



## Work in Progress: A Qualitative Study of Mentorship, Training Needs, and Community for New Engineering Education Researchers

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## **Abstract**

In this Work in Progress paper, we describe the initial insights from our study on mentorship of engineering faculty entering the engineering education research (EER) community. Recent funding opportunities have made it possible for traditionally trained engineering faculty to pursue research interests in EER. One such funding opportunity, the National Science Foundation's Professional Formation of Engineers: Research Initiation in Engineering Formation (NSF PFE: RIEF) grant supports the integration of engineering faculty in EER through mentorship. RIEF awardees are self-selected pairings of experienced engineering education researchers and engineering faculty seeking to enter the field. RIEF PI grantees are engineering faculty who are novice to formalized EER, yet who are experts within their own engineering discipline. Engineering faculty frequently have little experience conducting rigorous research using established social science theories and methods. RIEF mentors are experienced engineering education researchers. Mentorship in the context of a RIEF grant is unique, as it is different from graduate student training or peer mentorship between faculty in the same discipline. Common conceptions of mentorship include a novice receiving guidance from an expert, whereas RIEF PIs and co-PIs are both experts in their own domains. Mentoring relationships between faculty are understudied, especially in the context of faculty with expertise in different disciplines that have unique training needs. Therefore, we have proposed to study mentorship between engineering faculty mentees and EER scholars participating in the RIEF program.

Our study aims to uncover salient factors related to successful outcomes of mentoring relationships, as well as to understand the challenges participants encountered. We leverage in-depth, semi-structured qualitative interviews to better understand the experience of both EER mentors and engineering faculty mentees at various stages of completion on their RIEF project. Through an initial thematic coding analysis of a subset of our interview data, we propose there are several key factors relating to both positive RIEF experiences and challenges within mentorship relationships. These factors include the proximity of researchers (e.g. same institution or different institution), the style of mentorship preferred by mentor and mentee, the ability for mentees to network within the EER community, the academic rank of the mentor and mentee, and the interpersonal relationships between RIEF grantee pairings. The aim of the present work is to illuminate the ways in which these findings resonate within the EER community, as well as to move towards impactful distribution of future results. The outcomes of the study are related to a larger project which will fuse our team's experience hosting workshops, networking with RIEF grantees, and developing training materials for faculty joining the EER community. Developing an understanding of best practices for faculty-faculty peer mentorship can increase the likelihood of success with sustained engagement in EER. Such opportunities are critical to the discipline of EER moving forward, expanding to include those

from diverse professional backgrounds and experiences. Divergent experiences bring critical new perspectives to address the ongoing goal of positively impacting the overall engineering education experience of students.

## **Introduction**

Many skills needed to be an effective engineering faculty member are not explicitly taught [1]. For example, few engineering faculty experience basic training on teaching or mentoring. However, engineers possess the technical and design skills to innovate, recognize deficiencies, and strive for process optimization. These habits are relevant both in engineering labs and in classrooms. As engineering faculty look to translate their technical knowledge and skills into other professional activities, they often become interested in education and social justice in the engineering classroom, and may seek to conduct an intervention, case study, or survey to explore a phenomenon of interest. Unfortunately, a lack of evidence or rigor in their study methodologies may result in limited impact from their findings [2]. Yet, these voices are critical to advancing the engineering education discipline. A primary focus of EER is to better the experience of engineering classroom learners [3]. To integrate the diverse perspective of engineering faculty in the classroom, training is required in social science research norms.

While RIEF mentees range from somewhat familiar to completely novice on explicit social science methods, their background may be leveraged in developing their EER skills. As engineering faculty look to translate their technical knowledge and skills into the social sciences, EER mentors can guide mentees on effective means to apply these skills to achieve new research goals. Yet the mentorship between RIEF grantee faculty will involve negotiating each party's roles while accounting for unique variables (e.g. power dynamics, university responsibilities, promotion opportunities, etc.). Both mentor and mentee faculty may require resources to effectively assume their designated role. Literature addressing faculty mentorship relationships is outdated [4] and does not provide an adequate roadmap of success and pitfalls to avoid. Additionally, both mentors and mentees may experience isolation in their experience of either mentoring another (possibly senior) faculty or transitioning into an entirely different research domain. Work is needed to support the formation of a community that can build upon the success and challenges of other RIEF grantees.

