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Taking the next step: supporting postdocs to develop an independent path in academia

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Abstract

Background: In the USA, 28.5% of the population is considered underrepresented minority (URM) population; however, fewer than 8 % of US' research faculty in science, technology, engineering, and mathematics (STEM) disciplines are minorities (National Research Council, Expanding underrepresented minority participation: America's science and technology talent at the crossroads, 2011). In order to diversify the faculty, Big Ten Academic Alliance's Professorial Advancement Initiative (PAI) provided high-quality professional development for URM postdocs across multiple institutions. This study is part of the larger PAI project and examined the goals and experiences of URM postdoctoral fellows in science, technology, engineering, and mathematics (STEM) disciplines. In addition, we investigated the influence of a professional development workshop on postdocs' self-efficacy to pursue grants, improve relationship with their mentor, and apply for academic jobs.

Results: Our findings suggest that URM postdocs face a number of challenges in their position and lack the confidence, knowledge, and skills to pursue a career in academia. Our professional development workshops focused on developing postdocs' skills to pursue faculty positions significantly increased their self-efficacy in grant writing, improving relationship with their mentor, and applying for academic jobs.

Conclusion: Our findings have important implications for postdoctoral training and providing professional development opportunities for minority postdocs in order to diversify the faculty in STEM disciplines. Future research should examine the long-term influence of workshops to prepare postdocs to pursue and be successful in academia.

Keywords: Underrepresented minorities, Postdoctoral fellows, STEM, Career goal attainment, Self-efficacy

Introduction

Students from African, Chicano/Latino, and Native American heritages make up underrepresented ethnic minority students (URMs) in the USA (Syed, Azmitia, & Cooper, 2011), and it is estimated that they will become the majority in the USA by the year 2050 (Bernstein & Edwards, 2008). Even though minorities represent 28.5% of the total population in the USA, they only form 9.1% of science and engineering jobs held by college-educated Americans and hold only 7.9% of STEM faculty positions at universities and four-year colleges (National Research Council, 2011). In general, higher education faculty do not mirror racial and ethnic backgrounds of the students

served at the undergraduate and graduate level (Denecke, Frasier, & Redd, 2009). As a part of a large effort to increase STEM URM faculty at Big Ten universities, this study examined the needs of a particular group, postdoctoral fellows, who often use the position to pursue faculty careers (Åkerlind, 2005). This study was part of a large National Science Foundation-funded project titled, "Big Ten Academic Alliance Professorial Advancement Initiative (PAI) Program," a multi-institution effort to provide high-quality professional development for URM postdocs to pursue a career in academia. In this study, we investigated URM postdoctoral fellows, to better understand their experiences and how to support them to pursue STEM faculty positions. Below, we discuss social cognitive theory, challenges that URM students face, and present findings from the current study.

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Background

Social Cognitive Theory

Bandura's (1986) social cognitive theory (SCT) serves as a basis of our conceptual framework. The social cognitive theory explains how individuals acquire and maintain certain behaviors as a result of interactions between personal, behavioral, and environmental elements. Specifically, Bandura (1986) asserted that people's thoughts and beliefs affect how they behave and the social environment shapes those beliefs and expectations. Furthermore, most tasks, especially successful learning opportunities, require social interactions, such that when an individual interacts with people in a social environment, it awakens a variety of internal processes that support learning (Coser, 1970; Vygotsky, 1978; Weedman, 1999).

Building upon the role of environment, Lave and Wenger (1991) argued that people learn by participation in sociocultural activities when they are afforded legitimate peripheral participation in communities of practices. Communities of practice are learning sites formed by a group of people with shared domains of interest that lead participants to develop their identities (Lave & Wenger, 1991). Legitimate peripheral participation involves sponsorship from experienced members of the community, who engage newcomers in increasingly complex activities and develop their (newcomers) identities as members of that community (Lave & Wenger, 1991). Hence, legitimate participation provides a framework for implementing mentoring networks that allow individuals to participate in activities that are more central to the core activities of that community (Morrell, 2003). Being a member of a community not only allows novices to gain knowledge that is embedded in the community, but it also allows them to learn to operate within that community (Wasko & Faraj, 2000). Lesser and Strock (2001) further suggested that the "social capital resident in communities of practice leads to behavioral change—change that results in greater knowledge sharing."

Learning as a participant of a community directly connects to social cognitive theory construct of self-efficacy and how learners make decisions as well as choose and pursue goals. Self-efficacy is defined as the "beliefs in one's capabilities to organize and execute the courses of action required to produce given attainments" (Bandura, 1977, p. 3). One's self-efficacy is determined by four constructs, two of which are (a) learning from the experiences of those around you and (b) learning from verbal persuasion of people that you socialize with (Bandura, 2001). This illustrates the importance of community to self-efficacy. Additionally, one's behavior is "motivated and directed by projected goals and anticipated outcomes" (Bandura, p. 7). One of the most important constructs for behavior change includes one's belief that they can carry out or complete a task and has been found to be predictive of performances more than predictions based on ability alone (Chemers, Zurbriggen, Syed, Goza, & Bearman, 2011; Schunk & Pajares, 2005). Researchers have argued that self-efficacy and esteem are important predictors of persistence on a particular task as "individuals with high self-esteem will perform effectively in order to maintain their positive self-image" (Judge & Bono, 2001, p. 82). In one study, Chemers et al. examined how psychological factors, such as self-efficacy and identity, mediate relationships between science support activities (such as, research experience and mentoring) and desirable outcomes (such as commitment to a career in scientific research) for URM graduate/postdoctoral students. The authors found that for graduate post/doctoral students, their science self-efficacy, leadership and teamwork self-efficacy (LTSE), and identity each independently predict their commitment to a career in science. In addition, the effects of science support activities on their commitment were also mediated by science self-efficacy and identity as a scientist.

With self-efficacy playing a role in predicting behavioral outcomes, some have argued that when individuals do not feel they can perform up to their expectations, they either exert additional effort, lower their aspirations, or withdraw from a task entirely (Judge & Bono, 2001). This is relevant to our work with postdocs as the lack of professional development opportunities for postdocs could lead them to feel that they are not prepared to pursue a career in academia (Yadav, Soto, Clark, Dixon, & Smith, 2016). Given that efficacy beliefs mediate whether or not particular behaviors will be initiated and how long it will be sustained in the face of obstacles and adverse experiences, especially for minority population (Hackett & Betz, 1981), we need to better understand what support URM postdocs believe would be important for their academic careers.

