

Establishing a Framework for the Effective Mentorship of Junior Engineering Faculty

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Abstract

This research paper proposes a preliminary framework for understanding the factors contributing to effective faculty-to-faculty mentorship within engineering and the specific impacts of these factors on junior engineering faculty. Existing research on faculty mentorship primarily emphasizes the importance of individual mentoring functions. The broader structural and contextual elements that impact mentorship outcomes are overlooked, while the unique experiences of faculty in engineering are neglected. Our framework aims to address these gaps by providing insights for enhancing the quality and success of engineering faculty mentoring relationships. Emergent insights were informed by semi-structured critical incident interview data gathered from fifteen junior engineering faculty located at various research-intensive universities within the U.S. A hybrid deductive-inductive thematic analysis approach was used to uncover the factors that shape effective mentoring experiences for junior engineering faculty. These factors were categorized as behavioral factors (e.g., whether the mentor provides candid feedback or advice), structural factors (e.g., whether the mentoring relationship is initiated as part of a formal program), and contextual factors, (e.g., whether the mentor and mentee share common interests or identities). Findings from this work are expected to contribute to a deeper understanding of faculty-to-faculty mentoring practices while providing clear guidance for the development and implementation of effective mentorship programs for junior engineering faculty.

Keywords: mentorship, engineering, junior faculty, framework

Introduction

This research paper explores the intricacies of engineering faculty mentorship, defined as mentorship provided to faculty, by other faculty. We specifically propose establishing a comprehensive framework articulating the behavioral, contextual, and structural factors that influence the effective mentorship of junior engineering faculty. Mentorship can serve as a critical resource for junior faculty who are navigating the complex terrain of academia. Faculty mentorship is not merely a transactional exchange but a multifaceted relationship that significantly impacts career trajectories and personal growth. Effective faculty-to-faculty mentorship has long been associated with positive outcomes, including professional development, career satisfaction, and success [1], [2]. The current, extant understanding of what makes faculty mentorship effective reveals significant gaps in the literature, particularly within the field of engineering.

The engineering field is often characterized by markedly different working requirements than other fields, which presents unique challenges for engineering faculty, particularly junior engineering faculty. These experiences have not been thoroughly investigated [3], [4]. Junior engineering faculty must navigate complexities in research, teaching, and identity development within the academic environment [4]. Most studies of STEM-related mentorship focus on undergraduate students, graduate students, and, to a lesser extent, postdoctoral researchers [5].

The lack of exploration into the challenges engineering faculty encounter in their early career stages reinforces the need for research that comprehensively examines faculty mentorship in engineering.

Recent research on engineering faculty mentorship highlights the importance of individual mentoring practices, such as instrumental (career) support and psychosocial support, in order to cultivate effective mentoring relationships [6], [7]. Such studies contribute valuable insights into our understanding of faculty mentorship, but a notable void exists in considering the broader structural and contextual factors driving mentorship outcomes for junior engineering faculty. The broader literature on mentorship emphasizes shared interests and identities between mentors and mentees as critical contextual variables to the success of the mentorship relationship [8], [9]. Power dynamics also significantly shape mentorship outcomes, as power imbalances can undermine a mentee's ability to engage in a true partnership with their mentor [10], [11]. Additionally, the structural elements of mentorship, such as whether mentoring is part of a formal program in which mentees are assigned to mentors, can play a pivotal role in determining mentorship effectiveness [12]. These contextual and structural factors shaping mentorship outcomes for junior engineering faculty warrant further exploration. The forthcoming journal article intends to provide a deeper exploration of the various factors influencing the mentorship encounters of junior engineering faculty.

The current study bridges these gaps by adopting a holistic perspective on faculty mentorship. Guided by ecological systems theory, we consider the interplay between the behavioral, contextual, and structural factors influencing junior engineering faculty mentoring relationships and outcomes [13]. This work aligns with recent calls advocating for a more nuanced and detailed understanding of faculty mentorship patterns [14], [15]. We explicitly recognize that there is no one-size-fits-all mentoring experience. The mentoring needs of junior faculty can easily differ from mentors' assumptions. As such, we aim to identify the most essential mentorship practices and programmatic structures for enhancing mentoring support for junior engineering faculty. We anticipate this understanding to contribute to the development and implementation of targeted mentorship interventions within engineering and a discourse on effective faculty mentorship within academia in general. The following sections present our preliminary results related to the behavioral, structural, and contextual factors reported by junior engineering faculty as most important to mentorship effectiveness.