Understanding the best practices of peer mentorship in the context of RIEF grantees can increase the impact of EER as a field, expand the network of EER scholars, and promote the adaptation of research-based instructional strategies in the classroom. These enhancements all support the goal of positively impacting the overall engineering education experience of students. For these reasons, we propose that a study of mentorship between engineering practitioner mentees and EER scholar mentors can improve the quality of new EER research, inform the creation of materials to support EER faculty, and increase the number and diversity of researchers in EER. Through in-depth semi-structured qualitative interviews, the current project seeks to identify successful mentoring strategies between engineering faculty and EER scholars. Secondary

outcomes include understanding the training and networking needs of EER mentees and the mentors' opinions about the direction and deficiencies of EER as a field.

Our sample for this mentorship study includes current and past recipients of the RIEF award. Participants included mentors and mentees that were at various stages of their research projects. Here, we offer initial insights from the early phases of this project exploring mentoring relationships. To date, we have interviewed 18 past and present RIEF mentors and mentees to better understand their relationship. Semi-structured interviews were tailored for mentors and mentees. Early analysis of these interviews has revealed several themes related to successful RIEF mentoring relationships. We present the ways in which mentees increased their familiarity with EER literature and methodologies through mentorship, as well as how they developed connections to the broader EER community through the RIEF grant. Additionally, we discuss the challenges both mentors and mentees faced: cultivating mentorship relationships at a distance and navigating the power dynamics between mentor and mentee. While we anticipate that our work will directly benefit the RIEF program, we envision that this work will positively impact the larger EER community. These findings will leverage the development of workshops, networking, and training materials for faculty joining the EER community.

This work in progress paper reports our study design and provides insight into the ways in which these themes are expressed by participants in the data.

**Research Questions.** The research questions addressed by the current project are as follows:

- What are the characteristics of successful mentorship relationships under the RIEF grant?
- What common challenges that mentors and mentees encounter limit successful outcomes of the RIEF grant?

**Cognitive Apprenticeship Model.** The guiding framework for the research component of this project is the cognitive apprenticeship model (CAM), which consists of strategies used to train novices to develop expertise in their thinking. Unlike typical apprenticeship models, which may describe the relationship between mentors and mentees, or which may describe mentorship for more mechanical skills, CAM theorizes the ways in which novices come to think about a subject with expertise. This process is characterized by situated learning and social support provided by an expert and its processes are metacognitive [5]. While cognitive apprenticeship models are currently employed in the NSF PFE: RIEF program, it has not yet been studied how this model is effective and what components of a mentee-mentor relationship in this context best achieve the desired result of integrating engineering faculty into the EER community. We propose that this transformation occurs as the mentee moves from peripheral observation to active participation including implementing research-based instructional strategies (RBIS) [6], to the scholarship of teaching and learning (SoTL) [7], and ultimately towards becoming an engineering education researcher.

## Methods

**Interview protocol design.** Two related, semi-structured interview protocols were designed for mentors and for mentees. The interview protocols based on the CAM asked participants about three main topics: (1) the nature of the RIEF project in which the participant is involved (*“How did you and your mentor/mentee draft the proposal for this project?”*, *“Describe the structure of meetings you and your team conduct in order to work.”*), (2) the mentoring relationship the participant has experienced from their RIEF teammate (*“How would you describe your mentor’s style of mentorship?”*, *“What sorts of barriers and struggles did your mentee encounter, and how did you overcome them?”*), and (3) the participant’s views, interests, and perceived deficiencies regarding EER as a field (*“What impact would you like for your project to have?”*, *“What kind of training could have supported your mentoring?”*). The interview protocol was reviewed by the project advisory board with mentorship expertise, and then piloted with an engineering education mentor and mentee and an educational psychology mentor and mentee pair outside the study population. The pilot participants and project advisory board offered feedback on the interview design and offered suggestions regarding the interview presentation. The interview protocol was then revised. The order of questions was not strictly adhered to, as some participants chose to answer interview questions directly, and others in a more narrative way befitting an order different from the printed interview schedule.

