

Exploring the Mentoring Needs of Engineering Postdoctoral Scholars of Color: Is Systematic Change Required in the Postdoctoral Training Environment? (Research)

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Illya V. Hicks was born and raised in Waco, TX. He received a BS in mathematics (1995) from Southwest Texas State University (currently Texas State University at San Marcos). He also received an MA and PhD in Computational and Applied Mathematics (2000) from Rice University. Illya served as faculty member in the Industrial and Systems Engineering Department at Texas A&M University (2000-2006) and is currently a professor in the Computational and Applied Mathematics Department at Rice University. He has also served as the faculty advisor to the president of Rice University (2016-2019). In terms of research, his interests are in combinatorial optimization, graph theory, and integer programming with applications in big data, imaging, social networks, and logistics. Illya is the recipient of the 2005 Optimization Prize for Young Researchers from the Optimization Society of INFORMS and the 2010 Forum Moving Spirit Award from INFORMS for his work with the Minority Issues Forum of INFORMS. Illya was also recently named an INFORMS Fellow.

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Exploring the Mentoring Needs of Engineering Postdoctoral Scholars of Color: Are Changes Needed in the Postdoctoral Training Environment? (Research)

Abstract

This phenomenological study (Moustakas, 1994) explores the mentoring needs of 11 engineering postdoctoral scholars of color with an adaptation of the ideal mentoring model (Zambrana et al., 2015) used as the conceptual framework. A critical theory lens (Morrow & Brown, 1994) is applied to Moustakas' (1994) four-stage process of phenomenological data analysis to examine the interview data: epoché, horizontalization, imaginative variation, and synthesis. The essence of the phenomenon is engineering postdoctoral scholars of color have primary and secondary mentoring needs pertaining to their immediate career acquisition of a tenure-track faculty position. Primary mentoring needs include expanding professional networks for the tenure-track faculty job search and receiving guidance on work-life balance and enhancing technical skills. Secondary needs consist of refining research directions and research expertise promotion, as well as acquiring political guidance on matters of race/ethnicity in academia. These findings reveal the importance of higher education institutions and postdoctoral supervisors assuming greater responsibility for ensuring postdoctoral scholars receive the mentorship and career support they desire, which may require a systematic change in the postdoctoral training environment.

Introduction

This phenomenological study (Moustakas, 1994) explores the ways in which engineering postdoctoral scholars of color describe their mentoring needs, particularly as they relate to their desire to enter the professoriate. An adaptation of the ideal mentoring model that resulted from the research of Zambrana et al. (2015) is used as the conceptual framework, and a critical theory lens (Morrow & Brown, 1994) is applied to the interviews of 11 postdoctoral scholars. While an academic career is the single most desired career option for engineering postdoctoral scholars, only 16% secure a tenure-track faculty position (Andalib et al., 2018). The reason many fail to rise to the professoriate may lie in their mentoring needs being unmet during their postdoctoral appointment (Scaffidi & Berman, 2011; Yadav et al., 2020). Awareness of the mentoring needs of postdoctoral scholars of color may provide institutions with the knowledge to ease the transition to the professoriate, an important step in diversifying engineering academia. Presently, just under 10% of engineering postdoctoral scholars identify as racial/ethnic minorities (Yadav et al., 2020), which is a cause for concern since future faculty are derived largely from this career group. This research is sponsored by the National Science Foundation (NSF) Alliances for Graduate Education and the Professoriate (AGEP; award numbers: 1821298, 1821019, 1821052, and 1821008). The research question that guides this study is: What are the ways in which engineering postdoctoral scholars of color describe their mentoring needs, particularly as they relate to their desire to enter the professoriate?