Methods

Data for this paper was collected as part of a larger qualitative research study investigating engineering faculty perceptions of effective faculty-to-faculty mentorship. Engineering faculty were recruited by contacting the department heads at the nation's top twenty largest doctoral-granting engineering schools [16] and requesting they share a study invitation and screening survey link with their tenured and tenure-track engineering faculty. The screening survey asked faculty about their job, mentorship relationships, and demographic information. Faculty were selected to participate in an hour-long, semi-structured interview using purposive sampling to ensure diversity in mentoring experiences by faculty rank, engineering discipline,

geographical region, race, gender, and citizenship status. Interview questions asked faculty to share critical incidents [17] in which they provided (for tenured faculty members) or received (for tenure-track faculty members) formal and/or informal faculty mentorship related to: (1) the job duties associated with being a faculty member (e.g., teaching, research, service), (2) the interpersonal aspects of a faculty job, and (3) issues relevant to held identities in a faculty job. We interviewed fifteen junior engineering faculty (assistant professors and associate professors within two years of earning tenure) about their experiences as faculty mentees and sixteen senior engineering faculty (full professors and associate professors after two years of earning tenure) about their experiences as faculty mentors. The study included fifteen junior engineering faculty mentees, with thirteen in the assistant role and two in the associate role. In terms of gender, eight participants were female, and seven participants as male. Regarding race/ethnicity, there are two African American/ Black, six Asian, two Hispanic/Latinx, one Native American, and four White/ Caucasian participants. Furthermore, participants belonged to diverse engineering disciplines, with two in Mechanical Engineering/Engineering Science and Mechanics, six in Biomedical/ Chemical Engineering, three in Civil Engineering, one in Environmental Engineering, one in Metallurgical and Materials Engineering, one in Nuclear Engineering, and one in Electrical Engineering. This diversity in roles, gender, ethnicity, and disciplines contributes to a comprehensive representation within the study. Pseudonyms have been assigned to each participant to maintain confidentiality. Each interview was conducted over Zoom, audio recorded, and transcribed.

The interviews with faculty mentees were analyzed using a hybrid inductive-deductive thematic analysis approach using memoing [18] and informed by context based axial coding [19]. First, four interviews were open coded using inductive memoing. The resulting 78 different memo definitions were consolidated into 18 unique codes. These codes were subsequently sorted into categories based on both axial coding contexts (actions, conditions, consequences), and NASEM's descriptions of mentoring functions (behavior, contexts, outcomes). The categories for this analysis are defined as follows: (1) behavioral factors, defined as the actions taken by faculty mentors as reported by mentees, (2) structural factors, defined as the programmatic elements that mentees reported as shaping their mentorship relationships, (3) contextual factors, defined as the relational elements that mentees reported as shaping their mentorship relationships, and (4) outcomes resulting from the mentees' mentorship experiences, encompassing both positive and negative impacts. This paper describes the first 3 categories of codes as a preliminary step to the future endeavor of connecting mentoring behaviors, structures and contexts to desired outcomes for engineering faculty mentees.

Trustworthiness was established through research triangulation wherein the first and second authors independently analyzed and then discussed a set of four transcripts to establish common definitions of the codes; the third and fourth authors were used to resolve disagreements. Interrater reliability between the first and second authors was assessed using another set of four transcripts, wherein each code met the minimum acceptable Cohen's kappa and percent agreement values of 0.6 and 0.9, respectively [20]. The first and second authors then independently worked to code the remaining interviews.

Findings

Our initial results presented in the following subsections reveal the behavioral, structural, and contextual factors that shape junior engineering faculty's mentorship experiences. These findings identify specific mentoring activities and programmatic structures the mentees considered effective.

Behavioral Factors

The behavioral factors that mentees reported included instances where mentors actively formed collaborations with mentees, helped make connections, gave advice, demonstrated care, provided candor, and demonstrated ongoing commitment to the mentorship relationship. Each of these factors is illustrated with quotes from the participants.

