	male	Caucasian	Technician/ Post baccalaureate	The fantastic Institute
Winnie	female	Caucasian	Masters graduate student	Fiji State University

Table 2.1.
Core Theme 1: Relational Support & Identity Formation

Categories	Illustrative quotes
Mentor as gateway to discovery	“Working with a postdoc on putting together a trait database for the state flora that was a big moment for me and a big experience.” Zach
Recognition of unique thinking	“My undergraduate advisor said that the way I answered my test questions made him think that I thought differently about research.” Annie
Identity-affirming mentorship at an early career stage	“ I had asked one of my professors for a letter of [rec] for an REU program in my sophomore year for the upcoming summer and he’s like yeah sure i can write you a letter but i also am looking for a student to do research, would you be interested? and like you think i’m good enough to do research okay.” Meena
Identity- congruent mentoring	“My undergraduate advisor he’s a Mexican-American man, there are lessons he imparted on to me, like how to make it through and reach the goals I’m looking for.” Annie

Relational Mentorship as Motivator for Academic Persistence and Identity Formation	"My advisor in undergrad was hugely supportive. She was really available and had weekly meetings with me, which, as an undergrad, was really influential, made me feel like even though professors are busy, that she really cared about the people working in her lab." Brandy
Mentor Validation as a Catalyst for Motivation and Persistence	"I had an internship mentor my senior year who kind of blew me away with how much she knew about things. If she were to compliment me about certain things or say I could see me doing well on certain things, I'd be like, nice and that would just kind of reinforce my capacity to be able to keep on pursuing that thing, I'd try harder." Moses
Reflective Career Mentorship Through Expertise, Validation, and Calm Presence	"This agroforestry professor, he was the first person I could ever talk to about agricultural-related things. And he seemed to understand it. And not only that, he seemed to think that a lot of the thoughts I was having were valuable. I really admired the way that he seemed to be able to listen. And he just had a pretty calm demeanor." Moses
Disillusionment with Industry and the Role of Negative Mentoring in Career Redirection	"The advisor that I had in industry was influential in that he made it pretty clear that I did not want to work in industry, because I didn't enjoy the risk of putting a bunch of effort into a project, and then just being told not to work on it anymore" Brandy
Adaptive and Individualized Mentorship as a Model for Developing Mentoring Identity	"He knew that I needed to be prompted every day to have to tell him and justify what I was spending time on, because he knew I could get caught up in rabbit holes if not prompted and so he was really good at identifying those little day-to-day things that each one of us needed, and that has been impactful." Brandy
Mentorship Encouraging Independent Exploration and Creativity	"Even in psychology, I always had advisors who let me pursue different kinds of ideas and kind of be creative with it. That helped me broaden my experience to the point where I thought I could switch fields." Thomas
Enthusiastic and Respectful Knowledge Sharing Fosters Positive Learning Culture	"He presented this information generally in a way that felt very enthusiastic, and in a way that never felt condescending, like he just enjoyed teaching it to us" Moses
Reciprocal mentoring and personal connection with mentors	"My mentors put a lot of time into developing a relationship with me and reciprocating the interest I had in their work." Winnie
Personalized and Identity-Affirming Mentor Selection	"My advisor emailed me and said, 'I read your application and I want you to be my advisee.' It was pretty non-traditional but we identified with each other in a lot of ways." Winnie
Mentoring that Builds Academic Confidence & Self-Efficacy	"From the very beginning, he identified my capacity to do work. He had confidence that I could do it. "Shaya
Mentoring as Holistic Support for Social Wellbeing	"He was a person other than, I mean, more than a mentor. He was a friend to me, and for my husband as well. When I broke my knee, he was like, okay, I can call your instructor, and ask for some extra days to do the final. Just take your time, heal first, come back with full energy when you are able. The work will be there, but you don't need to stress about that." Shaya

Table 2.2*Core Theme 2: Skill Development, Research Autonomy & Career Progression*