Literature Review

In recent decades, numerous efforts to diversify the science, technology, engineering, and math (STEM) professoriate have been employed (Yadav et al., 2020). Despite these efforts, the

demographic makeup remains relatively unchanged (Allen-Ramdial & Campbell, 2014; Castaneda et al., 2015; Griffin et al., 2020; NSF, 2019; Zambrana et al., 2015). Presently, only 6% of engineering professors identify as racial/ethnic minorities (Roy, 2019). Postdoctoral scholars are the greatest source of future faculty and subsequently a significant factor in the diversification of the STEM workforce and professoriate (Wilson, 2020; Yadav et al., 2020). If postdoctoral scholars of color are to successfully transition to faculty positions, Yadav and Seals (2019) argue institutions must provide social and structural support including mentoring.

Mentoring is a key factor in the success of scholars of color and their successful transition into the STEM workforce. Chemers et al. (2011) found mentors who engage in activities that meet the unique socioemotional and instrumental mentoring needs of their mentees are most efficacious. Socioemotional mentoring is defined as behaviors that support a mentee's emotional development, while instrumental mentoring comprises activities that bolster their scientific, technical skills. Effective postdoctoral scholar mentoring in STEM fields has been attributed to increased performance, overall success, and opportunity for career advancement (Faupel-Badger et al., 2015; Levy, 2014; Scaffidi & Berman, 2011). Mentoring STEM postdoctoral scholars increases levels of leadership and teamwork self-efficacy, which is positively correlated with one's scientific identity and their connection and commitment to remain in STEM careers (Yadav et al., 2020). Additionally, effective mentoring has been shown to increase productivity, creativity, inclusion, equity, and positive mental health outcomes, while reducing stress, anxiety, and depression (Hund et al., 2018; Levecque et al., 2017; Panger & Janell, 2014; Peluso et al., 2011; Sorkness et al., 2017; Van Benthem et al., 2020). Most notably, postdoctoral scholars who receive research and teaching mentorship designed to broaden participation in STEM were three times more likely to transition into the professoriate (Rybarczyk et al., 2016).

While the benefits of mentoring postdoctoral scholars are evident for current and future career success, postdoctoral scholars of color receive significantly less mentoring than their White counterparts (Beech et al., 2013; Yadav et al., 2020). And yet, mentoring continues to be heralded as crucial in the support and retention of faculty of color in academia and is often recognized as integral in career advancement (Hund et al., 2018; Thomas, 2001; Williams et al., 2016; Yun et al., 2016; Zambrana et al., 2015). If efforts to diversify the STEM professoriate are to be realized, the provision of mentoring designed to meet the self-identified needs of STEM postdoctoral scholars of color is warranted, as well as the requisite to understand their unique mentoring needs (Yadav et al., 2020). One way to ascertain this information is to directly involve postdoctoral scholars of color in this process, querying them on their individual mentoring needs.