Collaborating: Some mentees described actively collaborating with their mentor, whether co-authoring an article, co-advising a student, or working together on a project. These mentees appreciated a senior faculty member taking an interest in partnering with them rather than adhering to conventional top-down hierarchies, as captured by Clark:

“One thing that he was really helpful with is, he started including me on...writing proposals together and co-authoring papers together...I think the fact that he was a mentor and he was wanting to be a colleague and work together on stuff, it was very different than somebody that was like, “Well, I’m, you know, up here, you’re down here, I’m gonna tell you what to do and you should do it.”

Making connections: Mentees also reported that their mentors helped create opportunities for mentees to form professional connections, such as inviting the mentee to networking events, introducing the mentee to other people within their professional community, or even helping find other potential mentors or sources of connection outside their disciplines. The example quote from Elle demonstrates the cruciality of a mentor's help in widening one's professional network.

“This is what I think a good mentor does. We were in a conference and...she was talking to someone, she saw me approaching, passing by, and then she was like, “Hey [name], come, I want you to meet this and this person.” And then she said, “Look, this is [name] and she does this.” And so, she has always looked for opportunities to highlight my work with other colleagues, especially with people that she knows are more senior.”

Giving advice: Many mentees recounted receiving guidance from their mentor, whether through resources, information, or problem-solving strategies. They seemed especially interested in hearing mentors share stories of their experiences and ways of doing things. As Dawn put it,

“It felt like that was just me and to hear senior faculty members saying that they got into like motivation ruts, like really meant a lot to me, I guess. That it's, I wasn't like some (laughs) like, it wasn't like I was less motivated to do science. It was more of just, it felt like more like normalized that like, people are not motivated all the time, I guess.”

Demonstrating care: The mentees we interviewed generally described their mentors as supportive, kind, and generous with their time, praise, resources, and compassion. This demonstration of care far exceeded what the mentees thought was reasonable to expect from their mentors. The mentees especially expressed gratitude towards mentors who nurtured and encouraged them or promoted camaraderie, making their workplace feel more inclusive. Earl described this sentiment, saying,

“That spirit of welcomingness and collegiality is so important and percolates into every interaction, I’m grateful that it’s there.”

Being candid: Mentees reported that mentorship was particularly effective when their mentor was honest and transparent. This approach to communication opened a safe environment where the mentees could ask for and receive clear, constructive feedback about both their strengths and their areas for improvement. This sentiment was captured in the following quote from Elle,

“When I share [a proposal] with her, she says, “You know, this is a great idea, I really like this, this, and that,” and then she might go on to highlight maybe ways of improving. Or when she said, “I think sometimes we have this, you know, imposter syndrome whether you’re like, I don’t know that I’m worth it to be in academia,” and she would just sit with me and remind me of all the things that I have achieved and that not everyone gets to that point.”

Showing commitment: Mentors demonstrated commitment to their mentees by being accessible and responsive. These mentors were willing and able to answer questions, offer advice, and fully support their mentees’ professional development. In addition, mentors who demonstrated commitment also proactively initiated contact and followed through with their promises, alleviating the mentee’s stress or guilt about relying on them. Bea described this feeling, saying:

“But, like if you give them the opportunity to do that instead of them waiting on you, waiting on you, waiting on you and then you don’t deliver it just leaves people feeling really upset. And so then if you do commit, block off some time, however long you think it’ll take you, maybe an hour, maybe two. And then, whatever you have done in that time, just send it, right? Like, I feel like people are so worried about like, “Oh, I’m either going to do it great or not going to do it at all.”

Overall, these results cover various supportive measures and align well with instrumental and psychosocial mentoring functions [21]. They also provide important insights into how junior engineering faculty’s mentoring perceptions and experiences can be shaped by the actions taken by their mentor(s), especially those related to establishing open communication and building personal relationships.

Structural Factors

The effective structured factors stated by the mentee involve having clear expectations, the role of integral mentorship, mentee-driven mentoring relationships, and formal vs informal institutional circumstances. These themes are described and accompanied by example participant quotes.

Clear expectations: The mentee highlighted the importance of establishing clear expectations and boundaries in their mentoring relationship. The negotiation and agreement about the scope of the mentoring provided a solid foundation for structured and effective mentoring. This involved establishing clear parameters which included availability, acknowledgment, and planning for potential challenges and their origins. Clear expectations allow the mentee and mentor to be on the same page, fostering a shared understanding of their goals. Earl described effective mentorship as:

“I think effective mentorship involves, above all else, transparency. So making it clear what the, um, you know, uh, what the expectations are, what the, what's going well, what's potentially not going well, what's i- important transparency and not dancing on the issues. I think that's very important. And hand in hand with transparency is also a, you know, general supportiveness, even when a mentee doesn't look like a mentor in terms of particular interest in, in research methods, particular disciplinary background or whatever, it's so uncommon that one's mentor would be doing the, the same things. So general supportiveness, but also coupled with a, with a spirit of transparency.”

