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Learning while Leading: Graduate Students as Mentees and Mentors in Multi-Level RIEF Mentoring and the Impact of Guidance in Engineering Education

Dr. Ayatollah S Yehia, University of Virginia

Ayatollah (Aya) Yehia is a postdoctoral research associate at the University of Virginia. She received her B.S. in Civil Engineering from the American University of Sharjah in Sharjah, United Arab Emirates, a MSc in Civil Engineering (concentration: Transportation Engineering) from the University of British Columbia in Vancouver, Canada and a PhD in Systems Engineering from the University of Virginia.

Prof. Devin K. Harris, University of Virginia

Dr. Harris is a Professor and Chair within the Department of Civil Engineering and Environmental Engineering at the University of Virginia (UVA). His research and teaching interests focus on large scale infrastructure systems with a primary focus on condition monitoring and system performance. His research leverages image-based measurement techniques, simulation, visualization, and data analytics with applications in the areas of structural health monitoring, smart cities, and digital twins.

Dr. Diana Bairaktarova, Virginia Polytechnic Institute and State University

Dr. Diana Bairaktarova is an Assistant Professor in the Department of Engineering Education at Virginia Tech. Through real-world engineering applications, Dr. Bairaktarovaâ€™s experiential learning research spans from engineering to psychology to learning

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Abstract

The National Science Foundation's Professional Formation of Engineers: Research Initiation in Engineering Formation (NSF PFE: RIEF) provides opportunities for experienced engineering education faculty to mentor engineering faculty new to engineering education research. Through this process, graduate students working on the RIEF project with the mentee faculty member are also indirectly mentored, which may differ from the graduate student's dissertation focus. This additional mentorship has the potential to impact not only the graduate student but also the undergraduate students they mentor. This multi-level mentoring has not been previously examined in the context of RIEF. This can provide insights on how to mentor others at different stages of their professional careers and outside the mentor's area of expertise.

This work examines a case study of mentorship dynamics through the lens of a graduate student who was indirectly mentored during the RIEF grant and the experiences of learning how to conduct social science research. The RIEF project evaluated the effects of introducing augmented reality in undergraduate structural engineering classrooms. This augmented reality application required development from computer science undergraduates, who were mentored by the graduate student. While the undergraduate students were not directly part of the RIEF meetings, the graduate student's insights on those meetings shaped how RIEF research was conducted, which created an unintentional mentoring chain from the faculty mentor to the undergraduate students.

Drawing on a retrospective autoethnography informed by meeting artifacts from the duration of the RIEF project, this work uncovered themes of graduate student positioning in RIEF projects, learning through uncertainty and growth, and resilience. These themes suggest key takeaways: a) intentionally positioning graduate students to be directly mentored through RIEF, and b) mentoring other students may best incorporate graduate students into RIEF and similar mentoring grants. The goal is to position graduate students as intentional, instrumental contributors to grant success and their own professional development, and not accidental beneficiaries. By understanding this effect, faculty mentors can improve project structures to maximize learning and impact at every level of the mentoring chain.

Introduction

Engineering education is central to the work of all engineering faculty, whether they engage with it through the classroom as instructors or as researchers established in engineering education research (EER). However, conducting EER can be difficult for traditional engineering faculty, as it requires applying social science methodologies, including qualitative and mixed methods approaches [1]. For faculty members who are interested in pursuing EER and do not have experience conducting social science research, the U.S National Science Foundation offers the Research Initiation in Engineering Formation (RIEF) program, which pairs faculty mentees with experienced engineering education research mentors [2].

While the primary goal of RIEF is to mentor faculty members, graduate students are often included on the grant for additional support. Previous work has explored how graduate students have contributed to RIEF and how they felt during the mentorship process through collaborative autoethnographies [1], but limited work has explored the relationship between these graduate students and the undergraduates they mentor on RIEF projects. Exploring how graduate students are mentored through RIEF and how they create an unintentional mentoring chain to undergraduate students can reveal insights into how graduate students may benefit from intentional inclusion on mentoring grants like RIEF, and how mentoring undergraduates may contribute to a broader network of support.