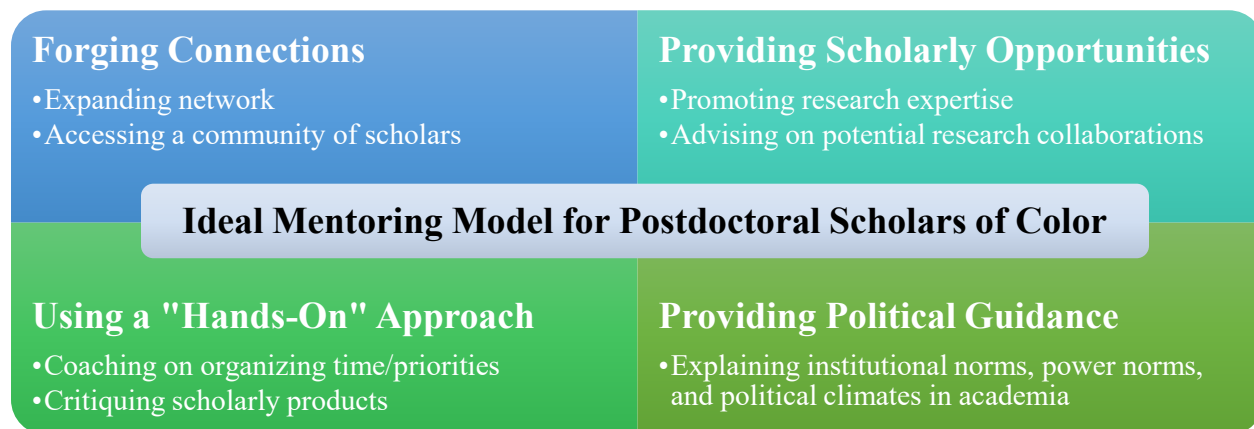
Theoretical Framework

Upon a thorough investigation of mentoring frameworks, the ideal mentoring model for underrepresented minority faculty that resulted from the research of Zambrana et al. (2015) was chosen and adapted for this study, as it provides a comprehensive picture of the mentoring needs and activities known to benefit faculty of color. Shifting the focus from faculty to postdoctoral scholars was a logical adaptation as frameworks utilize and build upon foundations of established knowledge, offer logical explanations for observed relationships, and reveal new understandings of a phenomenon (Anfara & Mertz, 2014)—in this case, the mentoring needs of

engineering postdoctoral scholars of color. In 2015, Zambrana et al. studied the mentoring needs of 58 faculty of color at 22 higher education institutions. The results led to the development of the ideal mentoring model comprising four discrete domains: forging connections, providing scholarly opportunities, using a hands-on approach, and providing political guidance.

The adapted ideal mentoring model for postdoctoral scholars of color encompasses the same four domains but ties specific needs and activities to those of postdoctoral scholars endeavoring to transition into the professoriate (see Figure 1). Forging connections involves the ways in which a mentor provides access and networking opportunities for a mentee, such as making connections for them while on the tenure-track faculty job market. Activities in the domain of providing scholarly opportunities comprise promotion of the mentee's research expertise and advice on potential research collaborations. A hands-on approach identifies the support a mentor provides to a mentee in terms of critiquing a mentee's scholarly products, such as grant proposals, and offering strategic coaching on time management and priority identification that supports career advancement. The final domain, providing political guidance, relates to explaining institutional norms, power relations, and political climates in higher education. The adapted ideal mentoring model provided the theoretical propositions of the mentoring needs of postdoctoral scholars and was used to guide the development of the interview protocol and in the data analysis procedures. Additionally, it was used in the consideration of the implications of this study.

Figure 1. *Ideal Mentoring Model for Postdoctoral Scholars of Color*



Methodology

Research Design. A phenomenological research design (Moustakas, 1994) was employed in the exploration of the mentoring needs of postdoctoral scholars of color with the use of the ideal mentoring model for postdoctoral scholars adapted from the research of Zambrana et al. (2015). The goal of phenomenological research is to capture and convey the experiences and stories of participants around specific interactions and events to stimulate transferability of findings to others in similar circumstances (Creswell & Poth, 2017). The application of a critical theory lens (Morrow & Brown, 1994) was utilized to ensure the researchers were cognizant of the structural systems of power in higher education that have served to exclude participation historically and today and the ways in which power may intersect with the disparate mentoring experiences of postdoctoral scholars of color. The research question of this study was: What are the ways in

which engineering postdoctoral scholars of color describe their mentoring needs, particularly as they relate to their desire to enter the professoriate?

Participants. A total of 11 URM postdoctoral scholars were recruited and interviewed for the study. Each participant was selected given their involvement and participation in the AGEPE Engineering Alliance, which is designed to address the career development needs of historically underrepresented minority engineering postdoctoral scholars who intend to successfully transition into tenure-track faculty positions. All participants were engineering postdoctoral scholars from one of three institutions situated in the southern region of the United States. One institution is classified as a doctoral university with high research activity (R2) and is a Historically Black College or University (HBCU). Another institution is a public doctoral university with very high research activity (R1) and a predominately White institution (PWI). The final institution is a private R1 and also a PWI. The sample is comprised of five females and six males, each self-identified as either African American or Latinx, and they are from a variety of engineering disciplines. The variations among participants are displayed in Table 1.

