To Be, or Not to Be, a Professor: Views of Engineering Postdoctoral Scholars

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Abstract

Through an embedded, multiple-case study design, this interpretivist research paper explores the ways in which 22 engineering postdoctoral scholars describe the appeal of pursuing a career in the professoriate. Interviews, grounded by social cognitive career theory (SCCT) (Lent et al., 1994), offered an in-depth understanding of the nature, meaning, and ways in which their postdoctoral scholars' learning experiences influence their view of the professoriate and, consequently, their career decision-making process. Data analysis strategies established by Silverman (1993) and Stake (1995) were utilized to examine the interview data, employing both inductive and deductive analysis techniques. Four themes emerged: (1) the professoriate appears daunting due to the competitive nature of the job market and the academic environment, (2) the work demands of the professoriate are contrary to the work-life balance sought, (3) possessing research autonomy in the professoriate is highly attractive, and (4) the professoriate is perceived as a calling for those who desire to teach and mentor the upcoming generation of engineers. A more nuanced understanding of the appeal of the professoriate and the career decision-making process of postdoctoral scholars may be an avenue to aid in diversifying the engineering professoriate. The preferred presentation method is a traditional lecture.

Introduction

This research paper explores the ways in which engineering postdoctoral scholars describe the appeal of pursuing a career in the professoriate. Scholarship concerning engineering career trajectories presently lack the depth necessary to understand the arc of the career from student to postdoctoral scholar to professor (Jaeger et al., 2017; St. Clair et al., 2017; Su, 2013). An investigation of this trajectory is critical for those invested in increasing the number of underrepresented minorities (URMs; African American, Latinx, and Native American) and women entering the professoriate and earning tenure. Researchers have found postdoctoral training is crucial for a scholar's productivity and ability to compete for professorships (Andalib et al., 2018), yet the transition may be more complex than merely publishing and grant writing during their postdoctoral experience. Perhaps their postdoctoral appointment leads them to view a career as a professor as more or less attractive than a career in industry, which begs exploration.

This embedded, multiple-case study (Yin, 2018) is grounded by social cognitive career theory (SCCT) (Lent et al., 1994). SCCT provides a theoretical structure to understand the nature, meaning, and ways in which engineering postdoctoral scholars' learning experiences influence their view of the professoriate and, consequently, their career decision-making process. An interpretivist lens is applied to this research by acknowledging the researchers' subjective analysis of the participants' actions and context effect the final product and interpretations offered (Patton, 2015). Thus, an empathetic approach is utilized to understand the experiences and perspectives of the postdoctoral scholars, accepting that they share their viewpoints through their own filters of personal identity, cultural norms, and social constructs. This research is sponsored by the National Science Foundation (NSF) Alliances for Graduate Education and the

Professoriate (AGEP; award numbers 1821298, 1821052, 1821019, and 1821008). The research questions that guide this study are:

1. What are the ways in which the learning experiences gained during engineering postdoctoral appointments influence postdoctoral scholars' view of the professoriate?
2. How does the view of the professoriate influence postdoctoral scholars' career decision-making process?

Literature Review

A postdoctoral appointment is evolving into an important stepping stone to entering the engineering professoriate because it affords doctoral graduates with advanced preparation to assume the research, teaching, and service responsibilities of a tenure-track faculty member (Andalib et al., 2018; Main & Wang, 2019). Research has demonstrated that postdoctoral appointments are exceptionally advantageous for URMs and women, as their enhanced training leads them to be more competitive in the professoriate job market (Pyke, 2013). Stephan and Ma (2005) found 80% of higher education institutions do not hire a new tenure-track faculty member who has not served as a postdoctoral scholar, signaling it as a de-facto requirement for an academic position. Engineering postdoctoral positions primarily include research duties in a laboratory to further their supervisor's and their own research agenda, which can involve collaborating with and mentoring students. Postdoctoral positions also can include formal teaching responsibilities, particularly introductory-level engineering coursework.

Obtaining a postdoctoral appointment in engineering is a substantial influencer and determinant on whether one ascends to a faculty position (Andalib et al., 2018; Burt, 2014; Enders, 2005; Levy, 2014; Melin, 2004; Yang & Webber, 2015). Webber and Yang (2015) concluded that postdoctoral scholars are 6.1% more likely to enter the professoriate than those attempting to do so directly upon completion of their doctoral program. Yet, after an average 2.9 years of a postdoctoral appointment only 17% go on to secure tenure-track positions (Andalib et al., 2018). However, many postdoctoral scholars remain in academia with instructor teaching contracts or in student support roles (Andalib et al., 2018). Postdoctoral scholars tend to exhibit higher scholarly outputs and productivity than their non-postdoctoral counterparts (Horta, 2009; Su, 2011; Waaijer et al., 2016) and a more mature research vision for the future (Higgs et al., 2006). When focusing specifically on women and people of color, postdoctoral scholar productivity is comparable to their White, male counterparts (Jackson, 2004).