This work explores how a systems engineering graduate student with a background in civil engineering (Author 1) experienced a two-year RIEF project and how Author 1's experience shaped the mentorship of the undergraduate students working on the project. Through a retrospective autoethnography and discussion of emerging themes, this work aims to understand how graduate students might be more fully integrated into RIEF mentorship structures.

Mentorship Models

Two mentorship models from the literature are particularly relevant to RIEF. The first is Eby et al.'s [3] process-oriented mentoring model, which emphasizes three core components: instrumental support, where mentors provide information and skill development; psychosocial support, where mentors offer encouragement; and relationship quality, which reflects the interpersonal bond between mentor and mentee [1]. This model also accounts for contextual factors such as interaction frequency, relationship duration, and social capital [4].

The second is Dennen and Burner's [4] cognitive apprenticeship model, which frames learning as a process of observing experts before gradually taking on authentic tasks [5]. In this model, mentors and a broader community of practice guide the learner through scaffolding, such as targeted feedback, and fading, a gradual reduction in support as the learner gains competence [1].

Methodology

To understand the mentorship dynamics experienced by Author 1, a retrospective autoethnography was conducted. Retrospective autoethnographies study past experiences through

current socioeconomic lenses, while acknowledging the limitations of recollection and memory [6]. Artifacts for this study included meeting notes from August 2023-May 2025, documentation created to evaluate student learning, such as rubrics, the mobile application that was the focus of the RIEF project, and two conference presentations from 2024 and 2025. In total, 42 meeting notes were collected across five categories: 3 undergraduate team meetings (approximately 30 minutes each); 11 meetings with the RIEF mentor (Author 3) and mentee (Author 2), lasting at least one hour each; 8 meetings with external organizations developing the mobile application, each lasting at least one hour; and 19 meetings with Author 2, who also served as Author 1's PhD advisor, lasting at least one hour each. While these 19 meetings were not solely about RIEF, a meeting was counted if it included discussions about study design, the mobile application, or tasks for the undergraduate students. Beyond formal meetings, 552 Discord messages related to the project were exchanged between Author 1 and the three undergraduate students, and approximately 17 additional informal undergraduate meetings occurred without written notes. An IRB protocol was obtained to permit thematic review of these messages as artifacts. Two of the three undergraduate students consented to inclusion of their messages, yielding 361 of the 552 messages for analysis; messages from the third student were excluded per IRB consent. Author 1 reviewed the consenting students' messages and grouped recurring content into categories to supplement the autoethnographic findings. The reviewed exchanges centered on deadlines for app rollout, clarifications about finite element and Unity models, and technical troubleshooting. These categories reinforced the themes generated from the autoethnography rather than producing new ones.

Figure 1 provides a timeline of the RIEF project and summarizes the artifacts used in the retrospective autoethnography; blue backgrounds indicate periods when interactions with undergraduate students occurred, whether in person or on Discord. Figure 2 illustrates the mentorship chain from Author 3 (RIEF mentor) to the three undergraduate students. Author 2 had a pre-existing mentorship relationship with one undergraduate student, who was already a member of Author 2's lab; the other two were hired specifically to develop the AR application.

The retrospective autoethnography was written in January 2026 and totaled about five pages. Author 1 analyzed the autoethnography through reflexive thematic analysis [7, 8], iteratively reading and annotating phrases and passages to generate preliminary codes (e.g., isolation, power dynamics, support networks, resilience, uncertainty). These codes were grouped into three overarching themes. Co-authors reviewed the final manuscript for clarity. Artifacts, including meeting notes and project documentation, were consulted to verify Author 1's recollection and to deepen reflection on specific events. Trustworthiness was supported through data triangulation across multiple artifact types and researcher reflexivity embedded throughout the autoethnographic writing and analysis, in which Author 1 critically examined their own assumptions, positionality, and emotional responses to experiences [8–10]. The timeline in Figure 1 and the collected artifacts provided structure for the autoethnography, which was guided by the following research questions:

1. What support is available to graduate students working on RIEF projects as secondary participants?
2. How do graduate students experience mentorship on RIEF projects when positioned as

secondary participants, and how might this shape their own mentoring practices?