Challenges for minority students

Diversity at all levels of STEM education is important to the progression of URM students from college to graduate school to postdoc positions and finally into the university faculty ranks. As stated above, social cognitive theory (SCT) spotlights the importance of social environment when understanding behavior. The composition of university faculty, as the experienced community member, plays a significant role in diversifying the faculty as they influence career choices made by undergrads, graduate students, and postdocs. URM faculty serves as role models to minority students, which helps them persist in completing their degree programs (Jayakumar, Howard, Allen, & Han, 2009). If a minority student sees a faculty with their ethnic and cultural background in successful positions, it signals that they too can be successful (Hagedorn et al., 2007; Plata, 1996).

While literature has emphasized the importance of students being able to see and interact with URM faculty,

there are additional factors that contribute to URM pursuit in/of STEM fields. Brown and Lent (2005) suggested that the complex interplay between individual variables (such as ethnicity and self-efficacy) and the environment influences career choice. Some of the multifaceted and often intertwined factors that influence URM students' self-efficacy in doctoral and career goal attainment in the STEM fields include experiences of bias, stereotype threats, career identity formation, and a lack of belongingness (Hernandez & Lopez, 2004; Malone & Barabino, 2009; Tine & Gotlieb, 2013; Turner, 2002). Prior research has indicated that students of color in STEM disciplines often face negative perceptions and stereotypes about their academic capabilities that are solely based on race or ethnicity (Strayhorn, 2010). The bias is especially prominent when a student has an "African-American-sounding" name (Bertrand & Mullainathan, 2004). Bertrand and Mullainathan found that similar resumes with White-sounding names receive 50% more callbacks for interviews than African-American-sounding names. Research has also found that even faculty members perceive traditionally underrepresented groups in STEM, such as females to be less competent than males with comparable experience (Moss-Racusin, Dovidio, Brescoll, Graham, & Handelsman, 2012). These social and systemic barriers could negatively influence minority students' self-efficacy beliefs and expectations to pursue a career in academia.

Federally funded programs, such as the National Science Foundation's Alliances for Graduate Education and the Professoriate (AGEP), and universities have been addressing the issue of diversifying STEM faculty and alter the social environment through the implementation of diversity and inclusion programs. Majority of such programs focus on increasing number of minority students pursuing and completing STEM doctoral degrees, but less attention has been given to understanding URM postdocs, their experiences, and self-efficacy in pursuing faculty positions.

Postdoc challenges

While there is a well-recognized need of postdocs being an important part of research in STEM fields (Gibbs, McGready, & Griffin, 2015), they often feel exploited for the low-cost labor they can provide (Rohn, 2011; Times Higher Education, 2012). In particular, postdocs feel they are invisible as they fall in the ignored space between graduate students and faculty, which is exacerbated by the lack of quality institutional infrastructure to uniformly and comprehensively support postdocs and provide mentoring. While universities are accountable to various accreditation agencies and review processes to monitor program quality and academic progress of graduate students, similar oversight protection is largely absent for postdoc training and education. As such,

postdocs receive minimal career development resources and end up in a system that is not necessarily supportive of their career goals (Institute of Medicine, 2014). In order for postdocs to pursue faculty positions, institutions need to provide social and structural supports.

There is some research emerging on the postdoc experience, including how to support and prepare them to transition into a faculty position. For example, Yadav et al. (2016) found that postdocs face a number of challenges including the lack of professional development for a career advancement, lack of confidence in securing funding and publishing, and lack of belonging. In another study, Rybarczyk, Lerea, Whittington, and Dykstra (2016) found that postdocs who participated in a mentoring program focused on research and teaching were three times more likely to transition into the professoriate. Researchers have also found that as postdocs matriculate into the professoriate, they encounter difficulties in creating career goals, networking with peers, and writing grants to support their research (Kohan, 2014).

While many of these challenges apply to all postdocs, different layers of complexity and systemic challenges exist for URMs, which makes them less likely to transition into the professoriate (American Institutes for Research, 2009). The racial and ethnic biases that URM postdocs face trying to navigate the gap between graduate school and the professoriate is just one of the barriers (Yadav et al., 2016). Furthermore, minority scholars receive significantly less mentoring than their non-minority peers (Beech et al., 2013). If we want to increase the faculty diversity in STEM disciplines, a first step might be to better understand the needs of URM postdoctoral fellows and how we can support postdoc self-efficacy given that self-efficacy is one of the predictors of career commitment for URM postdocs (Chemers et al., 2011). The goal of this study was to better understand the aspirations of URM postdocs, the skills needed to reach their goals, their self-efficacy, and confidence level in attaining their goals. Specifically, the following research questions guided our study:

1. What are URM postdoc experiences in STEM fields and what do they perceive to be the important aspects of their training in order to achieve their career goals?
2. What is the influence of professional development on postdoctoral fellows' self-efficacy in grantsmanship and career development?

Methodology
Participants
Forty-one minority postdocs from STEM disciplines participated in this study. There were 15 males and 25 females, 1 participant chose not to share their age and gender. Majority of the participants ($N = 22$) identified as Black/African

American and Latino/Hispanic postdocs formed the second largest group ($N = 9$). Other racial groups included Native American ($N = 2$), multiracial ($n = 2$), and Asian ($N = 1$). Participants' ages ranged from 28 to 49 years old ($M = 35.7$). The participants were part of the National Science Foundation (NSF)-funded project to improve faculty diversity within Big Ten Academic Alliance (formerly known as the Committee on Institutional Cooperation or CIC). The project, Professorial Advancement Initiative (PAI), had a goal of doubling the rate at which the alliance hired URM STEM faculty by creating a pool of well-prepared URM postdocs who could be recruited into tenure track faculty positions.