Table 1. *Demographic Indicators of the Postdoctoral Scholars*

Gender	Race/ Ethnicity	Institution Type	Field of Engineering
Male	African American	HBCU-R2	Chemical
Female	African American	Private-R1	Agricultural
Male	African American	Private-R1	Statistical Sciences
Male	Latinx	Private-R1	Computational & Applied Mathematics
Male	Latinx	Private-R1	Materials Science & Nano
Female	African American	Public-R1	Biomedical
Female	African American	Public-R1	Chemical & Biomolecular
Female	African American	Public-R1	Chemical & Biomolecular
Female	African American	Public-R1	Mechanical
Male	African American	Public-R1	Aerospace
Male	Latinx	Public-R1	Chemical & Biomolecular

Data Collection. Upon completion of the Institutional Review Board approval process, each postdoctoral scholar was contacted via email and provided with an informed consent form detailing the study and interview procedures. Participants were informed their participation in the interview process would be used to identify their mentoring needs and to guide researchers in the successful matching of mentors and mentees. Each of the 11 participants signed and returned the informed consent form and identified times for an interview, which were conducted over the

phone, averaged 30 minutes in length, and were digitally recorded. Data were collected in a one-on-one format utilizing an interview protocol based on the ideal mentoring model for postdoctoral scholars of color to ensure data were gathered in a systematic manner (Creswell & Poth, 2017). Adherence to the interview protocol ensured questions were carefully worded and asked in a specific order, additionally probing questions were included to seek clarification and meaning, as needed (Creswell & Poth, 2017). Upon completion of the 11 interviews, the interview recordings were transcribed by a third-party transcription service. The transcriptions were reviewed and cleaned for any errors, after which the digital recordings were permanently deleted. All transcripts were uploaded into the NVivo 12 platform for data organization and analysis.

Data Analysis. Analysis of the interview data was conducted utilizing a phenomenological approach. The systematic application of this approach allowed for coding credibility and dependability by discovering patterns in the data and developing a rich description of the phenomenon under study (Moustakas, 1994). The four-stage process of phenomenological data analysis as outlined by Moustakas (1994) was employed to examine the interview data: epoché, horizontalization, imaginative variation, and synthesis.

The first phase, epoché, occurred prior to data collection. During this phase the researchers engaged in the process of bracketing their individual and collective beliefs, values, assumptions, and experiences of the mentoring needs of hopeful academics in order to take an open and honest look at themselves. Epoché requires researchers to refrain from considering their lived experiences as absolute and instead to critically examine the way in which their unique experiences influence their interpretations of the world, and specifically the phenomenon at hand (Husserl, 1931/2014). This practice serves to reveal potential researcher bias and data misunderstandings that could interfere with the data collection and analysis processes (Moustakas, 1994). The researchers associated with this study are employed at higher education institutions and hold positions of professor, administrator, research affiliate, and/or graduate student. Each is committed to the diversification of the professoriate and has engaged in efforts to promote this cause through research, service, and policy avocation. All have participated in formal and informal mentoring programs and attribute these experiences as integral to their own career development. Bracketing occurred through all phases of data collection and analysis to account for and mitigate potential researcher bias through analytical memoing in which ideas and emerging patterns were noted (Giorgi, 2006). The theoretical underpinnings of critical theory (Morrow & Brown, 1994) were revisited during the epoché process to ensure the researchers attended appropriately to the systems of power in higher education that may influence the mentoring needs identified.