**Participants.** Participants were selected among RIEF grantees and found by searching the NSF award database. Ninety-six potential participants were identified and contacted via email by the research team and provided with a link to schedule an interview and to complete a short demographic survey. After the interview, participants were asked either verbally or by email to invite their research team, because sets of mentors and mentees provided the richest data in terms of our mentorship research question. In total, 18 RIEF grantees spanning 17 institutions participated fully in the study. Of the 18 participants, 8 mentors and 10 mentees contributed to this study. Of those 18, 17 were involved in ongoing projects, and 13 were in the first year of their project. The participant pool included two sets of paired mentors and mentees and one team of three RIEF grantees comprised of two mentors and one mentee.

The profile of the mentoring relationships (hereby defined as the RIEF project’s composition of mentors and mentees, and the factors which influence their mentoring relationship) varied largely between participants. While the most common RIEF project’s composition contains a single mentor and mentee, in some projects, the pairings are at the same institution and some projects include faculty at separate institutions. Project composition across all RIEF awardees also included grants composed of two pairs of mentors and mentees, of two mentees and one mentor, of two mentors and one mentee, and rarely of other combinations. Permuting the possibilities of different academic ranks, RIEF award dates and work completed, and differences in the mentor’s and mentee’s institutional locations with the project compositions yielded unique profiles of the mentoring relationships for our participants.

**Data collection and analysis.** Data collection was approved by the University of Illinois IRB #19398. The demographics survey was hosted on SurveyMonkey® and consisted of questions about gender, race, ethnicity, socioeconomic background, tenure status, and RIEF project status (mentor or mentee, names of team members). Interview scheduling was arranged via a Doodle poll, and participants were contacted again to confirm interview times. Interviews were generally conducted using Skype for Business, and participants were given the option of connecting via either voice or video and voice. In two instances, participants requested to instead conduct the interview via phone call.

The interview duration was initially intended to be 45-90 minutes but experience with piloting shortened the intended duration to 30-60 minutes, with an intended average time of 40 minutes. The actual interview range was 29 minutes and 48 seconds to 82 minutes and 11 seconds, with an average time of 45 minutes and 21 seconds. Interviews were transcribed verbatim by a professional transcription service, and participants were assigned pseudonyms and randomly generated participant numbers.

We used a grounded theory approach to analyze interview transcripts [8, 9]. First, three team members open-coded five different interviews apiece. The team discussed the major themes and sub-themes discovered during the open-coding process, and then an axial-coding process was used to create a common codebook. In the results section, some crucial themes uncovered during the open-coding are presented. Our team followed the team codebook development process outlined by McQueen and colleagues [10].

## **Results**

We present four primary themes identified during our team's open-coding procedure which are associated with successful outcomes and relationships of RIEF grantee pairs. We hope that aspiring RIEF grantees may consider the implications of these themes while deciding to create a mentoring relationship. This section ends with a summary table listing and defining each theme and providing an example from the interview data. For this Work in Progress paper, we have chosen to present themes which may inform aspiring RIEF grantees about the RIEF experience or about making decisions regarding potential mentoring partnerships:

*Familiarity with EER literature and methods.* Mentee participants working with qualitative data expressed struggles with understanding unfamiliar social sciences approaches, and most mentee participants expressed struggles with finding and interpreting social sciences literature, especially in terms of interpreting theories in social sciences. Several participants identified books or articles handpicked by their mentors to be part of their strongest mentoring experience during their project.