Data collection and procedure

Participants were invited to a 2-day professional development workshop focused on building skills in areas that were pertinent for postdocs to pursue a tenure-track academic career in STEM fields. This workshop included topics to support their grant writing and academic job search process. On day 1, postdocs had an opportunity to participate in workshops focused on topics related to their professional development such as networking, applying for an academic job, sharing research at a job interview, collaborating effectively with others, developing independent research goals, and developing a research team. On the second day, postdocs participated in all-day grantsmanship and worked with coaches and peers in small groups. Two weeks prior to the workshop, postdocs were asked to complete a survey to measure what they believed to be important aspects of a successful postdoc experience, their long-term career goals, and importance of various academic tasks (such as publishing and teaching) in achieving the career goal. In addition, the survey also included items that measured their confidence in grantsmanship. Following the workshop, postdocs completed a post survey to examine the influence of professional development activities on their grantsmanship confidence. The survey also included items on their confidence in understanding and applying for the job market. The survey items were adapted from a number of prior efforts to examine the needs of postdocs (National Postdoc Survey) and impact of mentoring on minority postdocs (Fleming et al., 2013). In addition, we also developed items based upon our prior work on examining challenges postdocs face in STEM fields (Yadav et al., 2016).

We acknowledge the limitations that come with using self-report survey data, which assumes that the respondents are willing to answer the questions accurately rather than believing that a particular response would be seen as favorable by the researchers (Lavrakas, 2008). However, we took steps to address this limitation by having the postdocs complete the survey anonymously so researchers would not know how they responded.

This helped us overcome the limits of survey data as anonymity allows individuals to willingly "report socially embarrassing attitudes, beliefs, and behaviors when their reports are anonymous" (Lavrakas, p. 3).

Data analysis

We used descriptive statistics to analyze the survey data and see patterns that emerged about postdoctoral fellows' experiences. In order to evaluate the influence of the workshop on postdoc self-efficacy in grantsmanship, increasing effectiveness of their mentoring relationship, and job application, we use a paired sample t test. Individual survey items for each of the three workshop topics were combined to create a composite self-efficacy score in grantsmanship, increasing effectiveness of their mentoring relationship, and job application, which were then used in the paired t test.

Results and discussion

Results on why participants chose their current postdoc suggested that developing expertise on a newer topic as well as access to specific resources (in the mentor's lab) to help develop that expertise were the two main reasons. In addition, participants were also attracted to the position due to the prospect of working with others, reputation of PI, and success of previous trainees. Figure 1 shows the percentage of postdocs that mentioned each of these reasons.

Results on career goals ($N = 41$) showed that 80% of the postdocs indicated their long-term career goals were academia research and/or academia teaching based. Specifically, postdocs indicated the following career plans: 68% ($N = 28$) academia research; 10% ($N = 4$) academia teaching; 10% ($N = 4$) industrial research; 5% ($N = 2$) equal teaching and research; 2.4% ($N = 1$) science policy, government, and non-profit career plan; 2.4% ($N = 1$) unsure of career plan; and 2.4% ($N = 1$) other not specified. Figure 2 shows the chart for participants' initial career goals. When asked how confident participants were in achieving their career goals, 17% ($N = 7$) of participants were very confident, 37% ($N = 15$) were confident, 37% ($N = 15$) were somewhat confident, and 9% ($N = 4$) reported being not confident—two participants were not sure. Figure 3 shows the chart for participants' confidence in achieving their career goals. We also asked participants what their second career choice would be in case they were not able to achieve their primary career goal. There was a large shift in participants' career goals with only 10% of the participants ($N = 4$) still wanting to pursue an academic career focused primarily on research. There was also an increase in the number of postdocs ($N = 9$) who would pursue academic positions focused on teaching. The number of participants choosing to go into industrial research also increased ($N = 12$),

Fig. 1 Main reason for the current postdoc position
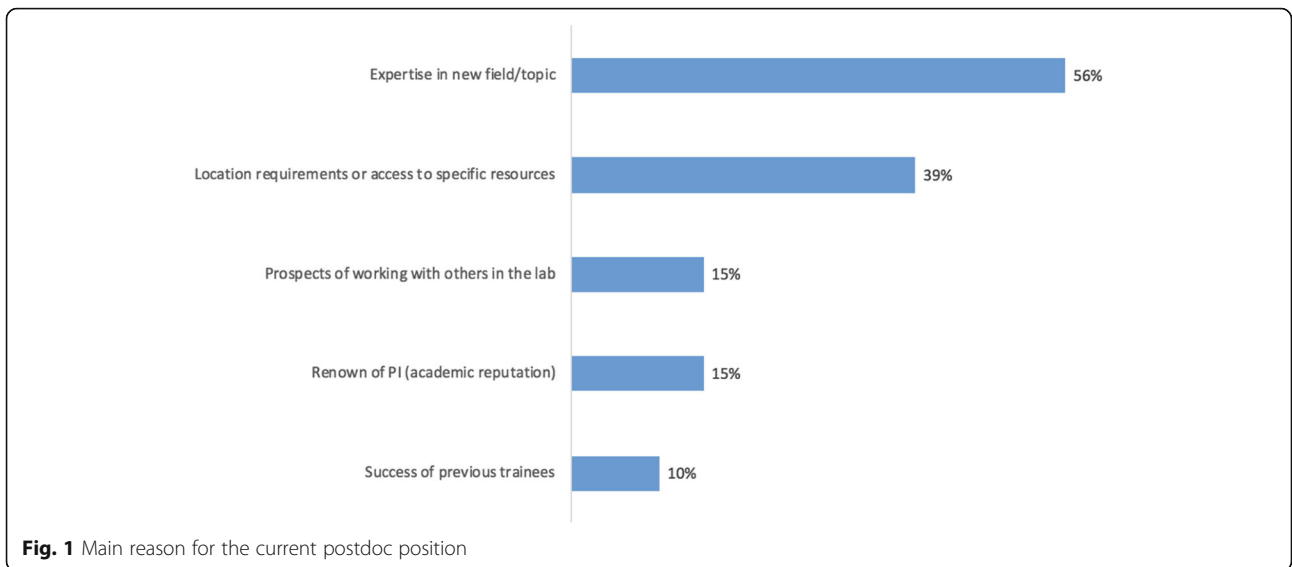
science policy ($N = 6$), and science publishing ($N = 5$). Figure 4 shows the distribution of postdoctoral fellows' second career choice.

