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Differential graduate student-advisor career mentorship for academic vs. non-academic careers

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Abstract

Despite the fact that only roughly a third of engineering PhD earners enter academic jobs, engineering graduate programs largely provide coordinated professional development only for tenure-track roles. As shown in this study, PhD and postdoc advisors are no different. This paper presents a subset of findings from a larger study of semi-structured interviews with 20 advanced (4th+ year) PhD students and postdocs to understand how their graduate and postdoctoral experiences influenced their career interests. Ten were interested in a tenure-track faculty job and ten were not. Here, we focus on advisors providing career advice and if participants felt comfortable discussing their career plans with their advisors. All ten of the participants interested in tenure-track faculty jobs received advice from their advisors–often, quite extensively through mock interviews and application materials feedback. In contrast, only four of the participants disinterested in tenure-track faculty jobs received any career advice from their advisors. Four participants did not feel comfortable talking with their advisors about their career interests largely because of perceptions that their advisors were unsupportive of non-tenure-track careers. Even if advisors personally lack non-academic work experience, part of inclusive mentorship is providing an environment where graduate students and postdocs feel comfortable discussing all types of career plans and helping connect mentees to helpful resources. This paper discusses how advisors can do that, as well as advice for graduate students on how to find additional mentors for career guidance.

1 | Introduction

Engineering and computer science PhD earners accept post-graduate employment in a wide range of sectors. Census-level data from the National Science Foundation's Survey of Earned Doctorates (SED) from 2015-2019 show that across all engineering disciplines, graduates who accepted positions are employed in industry (48%); four-year, medical, or research institutions (33%); the U.S. government (8%); outside of the U.S. (6%); and nonprofits (3%) [1]. Collectively, higher percentages of engineering PhD students begin their graduate studies interested in academic careers, but that interest wanes over time [2], [3], [4], [5]. Despite the fact that a majority of engineering PhD earners seek nonacademic careers, many engineering and science faculty advisors prefer working with PhD students who pursue academic careers [6], [7], but this way of thinking sets unrealistic expectations: in 2009, for example, there were roughly eight times as many engineering and 12 times as many life science PhD earners as there were faculty appointments in those fields [5].

Mentorship is an important part of PhD students' career preparation [8]. As engineering PhD earners pursue careers in such a wide range of sectors, they need mentors who will provide

them with advice that spans this range. Our research question for this study is: How does the nature of career mentorship between advisors and their engineering graduate student and postdoc mentees vary based on the mentees' intended career trajectory?

2 | Literature Review

It is important to note that the literature uses the terms "academic careers," "academic positions," and "careers in academia" ambiguously, and authors frequently do not define what they mean by "faculty careers," "faculty member," "research positions," and "teaching positions" (e.g., [2], [3], [7], [9]). As such, we are unable to define some of these terms when citing other authors. There is a wide variety of career paths available in academia, including tenure-track positions at research- and teaching-intensive institutions, in which research and teaching responsibilities will vary; research- and instructional-track faculty; lecturers; and non-faculty staff positions. In this study, participants described academic/faculty careers as tenure-track faculty positions at research-intensive institutions.

2.1 | Advising and Mentoring

There is significant literature on the role that advisors play in engineering PhD students and postdocs' experiences [4], [10], [11], [12], [13], [14], [15], [16]. Advising serves many functions, with varying degrees of commitment to and investment in students' personal development. At one end of the spectrum, functional advising is limited to merely project management and would be considered supervision. At the other end of the spectrum, developing a quality relationship demonstrates an advisor's enthusiasm and care for the student and is a component of mentoring [8]. Receiving the latter kind of mentorship correlates with mentees' higher interest in pursuing an academic career [17]. Not all advisors are considered mentors; De Welde and Laursen [10] found that only half of STEM PhD students participants considered their advisor a "mentor".

One aspect of mentoring is providing mentees with advice for their desired career path. However, research shows that many engineering PhD students either receive no career advice at all or, if they do, are largely unsatisfied with the amount of career mentorship that their advisors provide [10], [18]. The first step in providing career advice is knowing what careers one's mentees are considering. For advisors to know this, mentees must first feel comfortable discussing their career interests. In a study of 195 STEM PhD students and 272 STEM faculty members, Sherman et al. [9] found that both groups felt significantly more comfortable discussing faculty research careers than industry or teaching careers. Additionally, mentees may feel more comfortable discussing career interests of which they perceive their advisor to approve. That same study found that 79% of students perceived their advisor preferred they pursue a faculty research career, which stands in contrast to only 34% of students reporting interest in research careers.