The second phase of data analysis utilized inductive, open coding of significant statements through horizontalization, as all transcripts were read with equal value (Moustakas, 1994). The statements were parsimoniously reduced and clustered into initial patterns through successive combining of similar significant statements in Nvivo 12. The initial patterns indicated the broad categories of mentoring needs described by participants, such as networking, refining scientific arguments, and managing microaggressions. In the third stage, imaginative variation was used to clarify the underlying structure of the phenomenon by addressing the contextual factors and conditions that determined the participants' mentoring needs (Moustakas, 1994), such as superior

and inadequate preparation for the professoriate. The ideal mentoring model provided a lens with which to consider the emerging themes that were determined during the horizontalization phase. Moustakas (1994) considers this process an analytical, mental experiment to explore a variety of perspectives. The fourth and final stage involved the holistic synthesis of the essence of the phenomenon (Moustakas, 1994), which was found to be: engineering postdoctoral scholars of color have primary and secondary mentoring needs pertaining to their immediate career acquisition of a tenure-track faculty position. Primary mentoring needs includes expanding professional networks for the tenure-track faculty job search and receiving guidance on work-life balance and enhancing technical skills. Secondary needs consists of refining research directions and research expertise promotion, as well as acquiring political guidance on matters of race/ethnicity in academia. The essence is to be considered limitless, universal, transferable, and formulated in the context of the participants and mediated by the researchers.

Trustworthiness. Trustworthiness of the findings was established by using multiple verification strategies (Lincoln & Guba, 1985; Nowell et al., 2017). Thick, rich descriptions and the inclusion of participant quotations were utilized to foster transferability (Geertz, 1973; Patton, 2015; Tierney & Clemens, 2011). Credibility was achieved through interview triangulation and identifying that saturation occurred prior to the conclusion of the interviews as no additional significant statements were gleaned after the sixth interview (Creswell & Poth, 2017; Patton, 2015). Employing Moustakas' (1994) phenomenological data analysis approach safeguarded the consistency of the process and product, which ensured credibility and dependability. Bracketing during the epoché stage and the involvement of multiple researchers in the analysis process also bolstered the dependability of the findings. Following the guise of Miles et al. (2019), themes were authenticated in multiple stages of the data analysis process to establish confirmability.

Limitations. The study purposefully attended to exposing researcher bias through the epoché process but we cannot absolve ourselves from its potential influence in the findings and interpretations. Despite the fact that none of the researchers possess an engineering background, we are all employed at higher education institutions and believe strongly in the benefits of mentoring and the important role it often plays in career advancement; therefore, the data were approached from both an outsider and insider perspective which may have prejudiced the study's conclusions. Additionally the researchers are involved in the AGEP Engineering Alliance so their closeness to the project could have clouded their ability to be neutral on the mentoring views and needs shared by the project participants.

Findings

Moustakas' (1994) four-stage process of data analysis resulted in four themes. Two primary themes related to immediate postdoctoral scholar mentoring needs and tenure-track faculty position acquisition: (1) Expanding their professional network for the tenure-track faculty job search, and (2) Receiving guidance on work-life balance and enhancing technical skills. The two secondary themes presented as less urgent supports needed: (3) Refining research directions and promoting research expertise, and (4) Acquiring political guidance on matters of race/ethnicity in academia.

Theme 1: Expanding their Professional Networks for the Tenure-Track Faculty Job

Search. The postdoctoral scholars discussed the importance of expanding their professional networks and specifically leveraging their mentor's network as they entered the tenure-track faculty job market. All 11 participants hoped to flex their mentor's network in support of being recognized as a competitive applicant and in securing an interview, as noted by an African American male at an HBCU-R2:

I want to be a chemical engineering professor, I could definitely see myself in the chemical engineering department as a professor . . . to have someone on my side that can actually talk to people and mention my name sometimes or have me come to present in seminars and things like that, are pretty important.

A Latinx male at a Private-R1 shared the importance of truly understanding that which departments are seeking in an applicant and then appropriately tailoring the application package: "What I've found out so far from applying to faculty positions is that different departments have slightly different requirements . . . and the only way I found that out, is from actually talking to professors within these departments." Similar sentiments were echoed by an African American female at a Public-R1 who is seeking a mentor to help in developing dynamic application materials personalized to her sub-discipline: "I think really what matters most is someone that's in my field that understands the nuances of applying for a faculty position within biomed engineering, because it's a little bit different from the other engineering fields." In general, the postdoctoral scholars hoped their mentors would open their networks to them and confirm they were on track and were doing all the "extra things" to be successful in their career goal of entering the professoriate.