Although many postdoctoral scholars in engineering aspire to the professoriate subsequent to their postdoctoral training, a decline has occurred in academic positions and employment rates for engineering PhD recipients (St. Clair et al., 2017). A main concern for those nearing the end of their appointment is the supply-and-demand model surrounding their career choices due to an abundance of postdoctoral scholars in science and engineering fields coupled with an inadequate number of available academic positions (Silva et al., 2016; Waaijer et al., 2016). Postdoctoral scholars often attempt to weather this actuality by assuming multiple positions in academia and continuing in their postdoctoral appointment for a longer period (Waaijer et al., 2016). The availability of academic positions not only has dwindled in recent years, as compared to other STEM fields, but engineers are less likely to accept research-oriented, non-tenure-track faculty positions or to seek postdoctoral appointments (Su, 2012). Thus, the academic career landscape

for engineering doctoral recipients is in a state of flux, precipitating some to pursue careers in the private sector and in government. Recotillet (2007) reported that 20% of postdoctoral scholars enter the private sector upon completion of their appointment despite their desire for a tenure-track faculty position.

Half of all students entering graduate school in STEM fields consider a career in the professoriate desirable (McGee et al., 2019). This initial interest originating in the early experiences and family influences present in an individual's life (Burt, 2019), an attraction to academic work (Lindholm, 2004), the perception of research autonomy, independence and individual expression (Gibbs & Griffin, 2013; Lindholm, 2004), the allure of the university work environment (Lindholm, 2004), and as a platform to help others (Gibbs & Griffin, 2013). McGee et al. (2019) recently found 51% of students entering graduate school initially indicated an interest in a career in the professoriate; however, only half of these students considered an academic career a viable option at the time of graduation. The PhD socialization process students experience appears to negatively skew students' perceptions of the professoriate and pushes them in alternate career directions (Burt, 2019). Attributing factors for the dissuasion include the norms and pressures associated with academia, a general disdain for grant writing, work-life imbalance, inadequate financial compensation, the political climate of academia, as well as the formulation of opinions based on experiences during the PhD socialization process (McGee et al., 2019). In addition to these factors, underrepresented minority and female students identify issues of marginalization and racial and gender bias as contributing influences making academia undesirable (Griffin, 2019; Robinson, 2016).

Racial/ethnic minorities and White women continue to be underrepresented in academia from undergraduate student to graduate student to postdoctoral scholar (Allen-Ramdial & Campbell, 2014; Shaw & Stanton, 2012). The reverberating effect has long-lasting implications for the racial/ethnic and gender composition of the professoriate. Consequently, approximately 6% of engineering professors identity as racial/ethnic minorities and 17% are women (Roy, 2019). These statistics indicate a disproportional representation compared to the U.S. population. Fewer women are hired in academia than their male counterparts, which Shaw and Stanton (2012) refer to as "demographic inertia" (p. 3736). In order to bolster the number of URMs and women entering the professoriate, concentrated training and professional development is necessary for students, faculty, and administrators across the academic community (Cawyer et al., 2002; Gordon et al., 2015; Jackson, 2004; Kosoko-Lasaki et al., 2006; Lechuga, 2014; Leggon & Pearson, 2009; Scott, 2017; Zambrana et al., 2015). While professional development in the areas of teaching enhancements, mentoring, and combatting racist and sexist campus climates have been on the rise in the last two decades, the numbers of URMs and women entering the professoriate and earning tenure have not increased substantially.