We also asked participants what experiences during their postdoc would be important in helping them achieve their career goals. Developing an independent research plan emerged as one of the biggest factors with 66% of the participants ($N = 27$) considered it extremely important and 29% ($N = 12$) considering it very important. Having professional development (in grant writing, applying for academic jobs, etc.) was also considered an important need by postdocs with 51% ($N = 21$) seeing it as an extremely important skill and 44% ($N = 18$) seeing it as a very important skill. Participants also viewed

additional technical experience and targeted networking as being key to them achieving a career goal. It was surprising to see that while high profile publications and high number of publications were considered important, they were not considered as important as other things. Not surprisingly, teaching experience was not very high on postdocs list given that majority of them wanted to pursue research-based academic positions, which typically do not require teaching as an important skill. Figure 5 shows the importance of different factors in achieving a career goal.

We also examined URM experiences in their postdoc positions, in particular looking at whether they faced any stereotypes. We found that about 26.9% of the postdocs

Fig. 2 Primary career goal

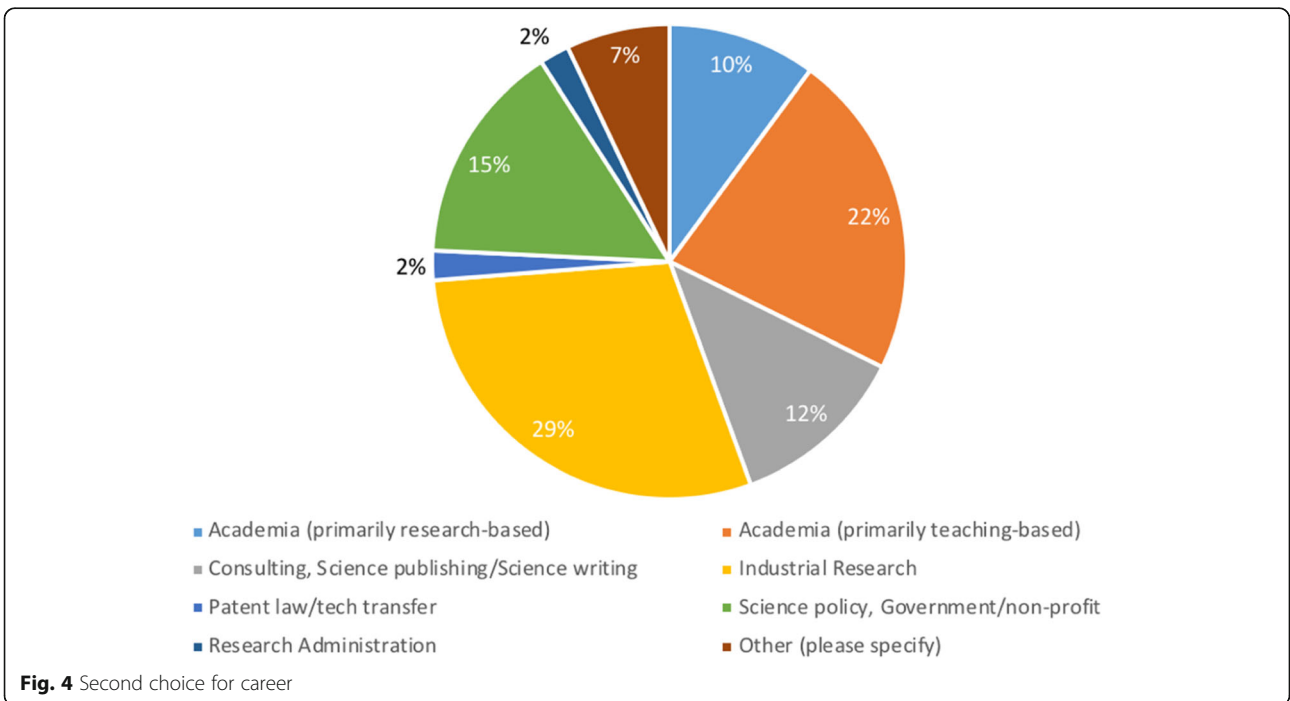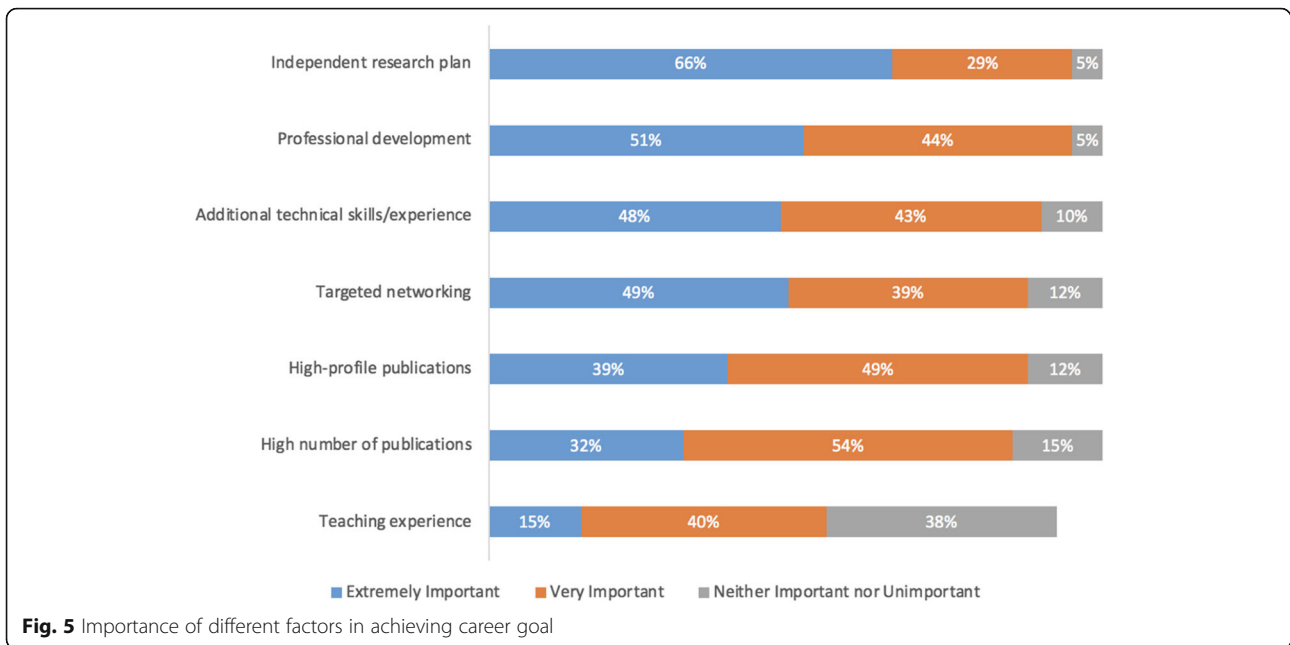**Fig. 3** Confidence in achieving career goal
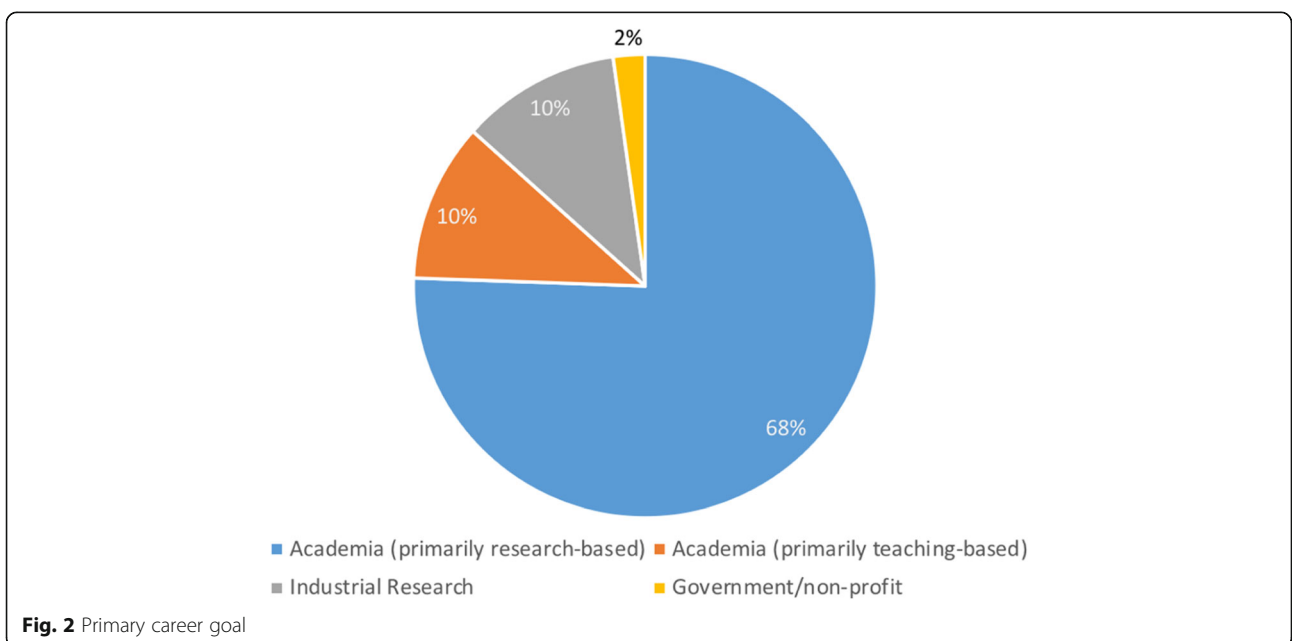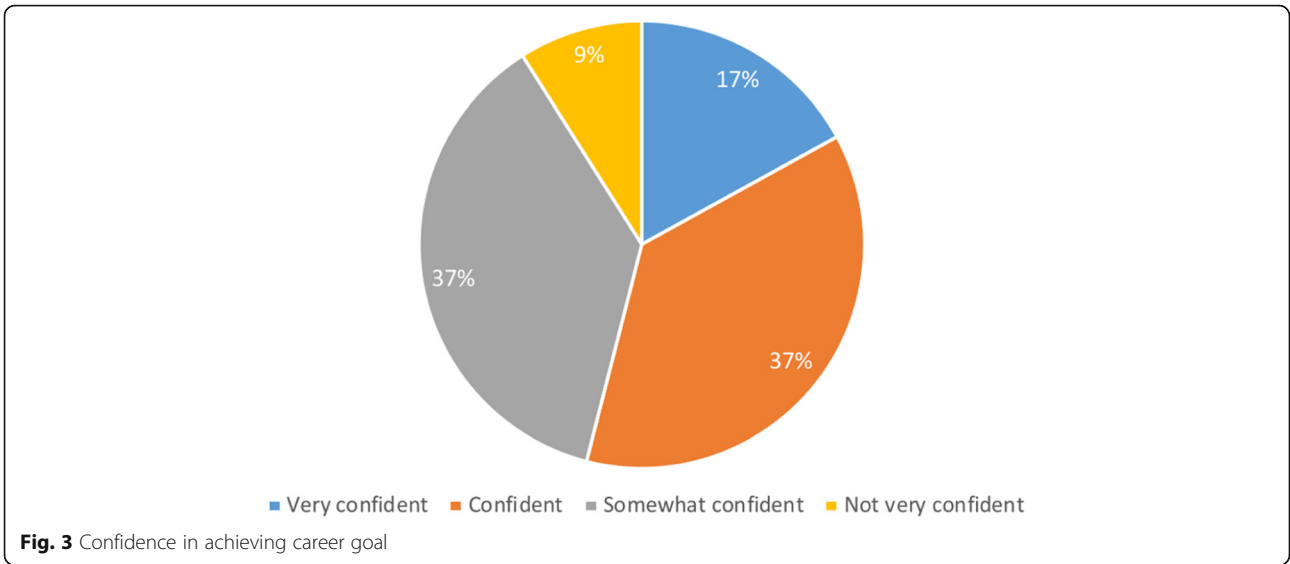
had experienced stereotypes in their current position while almost 70.7% of the postdocs had experienced stereotype at some point in their careers. In addition, 82.9% of the postdocs reported that they had to constantly prove themselves worthy of the position. These findings are concurrent with our previous qualitative findings that suggest URM postdocs face racial stereotype biases, experience microaggressions, and have to prove that they belong in STEM fields (Yadav et al., 2016). An example of what stereotypes and microaggressions look like comes from the work of Solórzano (1998), who documented examples of microaggressions

against scholars of color, such as: "When I talk about those Blacks, I really wasn't talking about you. You're not like the rest of them. You're different." (p. 125).