Relatedly, the postdoctoral scholars were interested in receiving mentorship on how to "have an edge in the application process," as described by a Latinx male at a Private-R1. The participants hoped their potential mentors could provide them with advantages in this process. An African American male at an HBCU-R2 shared his desire to engage in mock interviews with his mentor's colleagues in preparation for the faculty interview process:

There are some general questions that they ask during the interview that anybody would ask. Like, "What are your research ideas?," "When you get here who do you think you want to work with?" . . . I think it would help a lot, as far as me being able to find the right words or saying things the way that it needs to be said . . . Any kind of practice on that would be very valuable.

Postdoctoral scholars believed they could achieve an additional "edge" from their mentors' networks through connecting with institutions and faculty who genuinely desire to diversify their departments. An African American male at a Public-R1 stated, "Providing me more access to universities, especially with deficits in faculty and underrepresented minorities would be helpful." Each postdoctoral scholar identified extending their networks and obtaining customized, personal advice on institutions that may be a good fit for them as their top mentoring need. Each described specific ways a mentor's professional networks can be of benefit moving forward and, specifically, how they can leverage their connections as they seek to transition into the professoriate.

Theme 2: Receiving Guidance on Work-Life Balance and Enhancing Technical Skills.

In addition to expanding their professional networks, participants strongly desired guidance on work-life balance, as well as enhancing their technical skills. The postdoctoral scholars

expressed concerns on the stress that developed during their doctoral studies as they struggled to find a proper work-life balance. The resulting burnout left them feeling somewhat despondent about the possibility that the balance may become even more unachievable in the future if they failed to address it now. A Latinx male at a Private-R1 described this concern:

I need support with work-life balance because I see that's a big issue for me. Coming out of the PhD program, I felt like I was to the point where I was burning out. And I don't want to repeat that in the long-term race that is the tenure-track life.

An African American male at a Public-R1 echoed this idea and specifically referenced the need to be present with his family:

My wife and I had a baby this fall. Prioritization and time management of my time, yes professionally, but also by extension personally, is quite important to me. It's really important for me to know that I can succeed and have a strong career and also be available for my family.

While work-life balance was intimated as a challenge, most of the postdoctoral scholars believed it was achievable with appropriate modeling and focused counsel.

In addition to learning of ways to achieve a sense of work-life balance, participants desired support in expanding their technical skills. An African American female at a Public-R1 stated, “So I need someone who would read my documents and try to strengthen my scientific arguments.” An African American female at a Private-R1 shared a similar sentiment by noting her desire to receive additional methodological training from a mentor: “I’ve been trained as a qualitative researcher; I’m looking for some mixed methods and quantitative research opportunities.” Direct support in increasing technical skills, and specifically strengthening scientific arguments, was an area of need cited by many participants. While several postdoctoral scholars shared this was occurring within their positions and with their advisors, each sought more individualized support in this area, as they believed it would help them to be more marketable in the tenure-track faculty search process.

Theme 3: Refining Research Directions and Research Expertise Promotion. Some of the postdoctoral scholars of color shared a mentoring need of refining their research directions, which was particularly true of those steeped in interdisciplinary scholarly work. An African American female at a Private-R1 shared her thoughts on the need for support in determining how best to market herself as she pursues an academic position:

My research is so interdisciplinary . . . I have a hard time telling people why I would be a good addition. I can tell them I have done work around mentoring and graduate education, and also looking at higher ed programs. But I have also researched STEM education and qualitative positions. So, I could fit in a lot of places.