A student's PhD advisor is often the primary person from whom they receive mentorship, but PhD advisors infrequently give career advice and, when they do, it is largely focused on academic careers. In their study, Sherman et al. [9] found that less than a third of students had discussed non-academic careers with their advisors. One reason that advisors are not able to give advice about non-academic careers is because many faculty have only worked in academia without working in industry or government labs [10], [18]. In contrast, students who are interested in faculty careers receive ample career mentorship. Advisors' mentorship around faculty careers is focused more on socialization and aspects of the job itself, such as conducting research, writing grants to secure external funding, and managing a research team [11], [12]. Advice on more concrete aspects of successfully applying to faculty positions, such as preparing an application package, interviewing, and negotiating an offer, are more commonly reported as taught during professional development events (e.g., future faculty workshops), though these are often aimed at students and postdocs from groups historically excluded in engineering [19].

Although there has been research on the frequency and satisfaction of PhD students receiving career advice from their advisors, less is known about what types of advice is given. This study seeks to fill that gap.

2.2 | Framework: Leader-Member Exchange Theory

In an academic mentor-mentee relationship, faculty advisors can be thought of as leaders and mentees as followers. Leader-member exchange (LMX) theory describes three domains of leadership: the leader, the follower, and the relationship between the two [20]. LMX relationships depend on both leaders' and members' behaviors and characteristics, and higher-quality LMX relationships result in better outcomes for all (i.e., for leaders, followers, and organizations) [20]. LMX researchers have identified different dimensions of LMX. Graen & Uhl-Bien [20] identified respect, trust, and obligation, while Diensch & Liden [21] identified perceived contribution, loyalty, and affect. A high-quality LMX can include a leader understanding the follower's needs, a leader recognizing the follower's potential, and confidence in each others' decisions [20].

LMX begins as transactional but can become transformational over time [20]. Low- to medium-quality LMX relationships, in which the leader and follower are strangers or acquaintances, primarily involve material and social exchange and are aligned with transactional leadership. Transactional leaders reward employees for completing their objective through actions such as pay raises, favorable performance reviews, recognition, and praise. They clearly communicate work that needs to be completed and how to do it; as such, employees have a clear understanding of their job, work goals, and their leaders' expectations [22]. High-quality LMX relationships, in which the pair "transform" into a partnership, are more closely related to transformational leadership. Transformational leadership has four components, or the four I's [22]:

1. *Individualized consideration* involves recognizing employees as individuals with their own needs, listening to their concerns, building their confidence and advocating for them. A key component of individual consideration is mentorship to build an employee's abilities and confidence after taking the time to learn their strengths and weaknesses. Individual consideration is part of the LMX measure (e.g., item #2: "How well does your leader understand your job problems and needs?" [20, p. 237])
2. *Intellectual stimulation* can be one-way, in which leaders help employees to find evidence- and reasoning-based, novel approaches to old problems, or two-way, in which leaders not only intellectually stimulate employees but are also intellectually stimulated by the employees in return.
3. *Inspirational motivation* is how transformational leaders energize employees and build their confidence. This can be through giving pep talks, maintaining optimism, finding ways to reduce employees' workloads, and setting an example of working hard.
4. *Idealized influence* is the result of employees seeing their leader's respect and wanting to emulate a leader after witnessing the leader obtain desired outcomes. Idealized influence can be the culmination of the first three I's and results in employees who are emotionally committed to the leader.