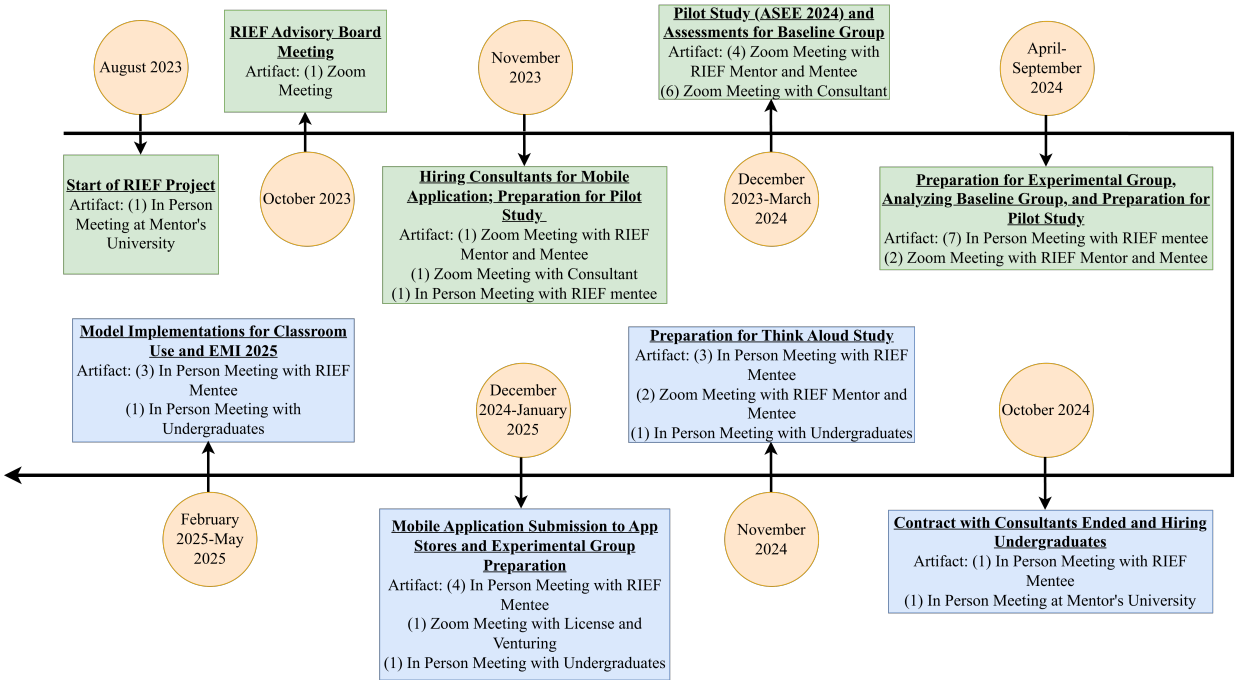

Figure 1: Timeline and Artifacts of the RIEF Project

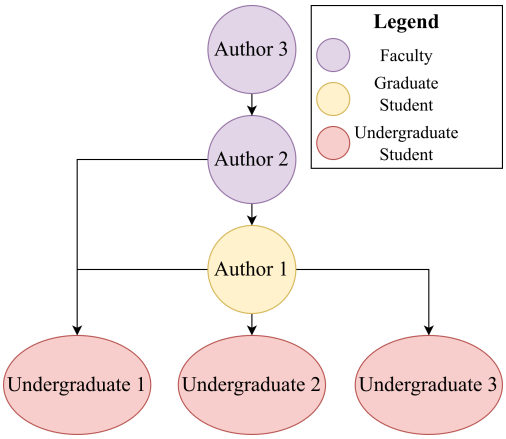

Figure 2: Multi-level Mentorship Chain of the RIEF Project

Results

From analyzing the autoethnography, three main themes emerged: a) graduate student positioning in RIEF projects; b) learning through uncertainty; and c) resilience and growth. Each of these themes is explored in the following sections, with selected quotes providing additional context and examples.

