”Mentoring is not created equal”: Doctoral STEM Faculty Perceptions of Mentoring and Implications for Underrepresented STEM Learners.

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“Unequal Mentoring”: Perceptions of Mentoring of Doctoral STEM Faculty

Abstract

Underrepresented minority (URM) students have not been well represented within the ranks of doctoral degree holders or faculty in STEM disciplines despite the increased attention in recent years to this concern. URM students lag considerably behind White and Asian students in degree completion and faculty appointments. One intervention widely touted as effective in promoting positive outcomes is mentoring however URM students often lack access to mentoring and just as importantly mentors lack culturally responsive knowledge, skills and dispositions required to be effective mentors to URM students. A qualitative study was conducted to better understand how the knowledge, skills and dispositions of STEM faculty align with culturally responsive mentoring. Three themes were constructed from the data: role ambiguity, preparedness, and culture of doing. The study concluded that faculty need more and better training around cultural responsiveness to meet the needs of URM students.

Introduction

America has failed to meet the growing needs of society as a result of its slow production of scientists. This is due in part to consistently not leveraging the talent pool present in population groups such as African Americans, Latinx, Native Americans, Native Alaskans, Native Hawaiians, and Native Pacific Islanders. These groups are considered underrepresented racialized minorities (URM) and have scant representation in Science, Technology, Engineering, and Math (STEM) disciplines both at the level of doctoral graduates and doctoral faculty. In 2015, over 225,500 graduate STEM degrees were awarded in the U.S.; 181,000 being master degrees and 44,500 were doctoral degrees [1], [2], [3] . According to the National Science Foundation (NSF) [4], URM graduate students only earned about 9% of the overall doctoral degrees awarded in 2015 and about 13% of undergraduate degrees. This evidence suggests that STEM doctoral programs in the U.S. are severely deficient in representation from students of different racial and ethnic groups. This is a disturbing historical and contemporary trend that universities should pay close attention because of the implications on America’s ability to compete on a global level with nation states succeeding at preparing individuals for careers in STEM fields.

The participation of URM students in doctoral STEM programs is a recalcitrant issue that has been taken up by scholars and government agencies with great vigor. Sowell, Bell, Kirby, and

Naftel [5] found that financial support, mentoring and advising, family non-financial support, and social environmental/peer group support were among the top things that impacted attrition. Okahana, Allum, Felder, and Tull [6] further reported that institutional level interventions for URM STEM doctoral students were scant and limited in intervention focus with most providing additional financial resources as the means to reduce attrition. Beyond that, institutional-based support existed in the forms of peer support groups and mentoring. Mentoring in particular has been noted as a key intervention to increasing persistence of URM STEM doctoral students but few studies have attempted to discover if and how those mentoring practices are culturally responsive. The purpose of this study which was funded by the National Science Foundation's (NSF) Alliance for Graduate Education Program (AGEP) was to better understand the culturally responsive mentoring knowledge, skills and dispositions of STEM doctoral faculty.

Mentoring

Mentoring originates from Greek mythology as a story of Odysseus who leaves to fight in the Trojan War. He entrusts the care of his household and son Telemachus to Mentor, who would serve as a teacher and guide [7], [8]. Other terms that have been applied to describe a mentor include role model, sponsor, coach, or master teacher [8]. Jacobi [9] has been cited for noting the absence of a "widely accepted operational definition of mentoring" (p. 505). The lack of a clearly understood term results in "lack of clarity of about the antecedents, outcomes, characteristics, and mediators of mentoring relationships despite a growing body of empirical research" (9, p. 505). Mentoring in the academy has been understood to occur in a dyad model between a more experienced professional acting as a guide and teacher to a novice or apprentice scholar [10]. This is a primarily top down framework where information flows from the more experienced scholar or professional to the novice apprentice. Emphasis in the research has been placed on mentoring activities such as meetings or discussion groups or the relational component that delves into psychological support. Hund et al. [11] refers to the qualities of mentors using a concept called *authentic mentoring* that includes terms such as patience, honesty, communication, empathy, and listening. Those individual characteristics are critical to effective mentor-mentee relationships and contribute to the personalized experience that evolves during the process of a student developing into an independent scholar [12], [13]. The symbiotic relationship between the mentee and mentor is important as it can fill the gaps and needs of the mentee that are salient to short and long-term goals [14].