Despite its origin of superior-subordinate pairs in formal organizations [23], LMX has been applied to graduate student-advisor relationships in fields outside of engineering [24], [25] as well as postdoc-advisor relationships in engineering [15]. Research on graduate students has been largely quantitative and shown that high-quality LMX relationships are correlated with satisfaction and self-efficacy of doctoral students in rehabilitation counseling programs [24]. In another quantitative study of Chinese students in many disciplines, high LMX was found to be positively correlated with creativity and negatively correlated with hindrance stress, the type of stress arising from circumstances that hinder personal gain, growth, or achievement [25]. Within engineering, LMX has been used in conjunction with social exchange theory to examine the relationships between engineering postdocs and their advisors. Mixed-methods research has shown profiles of types of advisors and that postdocs and their advisors can have misaligned expectations, which leads to postdocs having negative mentorship experiences [15]. Transformational leadership in doctoral student-advisor dyads in New Zealand has been studied using the Multifactor Leadership Questionnaire (MLQ) scale [26], finding that students' perceptions of their advisor's transformational leadership was positively correlated with their advisor's ratings of their creativity [27]. Although the transition from graduate student or postdoc to a faculty position is not a "promotion" in the traditional sense of the word, it is analogous in the sense that both are career advancements. We were not able to find literature on transformational leadership and graduate student or postdoc career development, but research has shown that transformational leadership (idealized influence, inspirational leadership, and intellectual stimulation) is positively correlated with followers' readiness for promotion [28]. In this paper, we use leader-member exchange theory to guide our discussion.

3 | Methods

This paper analyzes data collected from a study on how the experiences of engineering graduate students and postdocs from historically excluded groups influence their decisions to pursue or abandon pursuit of an academic career [4].

3.1 | Participants

There were two study eligibility criteria. First, participants needed to be a fourth-year or higher engineering PhD student or have graduated with an engineering PhD within the last three years. Second, participants must be from at least one demographic group considered historically excluded from engineering graduate education: women or gender non-conforming; Black/African American, Hispanic/Latino/a/é, American Indian or Alaska Native, or Native Hawaiian or Other Pacific Islander; first-generation college students; low-income mentees; mentees with disabilities; and/or mentees who identify as LGBTQ+. Several participants had multiple historically excluded identities, as shown in Tables 1 and 2. We interviewed 20 participants: ten who were interested in faculty careers (the *interested* group) and 10 who were not interested in faculty careers (the *disinterested* group). We make the distinction "disinterested"–rather than interested in non-academic careers–because participants had previously been interested in faculty careers but lost interest over the course of their graduate studies.

There are several reasons we chose a diverse sample despite the fact that people from these groups or with intersectional identities can have distinctly different experiences. First, universities' rhetoric around faculty diversity and increasing representation in faculty hiring commonly mean any candidate from a historically excluded group [29], and understanding the experiences of PhD students from these backgrounds could help increase representation. Second, the National Science Foundation's broadening participation efforts are to expand STEM opportunities for "people of all racial, ethnic, geographic and socioeconomic backgrounds, sexual orientations, gender identities and to persons with disabilities" [30]. Finally, although there is literature focusing on the experiences of mentees from these specific individual groups, diverse sampling allows for consideration of intersectional identities.

Table 1. Participants from the *interested* group

Pseudonym	**Year**	**Gender**	**Race/ Ethnicity**	**Additional Identities**
Ahmed	4th year PhD student	Man	Black/African American (refugee & naturalized U.S. Citizen)	First-gen student
Ana	6th year PhD student	Woman	Latin descent (Colombian)	
Brad	1st year Postdoc	Man	White/ Caucasian	First-gen student
Brianna	4th year PhD student	Woman	African American	
Candice	3rd+ year Postdoc	Woman	Asian (Korean)	
Jamal	Recently completed Ph.D., full-time professor	Man	African American & Caucasian	
Juan	5th year PhD student	Man	Latin, mixed-race	
Lorena	2nd year Postdoc	Woman	Hispanic/ Latina (Puerto Rican)	Disability
Malik	5th year PhD student	Man	Black: African- American descent	
Rosa	4th year PhD student	Woman	Latina (Colombian)	Disability

Table 2. Participants from the *disinterested* group

Pseudonym	**Year**	**Gender**	**Race/ Ethnicity**	**Additional Identities**
Amy	4th year PhD student	Woman	Asian, White	
Camila	5th year PhD student	Woman	Hispanic/ Latino	First-gen
Christine	7th+ year PhD student	Woman	White	Disability
Cruz	5th year PhD student	Non-binary (he/they)	Guatemalan-American	First-gen student, first-gen American, queer
Enam	4th year PhD student	Man	African (Ghanaian)	
Maria	Recent (<1 year) graduate	Woman	Mexican- American	First-gen, low-income
Monique	5th year PhD student	Woman	Black American	First-gen grad student, low-income
Naomi	7th+ year PhD student	Woman	White & Native	
Santiago	1st year Postdoc	Man	Hispanic/ Latino	First-gen student
Steve	4th year PhD student	Man	White	Bisexual, disability

3.2 | Data collection

Data were collected through 20 semi-structured interviews, which were conducted on Zoom in the fall of 2021, with the exception of one which was conducted in person. The interviews lasted approximately one hour and were recorded and professionally transcribed. The interview protocol was informed by our literature review and included questions about participants' advisor(s), perceptions of their advisors' work-life balance, research group climate, and department climate [4]. This paper focuses on responses to two questions from the larger study's interview protocol:

1) What advice does your PhD advisor give you about your suitability and preparation for your desired career path?
2) Are there some aspects of your plans you don't feel like you can openly discuss with your PhD advisor?