*Connection to the EER community.* Mentees who had engaged with more networking opportunities expressed more confidence and excitement towards the EER community than those who had not. While some participants had negative experiences engaging with the broader EER community, the RIEF grant holistically provided networking opportunities that connected mentees to the EER community. This connection was a factor in the desire to continue to conduct EER.

*Mentoring at a distance.* Some RIEF grantees collaborated across different institutions, including several projects conducted with grantees in different states. These mentoring relationships proved to be some of the most challenging. Mentors and mentees both expressed that an inability to regularly collaborate created challenges in their working relationship.

*Navigating power dynamics of mentorship.* RIEF PIs ranged from junior faculty to tenured faculty and administrators. In some grantee pairs, this creates a mismatch of power between mentor and mentee in their typical roles and in their mentoring relationship. Some participants expressed awkwardness or nervousness about navigating these relationships, while others found the experience rewarding or interesting.

**Table 1:** Summary of themes addressing the experience of RIEF mentors and mentees

	<i>Theme</i>	<i>Description</i>	<i>Example Quotation</i>
<b>Successful characteristics</b>	Familiarity with EER Literature and Methods	As the RIEF grant progressed, mentee participants noted the ways in which mentorship increased their familiarity with EER literature and methods, increasing their ability to make meaningful contributions to the field.	<i>Abbie, a mentee:</i> I'm already kind of familiar with the protocols that we're using. But, it's kind of, I don't know, it's informal learning. I've picked it up along the way, but I've never formally been trained in like how do you actually conduct these interviews. What's the right protocol? How are you able to demonstrate that this methodology is rigorous? That's something that's really new to me. [...] this is part of what I'm hoping will come- well, I know will come out of the mentoring, 'cause we've specifically talked about how it's gonna come out of the mentoring activities we do together.
	Connection to the EER Community	Mentee participants increased their connectivity with the EER community through their mentors, conferences, and other	<i>Tiffany, a mentee:</i> I think just the recent advances of having all of the RIEF grantees get together...going to the grantees conferences really helps, again, because it's about building your network and building

		means; participants noted the importance of this community for their development as researchers.	<i>your confidence. Meeting other people like you who are new to the field really helps.</i>
<b>Challenges</b>	Mentoring at a Distance	Both mentor and mentee participants noted the ways in which distance impacted their relationship, including ways, frequency, and type of communication that occurred.	<b><i>Caitlyn, a mentor:</i></b> <i>I mean, my real regret is that I changed institutions 'cause it just made it so much harder to work closely in the way that I think you have to when you're trying to stretch someone to take on new ideas and do really foreign tasks. I mean, I guess the only other thing... I don't regret it. She's still one of my close friends. Like, I really like her. I don't know that we'll do another project together because we didn't... I mean, we made a plan in our proposal of, like, how we will mentor and work together, and, like, we did that. We had our meetings, but with the combination of leaving and having a grad student that had a lot of trouble, I think that it just wasn't... I don't know what we could have done...</i>
	Navigating Power Dynamics of Mentorship	The academic rank of mentees often was equal to or greater than that of their mentors; both parties were forced to address the power dynamics at play as they negotiated their role in developing an effective working relationship.	<b><i>Zach, a mentor:</i></b> <i>I won't belabor it, but, you know, having this kind of a relationship with somebody who's much further up the food chain than I am, you know, that has made me develop an increased awareness of the way that, you know, may influence our interactions, and how I, kinda, manage that. So, you know, mentoring a graduate student is different than mentoring a school head, for sure. So, I think that's a big part of it.</i>

## Discussion

This study explores the challenges and successful strategies associated with mentorship between RIEF grantees. Overcoming and predicting these phenomena is helpful to developing a strong mentoring relationship. Many professional engineers attempting EER discover challenges in their understanding of social sciences research methods and language. Mentors who recognize the pitfalls their mentees will encounter may be able to circumvent these barriers. Mentors can also preempt barriers by helping their mentees to network. A community of RIEF participants and other EER professionals is valuable for mentees to develop in order to lean on multiple mentors with diverse skillsets to meet different needs. This work supports the formulation of



such a community by exploring the common and unique experiences of RIEF grantees. These findings serve as a starting point of conversation between RIEF grantees and among the EER community.