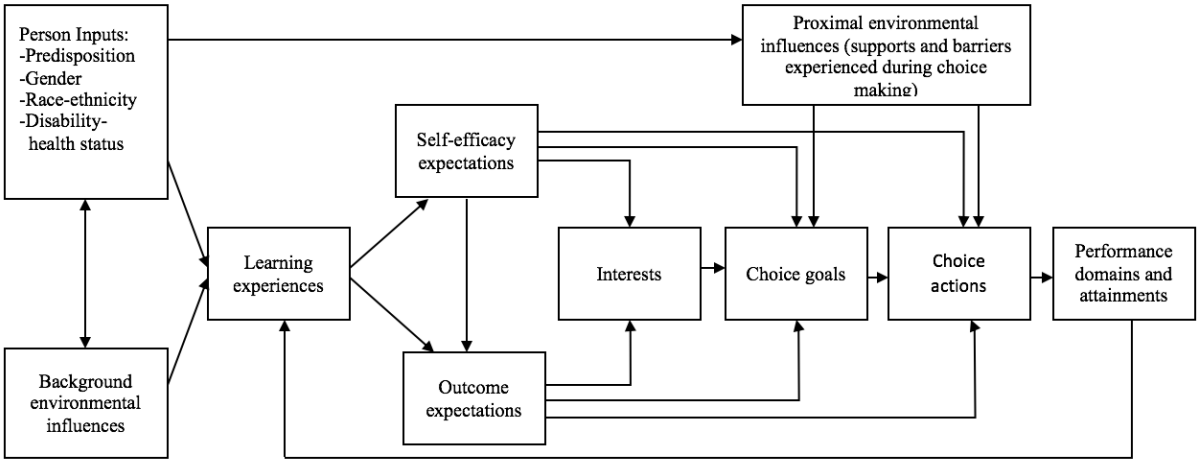
Theoretical Framework

Social cognitive career theory (SCCT; Lent et al., 1994) was utilized as the theoretical framework guiding this study. Frameworks build upon a foundation of established knowledge, offer logical explanations for the data and relationships observed, and reveal new understandings of a phenomenon (Anfara & Mertz, 2015; Babbie, 2015)—in this case, the ways in which the learning experiences gained during engineering postdoctoral appointments influence postdoctoral

scholars' view of the professoriate, and consequently, their career decision-making process. The theoretical propositions of SCCT (Lent et al., 1994) detail that individuals involved in career decision-making are weighing their career interests, goals, choice actions, and performance and that this process is guided by person inputs (i.e., race/ethnicity, gender, and age); cognitive-person factors (self-efficacy and outcome expectations); background and proximal environmental factors (supports and barriers experienced during choice making); and learning experiences. SCCT builds upon Bandura's (1986) social cognitive theory which asserts the cognitive functions of self-observation, self-evaluation, self-reaction, and self-efficacy interact to promote an agentic perspective that enhances motivation and, ultimately, goal attainment (Bandura, 2005). Figure 1 provides a visual representation of the SCCT components and the ways in which they interact and relate to one another during the career decision-making process (Lent et al., 1994). SCCT served as the basis of the interview protocol administered in this study, the deductive data analysis process, and in considering the implications of the study.

Figure 1

Social Cognitive Career Theory



Note. From "Toward a Unifying Social Cognitive Theory of Career and Academic Interest, Choice, and Performance," by R. W. Lent, S. D. Brown, and G. Hackett, 1994, *Journal of Vocational Behavior, 45*, pp. 79-122.

Methodology

Research design. An embedded, multiple-case study design (Yin, 2018) was utilized to explore the ways in which 22 engineering postdoctoral scholars describe the appeal of pursuing a career in the professoriate. Interviews, grounded by SCCT (Lent et al., 1994), offered an in-depth understanding of the nature, meaning, and ways in which their postdoctoral learning experiences influenced their view of the professoriate, and consequently, their career decision-making process. An interpretivist lens was applied to this study, as empathy was considered foundational to the research design, data collection, data analysis, and interpretations as described in the following sections (Patton, 2015). The researchers' subjective analysis of the postdoctoral

scholars' view of the professoriate was seen as critical to understanding and interpreting their actions and contexts. The research questions that guided this study were:

1. What are the ways in which the learning experiences gained during engineering postdoctoral appointments influence postdoctoral scholars' view of the professoriate?
2. How does the view of the professoriate influence postdoctoral scholars' career decision-making process?

Participants. A total sample of 50 STEM postdoctoral scholars was recruited from the National Postdoctoral Association utilizing a dedicated e-alert sent via email in July 2019. Participation was incentivized through the provision of a $25 Amazon gift card. Over 300 individuals responded to indicate their willingness to participate; the final sample was determined by their field of study and the race/ethnicity and gender with which they identified. This study reports findings related to the 22 engineering postdoctoral scholar interviews. The sample was comprised of 10 White participants, six Asian Americans, and six URMs who identified as African American or Latinx; seven females, 14 males, and one individual who identified as non-binary. The participants ranged in age from 29 to 43. Almost three quarters indicated they were currently employed in a postdoctoral position, while the other quarter were either in tenure-track faculty positions or in the private sector. Engineering fields of the sample included aerospace, biomedical, chemical, civil, computer, electrical, environmental/health, and nuclear. A summary of participant demographics is presented in Table 1.