3.3 | Data analysis

We completed two rounds of inductive coding using transcripts from the interviews [29]. In the first round of coding, we identified the five major themes of participant-advisor relationship, participant's perception of their advisor's/s' work-life balance(s), research group climate, department climate, and culture of academia, as presented in our prior work [4]. All of these themes except for "culture of academia" were directly asked about in the interview protocol. During the second round of coding, we identified codes and sub-codes for the first four themes, including "advisor career advice", which is the focus of this paper. The first author completed the two rounds of coding and met weekly with the second author to discuss the results. The first author and a graduate student also met weekly to discuss the larger project. We all examined codes across the three authors and ultimately achieved a consensus for final codes. Results have been grouped by participants who did and did not receive career advice, and we interpreted these findings through an LMX lens in our discussion.

3.4 | Positionality

The author team comprises one research scientist and two faculty members who have conducted multiple research projects focused on graduate education in engineering. The research scientist, who conducted the interviews, was a postdoc at that time. Two members of the author team have PhDs in technical engineering disciplines and one a PhD in higher education, and the two faculty members have served in administrative roles focused on graduate education at research-intensive institutions. Their perspectives contributed to our understanding of the influence of student-advisor relationships when designing the interview protocol. During data analysis, authors frequently discussed how their own experiences may influence results and how to ensure that their personal experiences would not bias interpretation of the participants' stories.

3.5 | Limitations

This study isolates the career advice portion of our interviews and doesn't look at other aspects of participants' relationships with their advisors. The participant-advisor relationships of participants who did not receive career advice may have had elements of high-LMX relationships or transformational leadership but were not captured here. The larger study considered aspects of participants' identities as PhD students and postdocs from groups historically excluded in engineering. This study focused only on the career advice that participants did or did not receive, which did not contain any mentions of their personal identities or how these impacted career advice. Thus, we did not observe patterns across participants as a function of demographics. The interview protocol did not contain explicit questions about personal identities and career advice; had it included them, it is possible that such themes may have arisen. Additionally, we only interviewed participants and not their advisors, so we only see one side of the mentee-mentor dyad relationship.

4 | Results

4.1 | Participants who received career advice

All ten of the participants interested in tenure-track faculty jobs received advice from their advisors, ranging from building the skills needed to be successful to how to obtain a faculty job. Only a few participants were on the job market at the time of being interviewed for this study, but their advisors had given them direct feedback on their written application materials (i.e., research, teaching, and diversity statements) and completed mock interviews with them. Lorena emphasized that her advisor helped her prepare for a short-notice interview despite being on vacation, saying her advisor is "someone who cares for the students and curious about [their] development, not only about doing papers and doing the research, but also what [their] career and future problems will be." Participants who were still graduate students received advice on doing and obtaining a postdoc position, as completing one before becoming a faculty member is the norm in most participants' fields. One of Candice's PhD advisors (as she was co-advised) recommended a research institute as a destination for her postdoc, where she ended up working. Although participants were asked what advice their advisors gave them about their suitability and preparation for their desired career, only Ahmed discussed the suitability part of the question, sharing that his advisor told him "you're more than capable." The other nine participants did not comment on their advisors' beliefs in their suitability and instead focused on advice about preparation.

Participants received significant mentorship on what skills were needed to be a successful faculty member and were provided with opportunities to build these skills during their graduate studies and postdocs. This included developing and teaching courses, attending and presenting at conferences, mentoring other students, leading outreach, writing grants, conducting meetings

with research collaborators, publishing papers, and, for one international student, improving their English. Participants were not able to gain first-hand experience in all aspects of a faculty role, but were still made aware of them, such as serving on committees and managing a budget. Additional support advisors provided to *interested* participants included writing letters of recommendation for Future Faculty professional development workshops and connecting them with professors or researchers who could hire them as postdocs.