In preparing for a RIEF grant, mentors and mentees should consider their interpersonal dynamics beyond their personalities and preferred mentoring styles, though these factors are important as well. Significant differences between mentors and mentees related to interests in EER content, academic rank, individual backgrounds and demographics, or distance between institutions may add challenges to mentoring relationships. Our data suggest that rewarding mentoring relationships are possible despite these challenges. Our results also suggest that mentors find the opportunity to reflect on their mentoring practices to be a rewarding experience. We suggest that potential and current RIEF grantees should consider these themes and their personal preferences as a mentor or as a mentee in order to improve and deepen their experience with RIEF mentorship.

**Limitations.** The primary limitation of the study is the specific set of circumstances regarding the population interviewed. The power dynamics at play between the mentors and mentees and the expert-to-expert style of mentorship is potentially not generalizable to the training of other engineering education researchers, such as graduate students. While a relatively large sample of RIEF grantees was interviewed, potentially offering a strong profile of RIEF grantees, most of the participants were in the first year of their grant, and thus may have had enough experience or time to describe the impact of their RIEF mentoring relationship on their career and interests. Overall, there are few more than a hundred RIEF mentors and mentees, and this study examines mentorship in only one method of entry to EER, while the overall EER community is much larger and from more diverse backgrounds. However, by understanding mentorship in this subset of the EER community, we can glean insight into mentorship performed by EER experts and can improve upon retention of RIEF grantees in EER. Additionally, by understanding the interests and needs of RIEF mentees in EER and their views of the field, we can better understand a cross-section of the personalities of new EER researchers and can shape the field to accommodate a new generation of EER researchers.

It is also important in this context to note that the definition of a successful outcome in a mentoring relationship is subjective. Participants may consider a good working relationship or otherwise positive experience to be a successful outcome, whereas the grantees' institutions and the NSF may have different standards for success.

**Implications.** In terms of cognitive apprenticeship, the unique structure of mentorship among RIEF grantees provides an opportunity to study the path from novice to expert from the context of apprentices who already possess scaffolds to be expert researchers. Research suggests that social scientists and engineers prefer different styles of mentorship [11]; here we have an opportunity to build upon that body of literature. Comparing EER-specific mentorship studies to those conducted in other disciplines with a larger body of faculty-faculty mentorship research

such as academic medicine [12, 13] may yield a deeper understanding of academic mentorship, CAM, and best practices while training faculty. More relevant is a connection within this study to training graduate students in EER coming from engineering backgrounds. Additionally, understanding more evidence of the roles of the many traits describing the mentorship profile of RIEF grantees (institutional distance, academic rank, etc.) can lead to results generalizable to many mentorship structures.

By assessing the values and interests of EER mentees and mentors in this project, further implications include determining the needs of the EER field at large, receiving mentee feedback on how supports can be built to best train and network the EER community, and including the needs of mentors in developing and supporting mentoring relationships in the RIEF program and in EER.

**Future Work.** This work is part of a larger study with an ultimate goal of involving more engineering faculty in EER and strengthening the RIEF community. Our team plans to leverage these results towards networking and workshopping meetings at future ASEE events, including ones in which the creation of new mentorship pairs can be supported. The completion of our current analysis will inform these plans and goals.

One problem discussed by some participants in this study and evidenced by the self-selection of first year researchers is a problem with sustained engagement in the RIEF program and in EER. To most effectively influence engineering education, a further goal of this study is to promote the RIEF program in producing researchers who continue to contribute to the scholarship of teaching and learning throughout their careers.

Future work by our team members is anticipated beyond this analysis to examine engineering faculty motivation and barriers to entering the field, as well as to study the motivations and barriers experienced by foundational researchers in the field. Exploration in these areas will further assist the above efforts.

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