Categories	Illustrative quotes
Skill-based mentorship through job roles	"And then the person I worked for as a lab manager, he really mentored me through a lot of the management aspects of what it means to run a lab because we forget that you're basically running your own private business. I learned a lot of those skills there. So I learned grant management and like purchasing and all that stuff. And he mentored me through that sort of stuff." Polly
Scaffolded Skill Development	"She also was a really good teacher in terms of actually teaching me things in the lab. I think a lot of people might have just been "Okay, read the protocol. Good luck." But she would show me it. She would watch me do it once and then I'd do it alone once and then after that it was "Okay, so I'm going to assume from this point on that you know what to do, but come find me if you need help." And I think that helped me to gain more confidence in the lab because once you get to graduate school people aren't doing that so much." Quinn
Support for career exploration and transition	"When I had applied for the position I had told my advisor up front I'm interested in being a technician because I want to go to grad school and she was very supportive." Meena
Support for transition to independent research	"It really occurred to me that as a PhD student you are being trained to become an independent researcher to see gaps, design experiments." Charles
Offering research opportunity	"My undergraduate advisor asked me to do research with him, I didn't know where I was barreling toward, he helped me hone in on what I should be doing." Annie
Mentor-supported progression through research roles	"It was really special to get to evolve through the different levels of position, to mentor Paxton when he came in as our post-bac." Winnie
Mentorship fostering grant writing, qualitative research, and independent project development	"My advisor is the perfect fit for me in terms of what I wanted to learn next about working with real people and gathering qualitative data. And I've gained a lot of grant writing experience since I started the program to fund my own research." Winnie
Empowering Autonomy Through Enthusiastic, Knowledgeable Mentorship	" My internship mentor from my senior year, she has this professional enthusiasm and is generally excitable where she was both approachable and very clearly knowledgeable in her field. She gave me pretty much free reign in how I wanted my internship projects. I got to self-teach certain things, and work with some people within that group. She was able to answer, to be honest, a lot of, like, larger-scale questions that I was curious about that no one had really been able to answer before." Moses
Prioritizing Scholarly Communication and Grant Writing as Foundational Academic Mentorship	" My first paper I wrote myself with a lot of guidance from him. And the same is true of the first grant that I wrote. During my time in his lab, he walked me through that. He also gave me feedback on the postdoc grant that I eventually submitted. Because papers and grant writing are a big part of an academic career. He spent more time on that than, sort of, some of the hard skills that I think some of my colleagues wanted for, like, bullet points on their resumes that would be better for." Brandy

Mentorship Influence on Publishing Philosophy and Career Development: Impact of Advisor's Publishing Approach on Trainee Career Outcomes	" my postdoc advisor was influential in the way that I think about scientific publishing. He had this idea that nothing was ever gonna be good enough to publish, and so you have to just go with whatever comes together eventually, and that led to huge delays in publication while he tried to cobble together something that was bigger, involving more people. And I feel like that had some negative impacts on my own career, because I didn't get very many publications out of my postdoc, and other careers that I saw go through his labs. And so that has been super influential to me, when and if I have my own lab, I definitely want to make sure my students feel comfortable with the kind of publishable units of science that they can produce on their own, so that everyone's career moves forward at a reasonable pace." Brandy
Mentors Offering Confidence-Building and Early Research Access	"She was a major influence, because it was a combination of letting me participate in research that I had no experience in and giving me a lot of responsibilities, and then also building my confidence that I could do that kind of stuff." Thomas
Mentoring that Encourages Career Progression & Research Autonomy	"I was handling data from 3 separate projects, while doing that, I did the big planning for the plant soil feedback experiment." Shaya

Table 2.3
Core Theme 3. Mentorship Networks & Peer/Community Supports

Categories	Illustrative quotes
Mentor advocacy and connection to broader networks	"My advisor didn't have a background in soil or ag either, but she put a lot of time and effort into connecting me with the right people." Winnie
Mentorship as access to a broader ecosystem	"And Doctor Cox also opened up my network, gave me access to more networks. For instance, a mentorship program for graduate students in Midwest, I applied for that program, and I got selected" Charles
Peer and near-peer mentorship	"I learned a lot from my peer groups, I had a lot of friends who weren't just in my department but were in other departments. They taught me how to do science because they all had their own strategies for dealing with their dissertations and their thesis." Polly
Peer-based informal mentorship	"I had the opportunity to speak more with other young researchers within Midwest, and that has been a huge opportunity for me to build a network in this space, meeting other grad students working in this space" Charles
Mentors Facilitating Professional Networks & Field Visibility	"Networking opportunities at conferences or just introducing me to people I never would have talked to otherwise. When someone else vouches for you, it makes a huge difference." Thomas
Mentorship outside of direct supervisors	"None of my bosses were my mentors, right? It was all those other people who were around me. I remember going and talking to some of the other faculty members deciding whether or not this was right for me. Obviously, that's not a conversation you can really have with the person who you're working directly for. And they were incredibly helpful." Polly
Mentors Supporting Community-Building and Collaborative Belonging	"Sometimes you go to a conference, and you don't have to think about who to talk to because others in your lab introduce you to people. It makes a difference." Thomas