Graduate Student Positioning in RIEF Projects

Value of the Advisory Board

By design, RIEF projects aim to mentor the faculty member, who will become a member of the EER community and conduct research. Graduate students are written into proposals to receive funding support and contribute to the work required for the project. As a result, graduate students on RIEF projects are not necessarily included in meetings or directly mentored by the RIEF mentor. For this project, Author 1 attended most meetings where the mobile application was discussed with Author 2 and Author 3, and had the opportunity to attend the advisory board meeting. Author 1 noted the following about the advisory board meeting:

"The advisory board meeting was one of the most helpful parts of RIEF. The Zoom felt supportive... all the questions I had were answered... Having 4 other faculty members in the meeting wanting to make the project better was amazing, especially since they all had some sort of structural engineering experience... The advisory committee helped explain what a concept inventory is...and provided resources on how to create our own... This felt like actionable work that was not overwhelming..."

Power Dynamics

While RIEF projects often involve power dynamics between the faculty mentor and mentee [11], Author 1 experienced a shift in the standard advisor-student dynamics. Although Author 2 was Author 1's PhD advisor, both were novices in EER, which placed them on similar footing with the RIEF project. Author 3, as the experienced RIEF mentor, guided both. Author 1 reflected on the collegial relationship with Author 2:

"While [Author 2] was also my PhD advisor...it was fascinating to see [Author 2] also be a mentee like I was and be on an even playing field in a way for this project. I noticed this more when we would try to design activities such as the think-aloud, and we'd step through it together...We iterated several times over the think-aloud, changing how students would answer questions...it made me feel like part of a team."

As the only graduate student actively working on the RIEF project and one without prior experience in social science research, Author 1 often needed additional help, for example, with crafting consent forms for the IRB or designing pilot studies. Author 1 and Author 2 were at a university without an engineering education department, and communications with Author 3 were primarily virtual. Given the power dynamics and distance between Author 1 and Author 3, Author 1 pursued a more independent approach to the research. Author 1 reflected on this experience:

"Sometimes I wonder how my experience would've improved if there was an engineering education graduate student, if someone with the same level of academic standing was accessible for questions, rather than the power dynamic I found myself in."

Building Community Outside RIEF Structures

This independent research dynamic led Author 1 to create an unconventional network of support. In October 2024, three computer science undergraduate students were recruited to expand the features of the mobile application after the previous consultants' contract ended. These undergraduate students had limited experience with Unity, the software platform used to develop

the mobile application, and were required to navigate documentation left by alumni of Author 2's lab group. Because the mobile application required understanding the basics of finite element modeling for mesh formation, Author 1 found themselves explaining an unfamiliar field to newcomers, mirroring the mentoring relationship between Author 3 (EER expert) and Author 1 (mentee). Author 1 described the relationship with the undergraduates as follows:

"However, maybe because I saw myself in those undergraduate students I was mentoring, I made myself extremely available, potentially emulating the behavior I wish I experienced during my own EER experience. Undergraduate students met me every week with frequent Discord messages over the course of the week...While the students weren't directly helping with the EER data (not evaluating student data), I did feel some of the solidarity that I was searching for in terms of RIEF. One example was jumping on a Discord voice call at 1 am, talking with one of the undergraduate students about a finite element model I just finished creating, and leaning on them for help for placing the scenario elements and compiling the build. It was a dynamic, vibrant conversation, as messages were exchanged rapidly against the ticking clock of an Apple App Store deadline for class on Wednesday afternoon. This felt different than the EER mentorship, as I was coworking side by side with someone who had a different academic standing than me, where I held the power in the relationship, but it felt more like colleagues and a partnership in that moment..."