Majority of the postdocs (60.9%) also reported that they often struggled to find peers and colleagues with similar life experiences. Our prior work has suggested that URM postdocs often have to juggle competing priorities balancing family and work as they often are first from their families to get an advanced degree, if not the first to go to college (Yadav et al., 2015). Our results suggested that majority of postdocs (68.3%) have to juggle between personal and professional priorities and a

Fig. 4 Second choice for career

**Fig. 5** Importance of different factors in achieving career goal

number of them (53.6%) also reported having to prioritize family over work. While URM postdocs reported some challenges, majority of them (68.3%) felt they could be themselves in their current position. Figure 6 shows postdoc experiences in their positions.

Our results suggested that postdocs came in with a high self-efficacy in their ability to conduct research, including selecting suitable areas of study, developing rationale for a research study, and how to measure variables. So, our professional development focused on postdoc self-efficacy in having a better mentoring relationship, grant writing, and

applying for academic jobs. The results suggested that on average, postdocs were more confident in their grant writing skills after the workshops ($M = 10.40$, SD = 1.95) than before the workshop ($M = 6.37$, SD = 2.30). This gain in confidence was significant, $t(36) = -12.65$, $p < 0.05$. Figure 7 shows the charts for individual item confidence in grantsmanship.

We also found that the workshop gave postdocs more confidence in increasing the effectiveness of their mentoring relationship with their principal investigator. On average, postdocs were more confident in increasing the

Fig. 6 Postdocs' experiences in their position

Fig. 7 Growth in confidence in grantsmanship
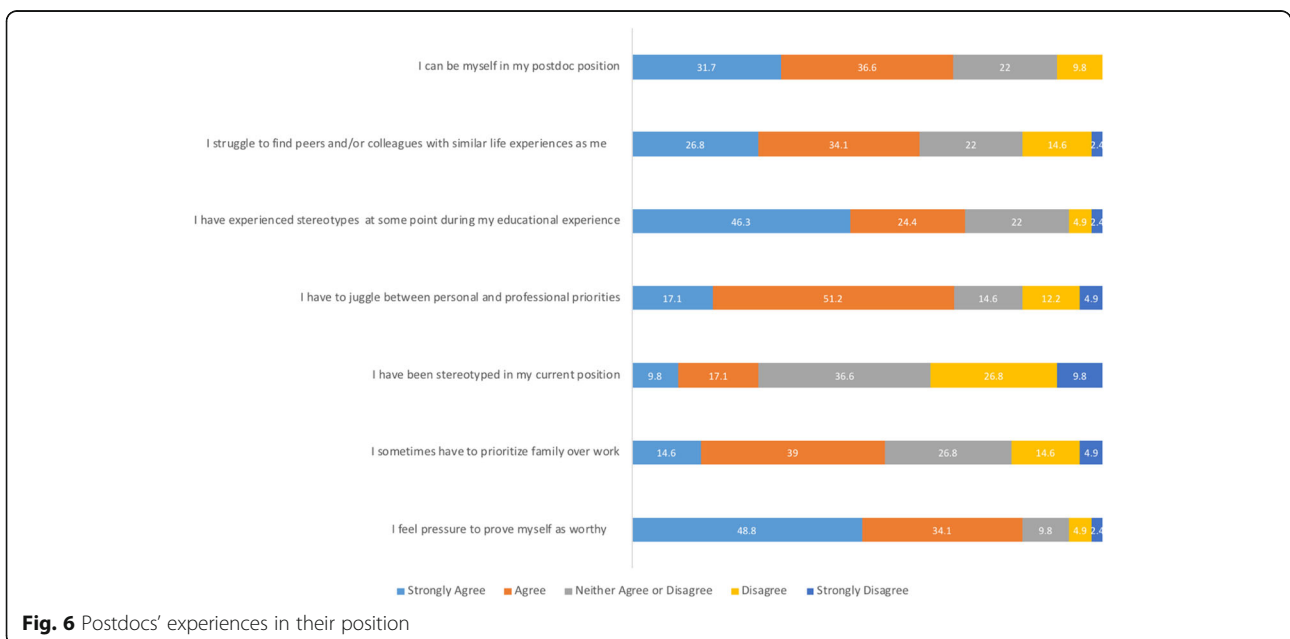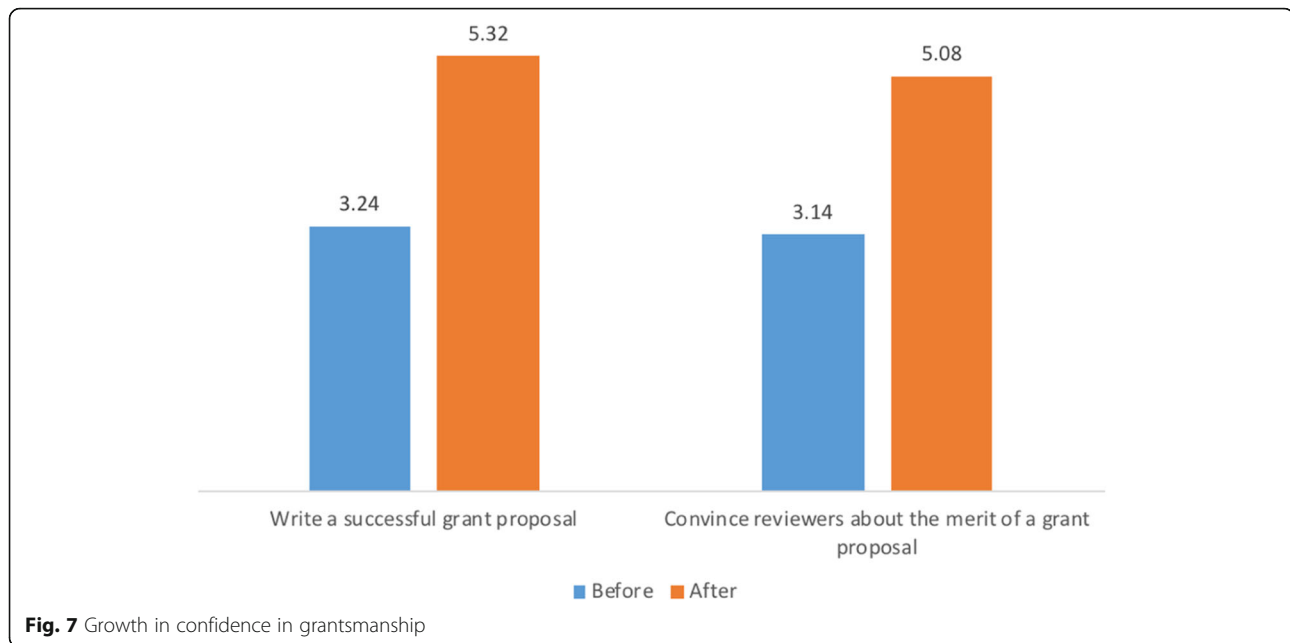
effectiveness of their mentoring relationship after the workshops ($M = 16.00$, SD $= 3.35$) than before the workshop ($M = 11.08$, SD $= 3.89$). This gain in confidence was significant, $t(36) = -7.12$, $p < 0.05$. Figure 8 shows the charts for postdoc confidence in the effectiveness of mentoring relationship.