Table 2.4
Core Theme 4: Structural & Programmatic Mentoring Approaches






Categories	Illustrative quotes
Financial and institutional navigation support, reciprocal mentoring	"I wasn't as informed as I would have liked to have been, it is something that informs the way I advocate for particularly students in our program and how students are treated and how their time is valued." Zach
Open-door policies, holistic advising, and proactive faculty engagement	"My undergrad, i went to smaller institution the professors would develop one-on-one relationships with their students and they always had an open door in their office and i could walk in ask them about something from class or ask them how do i make decisions in my life and they were happy to just take the time to sit down and chat". Meena
Multi-mentor model	"Doctor Lax, I reach out anytime I have challenges. Doctor Lenny, was very instrumental and helpful" Charles
Modeling Mentorship	"She helped me see how to mentor others. Now I try to explain things explicitly, ask people to explain back, and not assume they know."Quinn
Structured, Predictable Mentoring Approach that Reduces Stress & Builds Belonging	"We had weekly meetings every week with him, we just planned the upcoming weeks in that meeting." Shaya
Mentors Providing Constructive, Specific Feedback	"The biggest things that have helped me are letting me learn new stuff and providing feedback on everything, giving concrete ideas for what I did wrong and what I did right." Thomas
High Expectations and Experiential Teaching as Drivers of Academic Engagement	" The academic director of my study abroad program had very high expectations of our academic performance, had a lot of respect for good quality work. I liked having that academic style of very clearly knowing that there were high expectations of the work that I did. Especially with the fact that we're studying away in another country." Moses

Table 2.5
Core Theme 5: Culturally responsive mentoring, normalizing vulnerability, fostering resilience and transparency

Categories	Illustrative quotes
Guidance on navigating dominant culture	"My undergraduate advisor, he gave me advice like how you play the game to get where you need to go, we're not often taught about those kinds of cultures and systems." Annie
Proactive Guidance & Transparency	"I was working with a post-doc who was really great and cared a lot about mentoring me. I think she's a lot of the reason that I even ended up in grad school just because I find for me it was a very opaque process. I had no idea how you apply to get a PhD and probably wouldn't have gotten started early enough on it or had been as almost regimented about it without her helping me. And she really helped me to figure out my research interests just by asking me questions that I wouldn't have thought to ask myself." Quinn

Mentoring through identity representation that helped normalize difficulty, built resilience	“My undergraduate thesis mentor, a postdoc, working with him was eye-opening because he was very open about the process being hard and talked a lot about there being blood, sweat and tears in every single paper that he’s ever written and he talked about being the type of person that nobody would have expected to get a PhD. I think he was pretty influential in the sense that he made it accessible for me. I was just like anyone can really do this. You just have to be willing to work hard and be resilient to be able to do it.” Polly
Normalizing vulnerability and uncertainty in STEM	“My graduate advisor said to me, “Well, I don’t know much about mycorrhizal fungi right now, but I can learn with you” Meena

Figure 2:
Mapping the salient themes from mentoring strategies to Keyes’s dimensions of social wellbeing

Mapping Mentoring Themes to Keyes' Dimensions of Social Well-Being					
	 Social Integration	 Social Acceptance	 Social Contribution	 Social Actualization	 Social Coherence
Relational Support & Identity Formation	✓	✓	✓	✓	✓
Skill Development, Research Autonomy & Career Progression	✓			✓	✓
Mentorship Networks & Peer/Community Supports	✓	✓	✓	✓	✓
Structural & Programmatic Mentoring Approaches	✓	✓	✓	✓	✓
Culturally responsive normalizing vulnerability,	✓		✓	✓	✓