This was also evident in the Discord messages, where the students would walk Author 1 through file structures on Unity, while Author 1 would explain how finite element model numbering worked. Unlike a traditional mentor-mentee exchange, where expertise typically flows from higher to lower academic standing, the undergraduate students here held technical authority that Author 1 depended on, reinforcing the collegial rather than hierarchical nature of the relationship.

Beyond the undergraduate students, Author 1 also relied on support from the IRB office. With guidance from Author 3, Author 1 submitted several IRB protocol modifications throughout the RIEF project. However, due to the physical distance, Author 1 required additional help with submitting these documents. One source of support was the IRB office at the University of Virginia, where Author 1 and Author 2 worked. Author 1 reflected on this relationship with the IRB Compliance Analyst:

"I could call the university's IRB and discuss how I can conduct my study. I think the reassurance of knowing what I'm doing and removing the uncertainty of venturing into the unknown field of EER really helped."

Author 1's dual positioning as both mentor and mentee during RIEF created several moments of learning through uncertainty. This was shaped by the physical distance between Author 1 and Author 3 and by RIEF's primary focus on faculty mentorship. Key moments are discussed below.

Learning through Uncertainty

Navigating Unfamiliar Research

Author 1 experienced uncertainty in social science research, as their dissertation did not involve human subjects or pilot studies. This led Author 1 to feel significant uncertainty about creating

pilot studies and recruiting participants, particularly because impactful research required human data. Author 1 reflected on this aspect of EER:

"As an experimental researcher, the only part of research I had to worry about was whether my equipment was working and if my samples were in place. I didn't have to worry about not having data since I was in control of that, but with social science data, I was at the whim of my participants. I had planned for a pilot study...only to have no participants and no data... While [Author 3] kept cheering us on, providing support and reassuring us that this was the nature of behavioral research, I only found a little reassurance..."

The fear of not being able to redo studies or access additional participant data also contributed to Author 1's uncertainty about EER. Author 1 noted the following:

"[Codebooks] were something like what I was doing with regards to my machine learning data, but there were much higher stakes. With machine learning, if you forget to include a feature, you can go ahead and extract that from your simulated or experimental data. With social science research, if you forget to do that, you need to obtain permission from the IRB, somehow chase the participants down again (which wouldn't happen). That might have contributed to my fear of EER research; not only was I in a new space, but if I didn't get it right, there would be no second chances..."

Developing Expertise

Through this uncertainty, Author 1 learned and began to see themselves as a colleague to Authors 2 and 3. One such experience involved creating rubrics to assess student learning:

"Creating the rubric was one of the most difficult tasks that I had to do since I had no frame of reference to go about. While ANSYS models had YouTube tutorials and spatial visualization was the EER mentor's area of expertise, rubrics were different...I found it oddly therapeutic once I developed a system...In the chaos that was RIEF and learning new EER terms and procedures, creating the rubric was the calm... maybe because [Author 2 and 3] trusted me as a colleague."

Through this learning process, Author 1 grew as an independent researcher while completing their dissertation and developing expertise in the EER space. Some of these reflections are below.

Resilience and Growth

Becoming an Independent Researcher

Author 1 created a network of mentors and collaborators to build a sense of solidarity and support their learning through uncertainty. Through this process, Author 1 developed resilience and experienced significant growth. Author 1 reflected on this:

"And while the [RIEF] mentoring experience was a little daunting, since I was expected to know a lot about the terminologies, it did teach me how to be a more independent researcher and have some confidence in myself."