An African American male at an HBCU-R2 expanded on this notion in his specific desire to learn how to refine his research profile and to better understand the disciplinary fields that would be best with which to collaborate:

All the research [at my postdoctoral institution] is completely different from what I'm doing now. But it's not too far away that I couldn't learn it, and actually get into another field. If I were to somehow start collaborating with another researcher in another department here, they may be able to help me there.

All individuals indicated they would appreciate their mentors promoting their research expertise, as described by a Latinx male at a Private-R1: “I think access to not necessarily just conferences,

but to meet other professors at other universities, somebody that can introduce me and kind of help me show off my research, what I've done and can do." Yet, most were unable to articulate the ways in which a mentor could promote their research expertise despite their understanding that sponsorship is an important mentoring function to engage in.

Theme 4: Acquiring Political Guidance on Matters of Race/Ethnicity in Academia. Nearly all participants desired mentorship relative to matters of race/ethnicity in academia. An African American female at a Public-R1 simply stated, "I think the main need for me is managing microaggressions," the subtle everyday insults and insensitive comments typically heralded toward faculty, staff, and students of color in academia. As these situations occur infrequently, practice on handling them does not present often. She desired to be proactive in effectively countering these comments and behaviors directly. The postdoctoral scholars were clear, in that as scholars of color they faced nuanced challenges; thus, they particularly sought mentorship in this area. A Latinx male at a Private-R1 noted the need for a mentor with whom he has a shared background in order to better enable this process:

I definitely want to have a personal connection [with my mentor], because that will facilitate having these conversations of what does it mean to be an underrepresented minority at these top levels of higher education. What does it mean in terms of the politics? What is that going to mean in terms of my professional development?

An African American male at a Public-R1 elaborated on this mentoring need:

I think what can happen, particularly as a minority faculty member, is that a lot of service might get thrown your way. I think that the pressure not to say no to overburdening yourself is there. I do. You want to do a good job and you certainly don't want to be seen by your colleagues as someone who isn't willing to play ball, but yet in academia, time is finite and you're still going to be held accountable for the research that you're not doing during that time.

While the need for political guidance was acknowledged as critical to their professional development, participants were generally positive about their ability to effectively manage the racial/ethnic politics that permeate academia with effective mentorship. Interestingly only half of the postdoctoral scholars believed a faculty of color mentor was essential in meeting this need.

Discussion

This phenomenological study (Moustakas, 1994) grounded by a critical theory lens (Morrow & Brown, 1994) sheds light on the self-identified mentoring needs of postdoctoral scholars of color. Each was eager and committed to the mentoring opportunity offered by the AGEP Engineering Alliance and believed their mentors could elevate their potential for securing a tenure-track faculty position, which was the ultimate career goal for each. Four themes emerged relative to postdoctoral scholar mentoring needs: (1) Expanding their professional network for the tenure-track faculty job search was of paramount importance; (2) Receiving guidance on work-life balance and enhancing technical skills were key; (3) Refining research directions and research expertise promotion were highly desired; and (4) Acquiring political guidance on matters of race/ethnicity in academia was required. The mentoring needs identified in this study coincide with and extend the scarce but growing literature on this topic for postdoctoral scholars of color (Beech et al., 2013; Scaffidi & Berman, 2011; Sorkness et al., 2019; Yadav & Seals, 2019; Yadav et al., 2020).

The ideal mentoring model for postdoctoral scholars of color (Zambrana et al., 2015) was a useful tool for considering, organizing, and communicating ideas about the mentoring needs shared by the participants. The themes aligned well with the four domains of the model: forging connections (theme 1), a hands-on approach (theme 2), scholarly opportunities (theme 3), and political guidance (theme 4). While this model was originally conceived with the mentoring needs of faculty of color in mind, this study indicates the adaptation has merit with postdoctoral scholars. Primary themes relating to forging connections and a hand-on approach were linked to more immediate career acquisition and were of utmost importance to participants. Secondary themes aligned with scholarly opportunities and political guidance and were couched as less urgent despite the value attributed to them. These findings suggest mentoring has the capacity to be particularly beneficial when it is responsive to the unique, individual circumstances of the mentee and spans both socioemotional and instrumental mentoring practices (Chemers et al., 2011; Rybarczyk et al., 2016; Scaffidi & Berman, 201; Van Benthem et al., 2020; Yadav et al., 2020).