Table 1

Postdoctoral Scholar Demographics

Indicators	*n*	Percentage
Race/Ethnicity		
African American	3	14
Asian	6	27
Latinx	3	14
White	10	45
Gender		
Female	7	32
Male	14	64
Non-Binary	1	4
Current or Past Postdoctoral Scholar		
Current	16	73
Past	6	27
Age		
Range	29 – 43	
Mean	33	
Median	34	
Mode	29	

Data collection. Per Institutional Review Board approval, all participants were provided with a consent form detailing the purpose of the study, the interview procedures, and the safeguards in place to protect their anonymity. The interviews were administered by multiple individuals and averaged 60 minutes in length, were digitally recorded, and were conducted via a one-on-one process through web conferencing or by phone. A semi-structured interview protocol grounded by the theoretical propositions of SCCT (Lent et al., 1994) was employed. Queries were focused on career interests and goals, the ways in which interests and goals were developed and refined from childhood through their postdoctoral appointment, times in which feeling of career success and defeat were experienced, confidence and capacity to be successful in the intended career field, and the ways in which their race/ethnicity and gender affected their sense of belonging in the field. As an interpretivist lens was employed in this study, great effort was made to build rapport with the participants and to ensure they felt heard and respected; emphasis was given to empathetically honor their voices, identities, and experiences in the final product (Patton, 2015). These efforts created a natural, free-flowing dialogue in which the researchers were active listeners and participants in the interview. While the interview protocol was carefully worded and questions were specified in a particular order, the interviews were conducted in an unstructured manner to create a comfortable, genuine dialogue between the researchers and the participants. Upon completion of all 50 interviews, the recordings were transcribed by a third-party transcription service, all recordings were permanently deleted once the transcripts were reviewed and cleaned for any errors. All transcripts were uploaded into the NVivo 12 platform for analysis.

Reflexivity and positionality. Before data analysis began, the researchers engaged in the process of reflexivity in which experiences, beliefs, values, and assumptions about the arc of the academic career and what each considers to be attractive about the professoriate were bracketed out individually and collectively (Watt, 2007). Reflexivity is integral in a qualitative research design as it forces the consideration and exposure of researcher bias and prejudices in the data analysis process through analytical memoing and dialogue. Per the guidance of Lincoln and Guba (1985), the positionality of the researchers also must be clarified in qualitative research—each are social science academics trained in qualitative research methods within educational settings. All are employed at higher education institutions and hold professorship, research affiliate, and/or administrative positions. Each is committed to diversifying higher education and their efforts have involved research lines and service endeavors advocating for policies and practices to increase the representation and success of URM students and faculty across various career fields.

Data analysis. Data analysis strategies established by Silverman (1993) and Stake (1995) were utilized to examine the ways in which the postdoctoral scholars' learning experiences influenced their view of the professoriate and, consequently, their career decision-making process. The theoretical underpinnings of the interpretivist lens were revisited before the data analysis began to ensure empathy was foundational to the ways in which the transcripts were assessed, and meanings were interpreted (Patton, 2015). Emphasis was given to the participants' experiences and perspectives rather than the researchers' point of view, which was acknowledged through the process of reflexivity. Employing Silverman's technique of thematic content analysis, an inductive approach was followed in order to search for themes and patterns that related to the research questions. Using this method, the researchers coded the transcripts individually in a

comprehensive manner and then collectively identified cross-references between the data and the evolving themes while memoing. This method allowed for flexibility when approaching research patterns in inductive ways (Silverman, 1993; Watt, 2007). Process and evaluative codes were created, collapsed, and amalgamed into themes to summarize the appeal of the professoriate and the ways in which their learning experiences influenced their career decision-making process (Patton, 2015). Process codes included observable and conceptual actions taken by the participants, such as work-life balance, mentoring, academic freedom, and unsuccessful job searching; evaluative codes included judgments about the merit or worth of the learning experiences, such as costly, beneficial, time-consuming, and meaningful.