Experiencing Research Impact

Author 1 also reflected on growth through research impact, particularly the mentorship of undergraduate students and the pilot studies:

"Doing the one and only successful pilot study of the RIEF project was incredibly rewarding... With my traditional civil engineering research, I didn't really get to see the direct impact of my machine learning algorithm...But with social science research, I could interact with my subject matter, ask them questions, engage in discussions, and understand how to make the app better with different perspectives... Seeing one participant's face...lit up using the application warmed my heart, because it felt like the research was making an impact...It made the work more impactful to me and more fulfilling..."

For Author 1, experiencing this research impact firsthand helped with learning through uncertainty and fostered a feeling of belonging in RIEF. Further discussion of lessons learned and how this experience relates to other graduate students in RIEF can be found in the following section.

Discussion

This work reflected on the experience of Author 1, who was a systems engineering graduate student with a background in civil engineering, during the two-year RIEF period, and how that experience shaped their perception of engineering education research and mentoring relationships. Author 1 served as both a mentee to Author 2 and Author 3 and a mentor to three computer science undergraduate students working on the project, which contributed to the network of support Author 1 needed to feel welcomed in the EER space.

Through a retrospective autoethnography using meeting note artifacts, themes of graduate student positioning in RIEF projects, learning through uncertainty, and resilience and growth were uncovered. While RIEF-related subthemes such as power dynamics, fear of social science research, and mentees navigating how to mentor graduate student peers are documented in the literature [1, 11], subthemes of alternative networks and support are limited, particularly when the graduate student is mentoring undergraduate students on elements of the project. From Author 1's experience being mentored, lessons were learned on how to mentor students unfamiliar with a field, and how a cooperative mentoring relationship can foster community and a sense of purpose.

Connecting Themes to Mentorship Models

The mentorship models previously presented were evident in this RIEF project, though applied differently across the chain. Author 3 mentored both Author 1 and 2 using elements of the process-oriented model (encouraging social science research, biweekly interactions with Author 1, weekly with Author 2) and the cognitive apprenticeship model (extended in-person meetings at the start of each phase, with reduced scaffolding as learners gained competence). However, Author 1 mentored the undergraduate students primarily through the process-oriented model, providing instrumental support (civil engineering knowledge needed to code the AR app), psychosocial support (encouragement and availability), and relationship quality (treating undergraduates as colleagues working toward a shared goal). This difference may reflect the undergraduate students' position as newcomers to both the project and the technical domain,

requiring sustained support rather than the gradual fading characteristic of cognitive apprenticeship.

Recommendations for RIEF Program Designers

Based on this experience and the findings of other graduate students [1], the following structural changes are proposed to better support graduate student mentees:

1. Position graduate students as direct RIEF mentees: Graduate students often handle day-to-day research tasks, such as IRB protocols or analyzing participant data. For graduate students who are unfamiliar with EER research, this can be challenging to navigate as RIEF mentors have limited time and may be geographically separated from mentees, while faculty mentees are themselves EER novices like the graduate student [1]. This contributes to feelings of uncertainty and lack of support. RIEF proposals should explicitly include graduate students in mentoring plans, with designated meeting times and clear expectations for mentor support.
2. Encourage multilevel mentoring chains that include undergraduates: For Author 1, significant moments of belonging included working sessions with undergraduate students. Having graduate students mentor others involved in the project may contribute to a sense of support and create a network for collaboration.

Conclusion

This case study examined how a graduate student (Author 1) experienced a RIEF project as both mentee and mentor. Through mentoring undergraduate students, Author 1 developed a sense of belonging and support. This experience aligns with mentoring literature documenting that mentoring is a two-way relationship with the potential to motivate the mentor [12].

These findings suggest that graduate students should be positioned as intentional contributors to RIEF projects, attending meetings and being mentored by the RIEF mentor through direct communication [12]. Including undergraduates to form a multi-level chain can also benefit graduate students by creating a network rather than working in a silo.