We also found that postdocs were more confident in the job application process as a result of the workshop. On average, postdocs were more confident applying for academic jobs after the workshops ($M = 20.00$, SD $= 3.58$) than before the workshop ($M = 14.62$, SD $= 4.29$). This gain in confidence was significant, $t(36) = -10.76$, $p < 0.05$. Figure 9 shows the charts for postdoc confidence in job application.

Our findings suggest that majority of URM postdocs in STEM disciplines had a research-based academic position as their primary career goal, but did not feel confident in achieving it. As a result, their goals shifted towards either teaching-oriented academic positions, industrial research, or pursuing science policy in government/non-profit organizations. When asked what our participants thought were important factors in helping them achieve their primary career goal, developing an independent research plan and receiving professional development were identified as being extremely important. Minority postdocs also reported that while they felt they could be themselves in their positions, they struggled to find peers with similar life experiences, experienced being stereotyped, and wrestled to juggle personal and professional commitments.

The professional development activities provided as a part of our work significantly impacted URM postdocs self-efficacy in grantsmanship as well as increasing their relationship with mentors related to communication and

aligning expectations. They also reported feeling more confident in applying and interviewing for academic jobs and in their ability to obtain a job after the workshop. The workshop not only helped the postdocs gain ability and knowledge in communicating and in the job search process, it was also effective in building postdoctoral fellows' confidence to compete for grants and finding funds to back their future research. Hence, to promote URM postdocs' success and build their confidence to successfully pursue their career goals, our professional development workshop was effective.

Given that self-efficacy has been found to predict persistence on tasks (Bandura, 1977; Schunk, 1981) in conjunction with postdocs' feeling of being exploited, our findings that the workshop improved URM postdoctoral fellows' (a) perceived competence in grant writing, (b) improving mentoring relationship, and (c) applying for academic job are important. These are significant steps to having more postdocs of color pursue faculty positions. However, providing professional development opportunities for URM postdocs is just one step to diversify STEM faculty. We also found that URM postdocs face unique challenges such as experiencing stereotypes and struggling to find peers with similar life experiences. As has been shown before, racial stereotypes and microaggressions can cause stress for minority students, who "must decipher the insult and then decide whether and how to respond. If they confront their assailants, victims of microaggressions often expend additional energy and time defending themselves against accusations of being 'too sensitive.'" (Yosso, Smith, Ceja, & Solórzano, 2009, p. 661). Thus, in order to make progress on increasing diversity in faculty ranks, we

Fig. 8 Growth in confidence in effectiveness of mentoring relationship
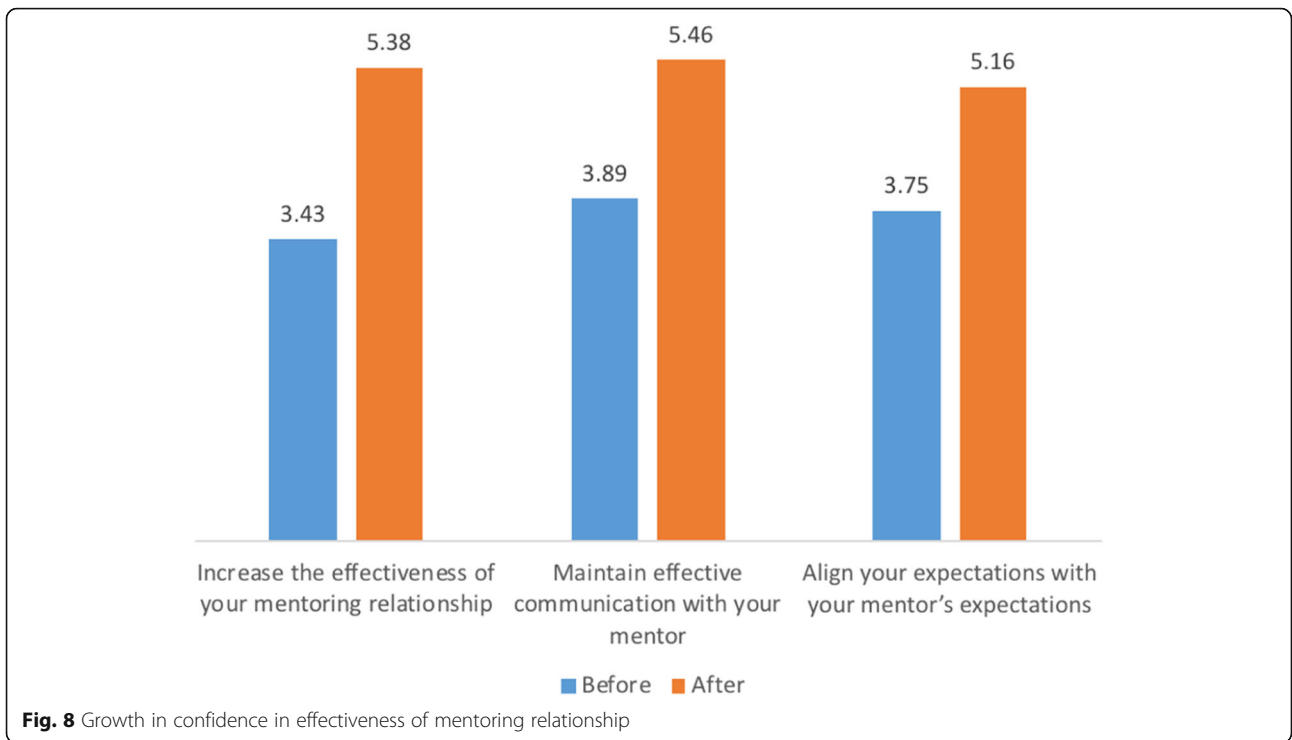
need to implement wide-ranging strategies to create a climate where students from minority populations can pursue academic positions.