Implications. This study illustrates key implications for higher education institutions, postdoctoral advisors, and postdoctoral scholars. Clearly, mentoring is needed and desired by postdoctoral scholars. Unfortunately, this study suggests they are not receiving it systematically, indicating changes may be required in the postdoctoral training environment. Institutional-based mentoring programs that leverage disciplinary alumni in government and industry may fill the gaps in available institutional academic mentors because the mentoring needs were not all germane to the higher education context. It also would be important to attend to mentoring matches that are considerate of the demographic backgrounds of the mentees since some intimated a desire for a mentor with a shared cultural background. Postdoctoral advisor mentoring training also may be warranted in order to increase awareness of the mentoring needs of their advisees, as well as the value of querying them on mentoring needs distinct to individual circumstances, such as parenthood and dual academic career-seeking households. Similarly, some postdoctoral scholars were unable to articulate their mentoring needs which likely will inhibit them from receiving the career and professional development required to achieve their career goals.

Future Research. A fruitful area for future research involves continuing to study the applicability and efficacy of the ideal mentoring model for postdoctoral of scholars adapted from the research of Zambrana et al. (2015). It also is important for future research to discern whether a fundamental difference exists between providing support to those themes deemed primary and those deemed secondary by the participants. Does the provision of mentoring support in only the primary domains of forging connections and a hands-on approach greatly outweigh the benefits of providing support in all four domains? It also is important to identify the way in which mentoring in each area directly influences career trajectories, both positively and negatively. Future exploration also must involve exploring the differences in educational experiences between African American postdoctoral scholars who attended HBCUs as undergraduates and graduate students, as they intimated less experience with negatively charged political climates and microaggressions. These scholars appear more optimistic regarding traversing future political hurdles and the racial/ethnic power dynamics present in higher education. Postdoctoral scholars who attended PWIs had more experience with microaggressions

and feeling tokenized; therefore, they ascribed greater need for support in this area because they were already wearied from their student experiences.

Conclusion

This phenomenological study (Moustakas, 1994) provides a deeper understanding of the unmet mentoring needs of postdoctoral scholars of color. While each of the four domains of the ideal mentoring model that resulted from the research of Zambrana et al. (2015) was acknowledged as a crucial area of need for engineering postdoctoral scholars of color, the domains of forging connections and using a hands-on approach were assigned greater importance. These two domains were attributed more value because the participants believed they spoke directly to career acquisition, particularly as they related to entering the professoriate. Mentoring needs within the domains of providing scholarly opportunities and political guidance were secondary and regarded as less urgent. Although the findings of this study are specific to the unique circumstances of the AGEP Engineering Alliance postdoctoral scholars and their mentoring needs, the goal of phenomenological research designs is to promote transferability of findings to others with similar experiences, so we encourage conversations regarding and the applicability of these self-identified mentoring needs to others in the postdoctoral training environment.

The application of a critical theory lens (Morrow & Brown, 1994) forced consideration of the ways in which higher education institutions may unequally distribute resources such as mentoring. The inability to address the unique mentoring needs of scholars of color may be key to understanding the persistent low numbers of faculty of color in academe. This supposition suggests a systematic change may be required in the postdoctoral training environment if postdoctoral scholars' mentoring needs are to be effectively addressed and their professional growth advanced. Each participant had been in their postdoctoral position for at least six months, and it was clear their mentoring needs had not been attended to or even queried. If that practice continues, they likely will not receive the career support and professional development desired to move into the professoriate. If those next in line to successfully compete for tenure-track faculty lines are not receiving sufficient mentoring, the structural systems of power in higher education are persisting. If this is the case, the call to action in diversifying the engineering professoriate is going unheard.

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