Several limitations should be noted. First, this work is a single case-study on a multi-level mentoring chain where the RIEF mentors indirectly mentor the undergraduate students through the graduate student. Other case-studies following a similar chain may yield alternative findings. Second, using a retrospective autoethnography introduces the limitation of the researcher's experiences affecting how information is presented [6]. Third, the perspectives of the undergraduate students on the mentorship model were not evaluated.

Future work aims to address this third limitation by including the perceptions of undergraduate students being mentored during this process and how this affects their perceptions of mentorship and EER, extending the multi-level mentorship perspective beyond the graduate student's experience.

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References

[1] J. P. Martin, D. E. Suresh, and P. A. Jensen, "Using collaborative autoethnography to investigate mentoring relationships for novice engineering education researchers," *International Journal of STEM Education*, vol. 11, p. 13, Feb. 2024.

[2] "PFE: Research Initiation in Engineering Formation (PFE: RIEF) | NSF - U.S. National Science Foundation," Mar. 2020.

[3] L. T. d. T. Eby, T. D. Allen, B. J. Hoffman, L. E. Baranik, J. B. Sauer, S. Baldwin, M. A. Morrison, K. M. Kinkade, C. P. Maher, S. Curtis, and S. C. Evans, "An interdisciplinary meta-analysis of the potential antecedents, correlates, and consequences of protégé perceptions of mentoring," *Psychological Bulletin*, vol. 139, pp. 441–476, Mar. 2013.

[4] V. P. Dennen and K. J. Burner, "The Cognitive Apprenticeship Model in Educational Practice,"

[5] J. Brown, L. Smith, K. Kennedy, F. Beyette, and J. Martin, "BOARD # 387: Learning the Ropes Together: A Collaborative Autoethnographic Study of an Unconventional RIEF Mentoring Model," in *2025 ASEE Annual Conference & Exposition Proceedings*, (Montreal, Quebec, Canada), p. 55760, ASEE Conferences, June 2025.

[6] P. Kairns, Lisahunter, and K. Lambert, "Navigating queer spaces in Australian tertiary STEM Education: a retrospective autoethnopoetic exploration," *Ethnography and Education*, vol. 19, pp. 114–134, Apr. 2024.

[7] V. Braun and V. Clarke, "Using thematic analysis in psychology," *Qualitative Research in Psychology*, vol. 3, pp. 77–101, Jan. 2006. _eprint: https://doi.org/10.1191/1478088706qp063oa.

[8] V. Braun, V. Clarke, N. Hayfield, L. Davey, and E. Jenkinson, "Doing Reflexive Thematic Analysis," in *Supporting Research in Counselling and Psychotherapy : Qualitative, Quantitative, and Mixed Methods Research* (S. Bager-Charleson and A. McBeath, eds.), pp. 19–38, Cham: Springer International Publishing, 2022.

[9] H.-H. Huynh and L. Pretorius, ""Inspired to be a teacher seriously": An autoethnography of student engagement in a Vietnamese TESOL training programme," *TESOL in Context*, vol. 33, pp. 4–24, Aug. 2024.

[10] C. Ellis, T. E. Adams, and A. P. Bochner, "Autoethnography: An Overview," *Historical Social Research / Historische Sozialforschung*, vol. 36, no. 4 (138), pp. 273–290, 2011.

[11] J. Mirabelli, A. Barlow, M. Ko, K. Cross, and K. Jensen, "Work in Progress: A Qualitative Study of Mentorship, Training Needs, and Community for New Engineering Education Researchers," in *2020 ASEE Virtual Annual Conference Content Access Proceedings*, (Virtual On line), p. 35601, ASEE Conferences, June 2020.

[12] P. Jensen, J. Martin, and D. Suresh, "Perceptions of shared experiences in mentoring relationships: a collaborative autoethnography," in *2022 ASEE Annual Conference & Exposition Proceedings*, (Minneapolis, MN), p. 41058, ASEE Conferences, Aug. 2022.