By 2050, it is projected that the present majority population will be in the minority (Bernstein & Edwards, 2008), which means that the scientists and engineers needed to maintain the US STEM workforce will have to come from the groups that are currently in the minority. We realize that while postdocs are increasingly indispensable to research in STEM fields, URM postdocs face additional challenges as they think about transitioning from a graduate student to a faculty (Rybarczyk et al., 2016). Results from our study could help future researchers have a clearer picture of what URM postdoctoral fellows' career goals are and what perceived skills they need to successfully pursue their career goals. Academic career-focused workshops could play an important role by building the skills and competencies of URM postdocs to matriculate into future faculty positions and succeed in academia.

Fig. 9 Confidence in job application
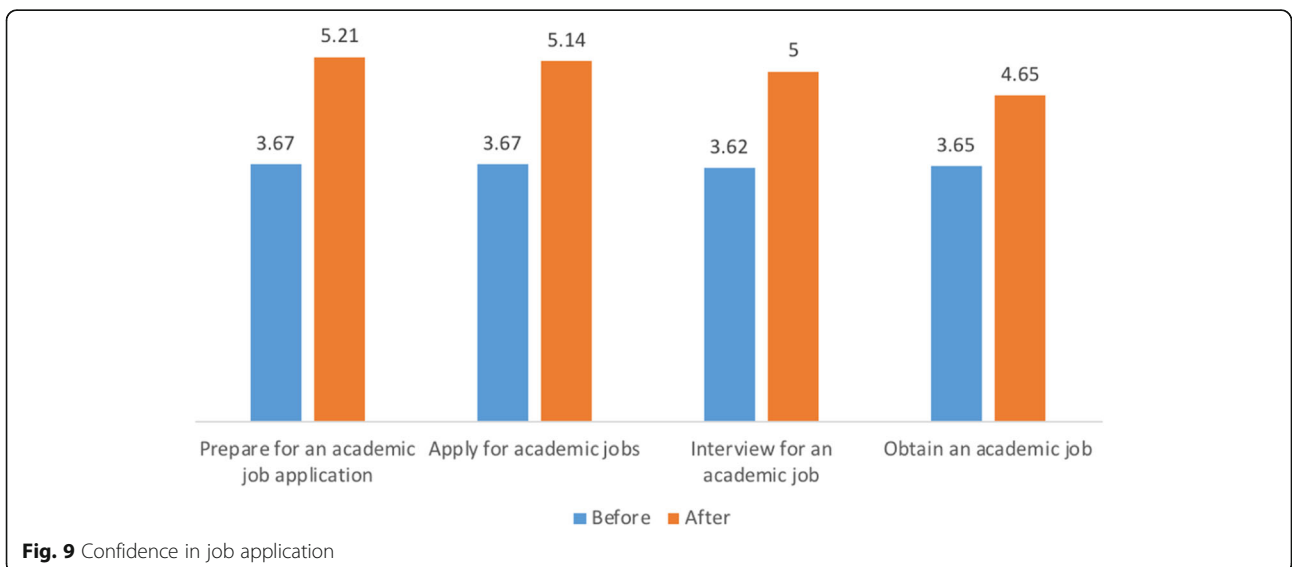
We believe our results are not just applicable to URM postdocs but could also inform professional development program for all postdocs. In particular, we believe that our results could be applicable to international fellows or visiting scholars because the challenges that URM students mentioned about facing microaggression and being stereotyped are also of concern for international students and scholars, who tend to face stereotypes about their language and communication abilities as well as their motivation to learn (Heng, 2018). Furthermore, given that international students are often not able to develop deep cross-cultural friendships, they might also need social support networks (Mallinckrodt & Leong, 1992). Future research in this area should examine the needs of international scholars, which could inform how to train faculty to meet the unique needs of these populations.

Our study had a few limitations, which should be considered when drawing conclusions. Given that there are few minority postdocs in STEM fields where this study was conducted, we did not collect identifying information (such as contact information and specific STEM discipline) in order to maintain confidentiality and anonymity. Since we did not have identifying information from participants, we could not examine the long-term impact of workshop on participant confidence as postdocs are a transient population and many of them moved institutions in a year or two. Future work should conduct a longitudinal study to examine how the workshops help prepare postdocs for life in academia. We also used a broad definition of STEM field (including life sciences and social sciences) as suggested by the National Science Foundation (2014) when selecting participants for the study to maintain the anonymity of participants. There could be cultures within each of the subdisciplines, which should be examined in more detail and how they impact URM postdoc experiences.

Conclusion

As discussed previously, increasing faculty diversity in the STEM field is important to recruiting and retaining minority students into college. Given that path towards university faculty typically involves first being a postdoctoral fellow, who often feel neglected in the ignored space between graduate students and faculty, we need to do a better job at providing effective mentoring and professional development opportunities for them. Findings from our study suggest that professional development can positively influence minority postdocs' self-efficacy in developing skills necessary to be successful in academia (such as grantsmanship) and also increase their confidence in pursuing academic positions. This suggests that higher education institutions need to provide targeted workshops that help postdocs develop skills and confidence to see that they could be successful in faculty positions and pursue them.

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