Doctoral mentoring is a dynamic longitudinal process that may be multidimensional, meaning it impacts both the individual student and the institution. At the institutional level it is understood as a mechanism that contributes to reducing attrition rates and enhancing recruitment plans but

there is a scarcity of empirical research related to PhD programs to understand this phenomenon. Contemporarily, Di Pierro [15] conceptualized doctoral mentoring as part of an institution's pragmatic retention plan to counter economic losses, potential loss in Carnegie classification, and voids in research. Thus, mentoring should not be thought of as a disjointed obscure process, but one that is integrated and benchmarked as part of an institution's best practices particularly for underrepresented populations. For individual students mentoring often times is described as a key element to a successful academic career. Dawson, Bernstein, and Bekki [16] recognized effective mentoring as being an important component in the academic and professional development of women and minority students. For women and minorities who matriculate in advanced STEM fields, effective mentoring is critical to their academic and professional development. Davidson and Foster-Johnson [17] contended that mentoring relationships, both formal and informal, were the underpinnings of success in graduate school. They asserted that mentoring served to (a) integrate students into a department, (b) cultivate critical professional and social networks, (c) enable development of essential research competencies, and (d) initial job placement post-graduation. According to Taylor and Anthony [18] and Patton [19] , higher education professionals identified specific approaches to mentoring that improve the mental and psychological development of URM students. Some of these approaches include providing pertinent information about the historical background of the field and career choices [20]. Other approaches include finding a mentor that has a similar cultural background or shared experiences with the mentee [19]. This provides the mentee with more comfort in knowing that they can identify with their mentor. Gay [21] acknowledges that using a culturally responsive approach, with regards to mentoring, requires more thorough knowlege of the mentees' specific culture and ethnic background. In other words, using a generalized approach to mentoring may be counterproductive in retaining students. Faculty and administration can not and should not take a "one size fits all" approach to mentoring especially when it comes to URM students.

Part of the challenge in understanding how mentoring is practiced is the tendency to conflate the term, mentoring, with the role of advising that is familiar in the undergraduate and graduate education taxonomy. Further, the terms advisor and mentor are used interchangeably without regard for the distinct roles [22], [23], [8], [24]. Advising roles are proximal to mentor, but usually with the distinction that advisors are assigned as part of a student's program or department; whereas, a mentor may be within or outside the department or institution and may or may not be assigned [25]. Another sharp distinction is that advising is time limited to enrollment in a particular academic program; whereas, mentoring is a more long-term commitment.

Another challenge noted in the literature was in defining the concept of "effective" mentoring specifically in STEM [11] . Hund et al. [11] contend that STEM fields lack a framework for mentorship training which is necessary for building mentoring praxis. Schlosser and Foley [26] similarly contend that mentoring relationships should be inclusive

of cultural identity, acknowledging the saliency of the characteristics of one's identity. Their work highlights the context specific nature of mentoring. This is especially important considering the prominence of gender and racial identit- in STEM disciplines [27] . Creighton, Parks, and Creighton [13] propose a conceptual model of effective mentoring inclusive of planning, practicing, and cyclical evaluation, suggesting that effective mentoring requires intentionality to the philosophical thought and commitment necessary for research productivity and the development of professionals.

In the sciences mentoring is positioned as an intervention program to support persistence and is framed as being a relationship between a mentor and protégé [28]. In this relationship mentors provide instrumental support which includes access to resources and opportunities and psychosocial support that enhances sense of competence, and relationship quality including feelings of connectedness. Another essential outcome of STEM doctoral mentoring is assisting students in developing an identity as a scientist.