In contrast, only four of the *disinterested* participants received any career advice at all, and only two of those were related to the participants' stated career interests. Santiago received career advice from his advisor, who recommended he apply to a postdoc fellowship that would pay well, give him freedom to do his own research, and lead K-12 outreach that interested him. However, other than the fellowship recommendation, he received no career advice. Enam's advisor told him that he "would do well in a faculty position" and suggested gaining teaching experience during his PhD. However, this advice was unsolicited, as Enam had not shared that he was interested in a faculty position. Similarly, Camila described how her advisor assumed she wanted a tenure-track job and was initially reluctant to accept her non-academic career interests, stating, "I feel like maybe she tried to convince me otherwise, like to take the professor route, but I never budged." However, once her advisor accepted that Camila wanted a job doing engineering research and development, her advisor encouraged her to network and attend an industry-related event. At the end of her PhD, she described her advisor as "very supportive, but it took some time to get there." Christine was initially interested in a tenure-track job before deciding to pursue a career at a government lab. During that initial time, her advisor "mentored" her and her husband (who was also interested in a tenure-track job but working in another research group at the same institution), discussing "what it means to become a faculty" and associated challenges. When Christine decided to pursue a career at a government lab, her advisor was supportive but did not offer advice, though she noted that he would have provided advice and "been right there" if she had asked. Out of ten *disinterested* participants, Camila was the only one who received explicit advice on preparing for a non-academic career.

4.2 | Participants who did not receive career advice

Only one *interested* participant and one *disinterested* participant did not receive any career advice from their advisors without feeling like they were not able to ask for it. *Interested* participant Jamal's Master's advisor did not provide him with career advice, but he did receive career advice after switching advisors for his PhD. Monique, a *disinterested* participant initially considering a faculty career, did not ask for career advice because the majority of her group's graduates pursue careers at government labs, and participating in a Future Faculty professional development workshop was considered "weird" for her research group.

Four of the 20 participants (one *interested* and three *disinterested*) did not feel comfortable talking with their advisors about their career interests. Two participants were

explicitly afraid to talk to their advisors about their career interests because they were considering non-academic careers. Maria, a *disinterested* participant, succinctly said of her advisor, “She didn’t want me to do what I’m going to do… For her, it’s like professorship or nothing else.” Fortunately, Maria was able to avoid confrontation and be direct about her career plans because her advisor lacked funding for her, causing her to seek out a government-funded PhD fellowship that required working at a particular government agency’s research lab after graduation. Ana, an *interested* participant, was considering industry positions in addition to faculty positions. Although she felt comfortable talking with her advisor about her academic career interests, including asking for letters of recommendation for Future Faculty workshops, not a single graduate of her research group had gone into industry, and she was not comfortable asking her advisor for advice on industry careers. Instead, she turned to her institution’s career center for guidance. The last two participants were not comfortable talking with their advisors about their career interests because of their relationships. Enam felt that his advisor was not interested in him: “I guess I typically like to share more from people who take a lot of interest. I don’t really have heart-to-heart conversations with him… I guess I withhold some information from him.” Fortunately, at the time of the interview, Enam had just gotten a new co-advisor who he felt “more readily inclined” to discuss his career plans with. Steve was dissuaded from discussing his career plans with his advisors for two reasons. His first advisor “is like ‘Well, why are you thinking about a career when you have all of this other work to do?’” It was unclear if this was a verbatim quote that his advisor had said or how he had made him feel, but it was significantly dissuasive. Additionally, Steve felt that it was “not a good use of the time” because his second advisor had limited time to meet and it needed to be “maximized” discussing research.

5 | Discussion

This study focuses on the career advice given to participants by their PhD and postdoc advisors. The career advice given to the ten *interested* participants by their advisors was indicative of high-LMX relationships and demonstrated transformational leadership by their advisors. Understanding participants’ job problems and needs and recognizing their potential are components of high-LMX relationships (items #2 and #3 on the LMX measure, respectively) [20]. *Individualized consideration* is one of the four I's of transformational leadership [22]. Advisors showed individual consideration for participants by considering their unique needs for becoming a faculty member and giving them advice on their application materials, interviews, and developing skills to be successful as well. Advisors provided participants with *inspirational motivation* by telling them which skills they needed to build to be successful and, in the case of Ahmed’s advisor, telling him that he is “more than capable” of becoming a faculty member. Though this study did not consider the broader relationships between participants and their advisors, our prior work on advisors positively influencing participants’ professorial intentions shows examples of *idealized influence*, another component of transformational leadership [4].