Integral Mentorship: Mentees emphasized the importance of “whole person” mentoring, which addresses personal and human aspects alongside professional relations. This holistic approach to mentorship extends beyond just professional knowledge; it encompasses individual development, well-being, and advancing of mentoring culture. Dawn shared an experience about being proactive in creating a comfortable environment.

“I think if you're being proactive, as you're asking questions, how they're doing? You're asking about, you know, teaching research service, if you're asking about the social parts, then I think the mentee will feel more comfortable opening up about them. So, I think that asking the questions is the important part. If you're not sure about exactly what advice to give or if your mentor, or mentee is not asking you questions, right?”

Mentee-Driven approach: The mentees underscored the importance of tailoring mentoring relationships and being centered around the mentee's needs and preferences. They believed that the mentor's role is to understand the mentee's needs and empower the mentee to take the lead in making decisions, allowing their experiences to be meaningful and relevant to their individual growth. Faye highlighted a common observation that many mentors prioritize professionalism over offering genuine, human-centered advice:

“Just like really getting into the weeds it's being willing to do that and able, or being willing and able to know exactly who to connect you with to solve the problem most efficiently. Like if it's not me, this is who it is and I will make this connection for you right now. Uh, those are good practices and just like being open, honest, you're true, 100% self, listening, good listening, uh, without like to talking over, not taking over meetings, like ranting about myself, like not making things about me, it's about them because, and like my whole ethos of my group is that if they succeed, I'm succeeding. So none of it is about me. It's all about them so.”

Formal vs. informal structure

The institution's role in structuring mentorship is influenced by factors such as institutional happenstance, where certain faculty members are brought together due to specific circumstances such as teaching the same class or office proximity. Dale shared insights indicating that upon joining their department, faculty members are formally assigned different faculty mentors:

"We have a program, the, the acronym is (name), I, I don't know what the individual letters stand for, and they have these things that are called launch committees, like launching a rocket. Um, and basically for the first 12 months, uh, on, on the job, you're paired with your department chair, um, with, uh, someone else in, in your department, uh, who is close to your research, someone that you'll kind of, that they assume will that you'll naturally get to know anyway, and then kind of a, uh, an, an, an engineering faculty member who is outside of this, who's, uh, who's kind of just there to moderate."

The structural factors such as clear expectations, "whole person" mentoring, a mentee-driven approach, and the interplay between formal and informal structures within institutions are crucial elements in effective mentorship. These factors collectively contribute to a well-rounded and balanced impact on the professional and personal growth of the mentee.

Contextual Factors

The contextual factors that are identified in our study highlight the dynamic inner workings of mentoring relationships for junior engineering faculty members. These factors include having respect and admiration for their mentor, establishing non-work connections with other faculty, recognizing the role of power dynamics, and having shared traits with mentors. We explore these contextual factors and provide example quotes from the participants.

Admiration/Respect for mentor: Mentees expressed profound respect and admiration for their mentors and how their mentors serve as role models in their mentoring journey. The mentor's influence on the mentee extends beyond just professional realms, promoting a sense of friendship and inspiration. This admiration fosters a cordial mentor-mentee relationship and contributes to a conducive environment for effective mentorship. As expressed by Hope:

"I feel I can look up to her as a role model though I know everyone passes differently, everyone's aptitude is different. But I can see okay, maybe those are the steps... Oh. Also because she now is tenured and got three RIs and built a center, she said she'll focus more on training grants and, um, those large P grants."

Non-work connections: Mentees discussed the connections they have built with their mentors outside of work through activities or interactions that are unrelated to work tasks. In the words of Earl:

"Talk about his background growing up in the [Caribbean Nation] and how he first took, sta- uh, took a stab at writing poetry and, um, even talking through some of the poems that he wrote at, during various phases of his faculty career, uh, some very, very introspective stuff, some very lighthearted stuff, was like just very int- endlessly interesting to me, um, how he felt when his, uh, when his son was first born, um, when he moved to [East Coast City]. Uh, all these things from a social and people aspect side has been absolutely very, very helpful to me. Uh,

our research areas do not overlap by any significant extent. We both use a lot of computational engineering techniques in our work, but that's really where the similarities end."