Science Identity Theory

Though science identity receives less attention than underrepresentation, its development, particularly in racially minoritized students, nonetheless is an important aspect of creating more equitable outcomes in STEM [29]. One must consider the stereotypical ideas of what guides the understandings held by self and others. Identity speaks to how we see ourselves and how others see us. Within the science community, there is a normalized visual representation of what a scientist 'looks' like. Scientist stereotypes are perpetuated when the faculty and student population are white resulting in the neglect of the existence of URM students [28].

The construction of a science identity involves dispelling stereotypes. Alston [30] notes "Scientist stereotypes are perpetuated when racial and sexual diversity are not fully embraced by both industry and academia" (p. 50). Such stereotypes are grounded in visual representations in the media and in classrooms of scientists being predominantly white and male. These visual representations undermine the viability of visual representations of minority scientists. Therefore, URM students find it difficult to see themselves as scientists, when historically, the image that is being sold to society is that of Eurocentric ancestry. These images disrupt the narrative of those successful scientists who are minorities and have contributed to STEM fields. For those URM students in STEM who are bombarded with negative stereotypes, it may affect their academic experience. A generalized approach to mentoring may do little but continue to perpetuate the racial divide among URM students and the white dominant group.

According to Guy [20] “Researchers in other arenas are shifting their focus from deficits and barriers to strengths to emphasize the variety of students’ abilities in what is termed as multiple dimensions of identity” (p. 33). Based on the experiences of Black male persistence in STEM, Guy [20] advanced an understanding of racial identity in science that ignites a compelling argument that could be applied to all URM students in STEM disciplines. Essentially students must be able to see their future selves as scientists. If there is a gap between the perception of self and one's' imagined future self, identity incongruence will occur. Alston [30] states “Identity congruence speaks to the space between how black men see themselves and how they see other scientists” (p. 50). Identityy incongruence can be problematic for URM students and can serve as a deterrent for those students seeking graduate degrees in STEM. Guy [20] further explains that “pathways to science learning” (p. 23) are in part determined by how they understand who and what a scientist looks like. To the extent that students do not see themselves reflected in the traditional image of scientist, they might be best steered toward an “everyday learning environment rather than in a lab setting” (20, p. 23).

Data Collection and Analysis

The findings from this report stem from a larger qualitative study that employed an embedded case study design using primarily qualitative methods and a descriptive survey. Embedded case studies are a means of conducting detailed descriptive inquiry where the phenomena of interest and the context are intricately intertwined, and the central phenomenon is studied in differing contexts [31]. The data from this report was drawn from one of the embedded cases within the larger study and was generated from phenomenological interviews with nine STEM doctoral faculty. The participants in this study were faculty members who served in leadership positions at the departmental level as department chairperson or graduate program director. The participants were employed at a large university in the southeastern region of the U.S. The participants included three Graduate Program Directors (GPD) and six Department Heads from six STEM departments. Of the department heads, four were male and two were female, all were White. Of the GPDs, two were male, and one was female and two were White and one was Asian. In total, six were male, three were female, eight were White and one was Asian. All were tenured faculty who had at least one doctoral student. Most of the faculty had not had a URM doctoral student as a student mentee. The departments represented physical, life and formal sciences.

The research was guided by the following research question: How do the knowledge, skills, and dispositions of STEM doctoral faculty in departmental leadership aligned with culturally responsive mentoring? Each participant participated in one semi-structured phenomenological interview that lasted approximately 45 minutes. The interview was recorded and later

transcribed. The participants were asked a series of demographic questions related to their academic and professional background and then were asked questions about their perceptions of mentoring and the role of culture in the mentoring process.

Data was analyzed using the constant comparative method [32]. Constant comparative analysis typically aims to identify themes and reveal patterns in the data. The purpose of using the constant comparative method is to discern and distinguish conceptual similarities in alignment with our research questions. Constant comparative analysis is a coding method. This study used open, axial and selective coding processes to arrive at themes. This involved multiple readings of the data, identification of key words, searching for associations between key words to form open codes and noting patterns between the open codes to form axial codes. The axial codes were then developed into selective codes which represented the themes within the data.