In contrast, the career advice *disinterested* participants received–or did not receive–was indicative of medium- and low-LMX relationships. Enam, Camila, and Christine received some career advice, though Enam received encouragement for a career path he did not want to pursue, and Camila only got advice after her advisor reluctantly accepted her non-academic career interests. Although Christine received extensive career advice when previously considering a faculty career, she did not ask for or receive unsolicited career advice after deciding to pursue a career in a government lab. The advisor relationships of *disinterested* participants who did not receive any career advice were suggestive of transactional leadership [22] and demonstrated functional supervision [8]. An extreme case of this was Steve, who felt he could not ask his first advisor for career advice because he should instead focus on his research and could not ask his second advisor for career advice because they had limited meeting time, which needed to be spent discussing research. Steve's relationships with his advisors are examples of social and contractual exchange: he provided his advisors with the research he was assigned to do, and they provided him with advice on how to complete it. As in the case of low-LMX relationships, advisors did not tell participants that they recognized their potential or, in the case of Enam and Camila, praised participants' potential for an undesired career path.

Bahnson et al. [15] used LMX to frame misalignments in mentorship profiles and competencies between engineering postdocs and their advisors. They found that such misalignments happen because postdocs and advisors have differing beliefs in what mentorship is and about the mentoring relationship itself. In our study, advisors who gave career advice would fit Bahnson et al.'s Well-Rounded Mentor(P) and Exemplar(P) mentor profiles. These profiles of mentors are interested in mentees' research, career, and success, including discussing mentees' career goals. Advisors who did not give career advice fit the Technical Manager(P) profile, in which advisors focus on research at the expense of mentoring. Our work provides examples of how these mentorship profiles could be further expanded to include career-specific mentorship.

6 | Implications

6.1 | Implications for Research

This work has several implications for further research in this area. Our discussion shows how future research can use transactional and transformational leadership as a framework to examine the relationships between engineering PhD students and their advisors. Further research through these lenses could expand beyond career advice to other aspects of these relationships and their impacts. Another opportunity for future research is to expand the sample size (such as through a quantitative study) to further understand the ways in which advisors provide students and postdocs with career advice. For example, we found that advisors either gave concrete advice or none at all. It is possible that other advisors may provide indirect advice by connecting

mentees with others in their network who are more knowledgeable about mentees' desired career paths.

6.2 | Implications for Practice

Our results reveal a stark contrast: PhD students and postdocs interested in faculty careers receive extensive career advice, while those pursuing other career paths receive little to none. It is understandable that advisors can more easily give advice on how to obtain a faculty position, as they themselves went through the process. It is also understandable that, given their own lack of experience outside of academia, they are less easily able to provide advice on non-academic careers [10], [18], and it is better for them not to provide any advice at all on topics they are not knowledgeable about rather than provide misleading information. Even if they themselves cannot provide non-academic career advice, advisors should at the very least cultivate an environment where mentees are not afraid to talk about their non-academic career interests. Advisors can also consider members of their professional networks (e.g., friends from their PhDs who work outside of academia) they can connect mentees with and learn about what resources exist on campus (e.g., career centers) so they can direct students to them. Building a network, or "constellation", of mentors is an effective way for mentees to gain diverse perspectives [30]. Institutions can also work to make faculty more aware of such resources. For graduate students interested in non-academic careers, one avenue is leveraging peer networks. Graduate students already turn to peers for career advice [31] but should consider how these peers, especially those who have graduated and are working, can expand their professional networks through introductions to experienced coworkers able to provide career advice.

7 | Conclusion

This study shows that engineering graduate students and postdocs interested in faculty careers receive significant career advice from their advisors. Advice about faculty careers includes concrete items such as feedback on application materials, interview preparation, and professional development to build the skills needed to be successful in their future careers. In contrast, engineering graduate students and postdocs interested in non-academic careers receive little to no advice, and some even feel like they cannot talk with their advisors about their career interests. We have also shown how future research can use leader-member exchange theory and transactional and transformational leadership as frameworks to study graduate student- and postdoc-advisor relationships.

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