Role of power dynamics: Mentees delved into the impact of power dynamics on mentoring relationships. Instances highlighted where these dynamics have influenced mentoring in either a positive or negative manner. These include experiences related to transitions from being a student to a peer, the mentee's feeling of powerlessness vs. having agency, or the mentor's limited ability to assist the mentee. Grace shared an example:

"We had been considering some ideas anyway, and this was a w- a way to formalize that. Um, and then I had to choose other people to be on the team, both from my institution and not in my institution at various stages of my career. And I thought very strategically about, like, "Who do I wanna include on this team that, you know, might write my tenure letter someday?" So, like, I wanna kinda be nice to, to them right now."

Shared traits: The interaction between a mentor and mentee is shaped by their dynamics, including how well their identities, interests, goals, worldviews, and values align with one another. Earl mentioned:

"And so finding other people who are senior and are also first principles in their professional identity, is very, very helpful so that in, at a superficial level, you can have some- somebody to laugh when you have an interaction that doesn't quite go, um, totally smoothly, but on a deeper level, you have an understanding as you're going through the promotion and tenure process, as you're going through establishing professional identity, what are ways to talk about your interests, your deeply, genuinely sincerely held interests, even in communities and crowds that are looking for very different things than what you wanna do. Um, th- that's an area of, uh, held identity that [Dr. A]'s been a really, truly incredible mentor to me, and I'm very grateful for every conversation we've had on this front."

The contextual factors highlighted by the participants shape mentorship relationships among junior engineering faculty members. The admiration and respect mentees express for their mentors goes beyond professional domains, fostering a sense of friendship and inspiration. Non-work connections contribute to a well-rounded mentor-mentee relationship. Power dynamics and shared traits, including identities, interests, goals, and values influence mentor-mentee dynamics. Understanding these factors is important for effective mentorship and professional development.

Discussion and Future Work

Our findings offer insights into junior engineering faculty perceptions of and experiences with effective faculty-to-faculty mentorship. Key behavioral factors influencing mentorship dynamics included whether the faculty mentor offered the mentee opportunities to collaborate, helped the mentee make connections, gave the mentee advice, demonstrated care, was candid with their feedback, and showed commitment to the mentorship relationship. Such identified activities coincide with those reported in other studies, reinforcing the significance of supportive behaviors to mentorship effectiveness [22]. Our analysis also highlights multiple structural and contextual

factors influencing the mentorship relationship. Structurally, mentees reported that their most effective mentorship relationships were ones in which the mentorship was informally, rather than formally, organized, the expectations between mentors and mentees were clear, the mentor customized their mentorship to the specific needs of the mentee, and the mentorship focused on both the mentee's professional development and personal wellbeing [12; others]. Contextually, mentees also benefited when the mentor and mentee had mutual admiration and respect for one another, shared common interests and identities, and directly addressed the power dynamics inherent in their mentoring relationship [8, 9, 10, 11]. These findings deepen our knowledge about the complexities involved in effective faculty mentorship relationships and the importance of treating mentorship as a multidimensional process.

The sum of our findings highlight specific mentoring practices and programmatic structures to enhance the mentorship of junior engineering faculty and support several recommendations for mentorship practice. Engineering departments, colleges, and institutions can leverage our initial framework as an assessment tool to evaluate their mentorship programs [15]. The tool could also support self-evaluation, allowing mentors to reflect on their mentoring practices and identify strengths and areas for improvement [11]. Further, faculty training based on our framework has the potential to promote more effective faculty mentorship relationships by increasing the competence of senior faculty mentors. Such training might include actionable strategies for mentors based on the study's findings, as well as the opportunity to share and reflect on experiences [23].

Our research also suggests several avenues for further research. Future studies could examine the links between the behavioral, structural, and contextual factors that influence mentorship effectiveness and mentorship outcomes, making it possible to identify the most critical factors to junior faculty success. In addition, researchers could compare junior and senior faculty's perceptions of effective mentorship using our framework to uncover potential (mis)alignments in mentoring expectations. Finally, our work not only illuminates effective mechanisms and research opportunities related to faculty mentorship in engineering, it also provides a basis for further research and interventions to improve faculty mentorship across academia.

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