Findings

Three themes were identified: role ambiguity, preparedness, and culture of doing. The first theme is role ambiguity. In this study the participants use the terms mentoring and advising as if they were mutually inclusive. Some did not distinguish a difference between mentoring and advising. For example, one participant explains his confusion by stating, “I don't see much different. I don't quite understand faculty doctoral advisor versus mentor”. This misunderstanding contributed to the confusion of the primary responsibilities of a mentor creating role ambiguity. This further insinuates that lack of knowledge among the faculty muddled understandings of mentoring, thus undervaluing the importance of culturally responsive mentoring. Some faculty members explained that science is driven specifically by research and data collection and therefore leaves little room for mentoring. One of the participants clearly states, “I think the good mentoring starts with - Okay, let’s talk science”. In other words, ‘research trumps mentoring”. Still others mentioned that the students’ focus should be on their research and lab assignments and there was no room for “hand holding”.

However, other faculty members acknowledged that they could do a better job at mentoring their students, which could ultimately lead to a more productive lab environment. When the focus of the interview shifted specifically to URM students, some faculty members felt that they “treated their graduate students the same” without any special treatment given to anyone. This response revealed that some faculty members were using a more generalized approach toward mentoring while ignoring the unique differences culturally that URM students bring. Insinuating that all “mentoring is created equal”. Contrary to what many of the faculty members conceive as an “equal opportunity” environment, there were a few participants that drew upon previous experiences with other cultures and understood that mentoring should be

tailored to each individuals' circumstances and background.

The second theme, preparedness, explains how being prepared to mentor is key to a successful mentorship. There are two primary attributes associated with preparedness: presumption of competence and developing the mentor. The concept of presumption of competence suggests that mentors are competent in all aspects of mentoring. For example, mentors were assumed to have effective communication skills, the ability to recognize cultural differences, and potentially most relevant to understand the importance of their contributions of mentorship for the success of PhD students. Failing to recognize cultural differences was evident in how departmental leadership understood the uniqueness of individual students. They often expressed a philosophical standpoint of an ideology of sameness as exemplified by using the phrase "I just try to treat people as people". Another participant stated, "I think it doesn't matter if you're an under-represented minority student or not. The department head and leadership within the department has to set the culture. You have to basically set the rules for what behaviors are accepted and what aren't."

Another way presumption of competence surfaced was in how STEM departmental leadership expressed a lack of confidence in their ability to mentor. They were extremely confident in their ability to instruct doctoral students on the technical aspects related to being a scientist but were less confident in their ability to deal with areas of development outside of that realm. For example, one department chair mentioned not being comfortable in mentoring or counseling a PhD student. The emotional needs of a student was an area that "they were not trained in" according to one participant. This may stem from their own experiences and structured preparation for the sciences or the professoriate.

The second attribute of preparedness was developing the mentor. Pervasively, the departmental leadership indicated that they had limited preparedness for enacting their role as mentors. They recognized that their preparation was constrained to that of developing scientists and minimally to the mores of being a mentor. Being a mentor was understood as training outside of their skillset. One of the participants shared that there was a lack of training to help mentors with being more effective by stating "Because you know you get to be a mentor, as an advisor, and you never really had any training and now you're a manager, and a guide, and sometimes a psychologist, so it's kind of learn by experience was what I went through".

Their training as a faculty did not include various facets of what mentoring entailed such as understanding students as individuals. They did not understand the impact of the differing motivations of learning and anticipated career trajectories that students were interested in pursuing or the impact of motivation on the needs of students. These processes required time and

commitment that was often noted as being limited. Intensive training, expanded knowledge, and intentional encounters with those often "othered" are needed to make a positive difference in the lives of URM STEM doctoral students. Overall the theme of developing a mentor speaks to the lack of emphasis on mentoring within the multiple roles of a faculty mentor. Because this aspect is not emphasized as critical, faculty have had few opportunities to develop skills as effective mentors.

The culture of doing was the last theme that was developed out of the data analysis. This theme explains how science identity is predicated on doing, requiring less attention on the person and more attention to the work (doing). Human beings are not developed in this process, human doers are. Culture of doing was understood as being the process of developing students into scientists. Faculty leadership in the study felt that their primary role is to "create scientists". This entails teaching how to conduct research, collect/analyze data and then defend their conclusions. One faculty member stated "Your research is what gives you your degree" implying that the end goal was to graduate but the means to this did not involve attending to other aspects of the student's development. A program director explained that the focus was to make sure that the students graduated on time, thus making sure that they were kept on track, emphasizing more of an academic advisory role focused on what students were doing rather than a mentoring one which emphasizes who the students are and what they need more holistically.

Another outcome of culture of doing is that students are treated as employees rather than human beings learning in a scientific environment. The data spoke specifically to this when a program director indicated that the student needed to be able to work independently with minimal direction from them. In other words, they were only concerned with the students ability to complete the project and not the process which includes the learning component that is associated with the project. This construct was also adopted within the lab environment. Students who worked in the lab were often working on grant related research that involved grant funding from an organization. Within the parameters of many grants, research needed to be done and the students assisted with the research. These grant funded opportunities were accompanied by a compensation package for the student that allowed them to 'get paid' while they were training to be scientists blurring lines between employee and student, creating more of a work environment than a learning environment. This approach is very impersonal and leaves little room for building a healthy mentorship, which can lead to almost no room for culturally centered mentoring since the assumption is that training one on how to "do science" is all that is needed in the process of developing students as scientists. This was underscored by one participant who said "I really don't see a big role of culture in doing research". Culturally responsive mentoring emphasizes the person first. Mentoring that is not person centered, engaged in by persons with culturally responsive competencies and knowledge, and understood as being multifaceted in

nature often inadequately meets the needs of and fails to meaningfully engage URM STEM doctoral students.

Conclusion

The data suggests that faculty need to be intentionally prepared to mentor. Being actively prepared not only assists in a successful mentorship, but it also allows the mentor time to gather all the necessary information to create a space of inclusion and equity. This is especially important in STEM disciplines because their understanding of their tasks and roles are governed in large measure by the culture of science that prioritizes doing science over developing scientists more holistically. This was evident in the proclivity of the faculty leadership to overemphasize the act of researching over the development of students.

Consistent with the extant literature on mentoring, this study found that STEM faculty conflated mentoring with advising. When asked to describe mentoring, faculty referred to tasks often associated with advising, and advising often focused on aspects of what students needed to do programmatically, or in the lab to successfully complete their programs of study. Without question, part of the responsibilities of a faculty member is dedicated to research, writing, and teaching. However, those responsibilities consistently overshadowed the responsibility of mentoring, which seemed to be an afterthought and disregarded as an essential duty. This is disconcerting given that the extant literature [10-12] recognizes how effective mentoring contributes significantly to the student's overall academic and social development. It is important therefore that faculty members are clear in understanding the differences between advising and mentoring and have training on how to engage both when working with students. Once faculty members have a clear and distinct definition of mentoring, then they can explore resolutions to creating an effective mentoring environment.

In addition to having a clear definition of mentoring, faculty also need to recognize that culture responsive mentoring benefits URM students and helps with their development as scientists. Developing culturally responsive mentors can take place through workshops, modeling, having experiences with URMs, and talking with people differently located which is not the typical experience of the STEM faculty serving in departmental leadership roles. Guy [20] explains that the pathway to the science of learning, starts with how we create our perspective of how a scientist looks. Despite societies "white coat" image, scientists are people who study science. There should not be a racial identity associated with scientists, but rather the work that a scientist does and their contribution to science. One way to ensure that we change our perception of scientists is through effective mentoring.

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