Stake's (1995) four-step deductive data analysis process of direct interpretation, categorical aggregation, pattern recognition, and naturalistic generalizations was utilized to refine the themes that emerged during the inductive data analysis process. A structured coding protocol was first designed using the SCCT theoretical framework components (Lent et al., 1994), the protocol focused the analysis process by narrowing the postdoctoral scholars' learning experiences that influenced their views on pursuing a career in the professoriate, as well as the career decision-making process. Through the application of the first step of Stake's deductive data analysis process, each interview transcript was reviewed independently by each researcher using the coding protocol, which engendered direct interpretation of the learning experiences that potentially influenced the perceived attractiveness of the professoriate as expressed by the participants. This process enabled each researcher to individually draw interpretations consistent with the interview data before collectively discussing preliminary findings. In the second step, categorial aggregation was accomplished cooperatively by synthesizing the overarching concepts and ideas drawn from the transcripts in step one. For example, this stage clearly revealed the aspects of the professoriate that drew participants away from pursuing a career in academia, much of the indecision revolved around poor self-efficacy and outcome expectations as many questioned their likelihood for success in the tenure-track job market.

Following Stake's (1995) third step of pattern recognition, more precise content was developed through grouping associated data, developing fuse codes, and refining the themes identified across the interview data. This process enabled the researchers to identify common background experiences that influenced career interests and, ultimately, career decisions. For instance, postdoctoral scholars who experienced strong, formalized mentoring as students desired to replicate mentoring in their laboratories, and those who had support and resources to do so felt empowered and optimistic they could continue this work as a professor. Those who experienced barriers and roadblocks in attempting to mentor often cited being overworked by their supervisors, which resulted in a diminished passion to help others and, subsequently, they began to reconsider entering the tenure-track job market. In the fourth step, naturalistic generalizations occurred by evaluating the themes to ensure they represented the entirety of the data and could be applied more broadly (Stake, 1995). For example, while this research reports specifically on findings related to engineering postdoctoral scholars, an additional 28 interviews were conducted with postdoctoral scholars in other STEM fields. The learning experiences that influenced the appeal of the professoriate and the career decision-making process noted by the engineering postdoctoral scholars resonated with the other STEM participants, such as research autonomy; thus, broader implications were regarded as feasible across contexts and fields of study. At the

conclusion of this step, the researchers were better informed of conflicting findings with respect to theme development (Miles et al., 2019), and four final themes were identified.

Trustworthiness. Multiple verification strategies ensured the findings were trustworthy (Lincoln & Guba, 1985). In order to address credibility, cross-case synthesis was utilized throughout the analysis of interviews to examine whether the themes were cases of similar or different perspectives of the participants (Hayes, 1997). To ensure transferability, thick, rich descriptions were utilized, and data saturation occurred prior to the completion of all 22 interviews (Patton, 2015). Dependability was addressed by evaluating the manner in which the themes represented the whole of the text (Silverman, 1993; Stake, 1995). Confirmability occurred by validating themes in the early and late stages of the data analysis process (Miles et al., 2019). Dependability and confirmability also were achieved by involving multiple researchers in evaluating and providing feedback on the identified themes, which enabled the comparison of several feedback loops. Additionally, bracketing through the process of reflexivity with the involvement of several researchers in the data anlaysis process bolstered the dependability of the findings. Application of these verification methods intended to mediate the limitation of including only individuals who self-selected to participate in the interviews and who self-reported their views and experiences (Lincoln & Guba, 1985; Miles et al., 2019).

Findings

Following data analysis with an interpretivist lens, four overarching themes emerged: (1) the professoriate appears daunting due to the competitive nature of the job market and the academic environment, (2) the work demands of the professoriate are contrary to the work-life balance sought, (3) possessing research autonomy in the professoriate is highly attractive, and (4) the professoriate is perceived as a calling for those who desire to teach and mentor the upcoming generation of engineers. The first two themes appear to negatively deter individuals from entering the field, and the latter two draw individuals into a career in the professoriate.

Competitive job market and environment. The appeal of the professoriate was strong among the postdoctoral scholars, as 68% noted their interest in remaining in academia and pursuing a career as a professor. However, nearly half of the participants expressed concern over the competitive nature of the job market; they doubted their ability to be successful in securing a tenure-track position due to the perceived limited number of available positions. A White male currently employed in a postdoctoral position who is seeking a position in industry indicated:

> I think the job itself [being a professor] seems really appealing. The fact that there are so few of them and they're so competitive makes it a little bit less appealing because it seems like I've got to do, well a lot more than what I've done, in order to get the type of a faculty position that I would really like . . . I've looked at some of the stats on that and seen that there is something like maybe 10 new faculty positions for every 200 PhDs, or something like that.

Another participant, an Asian American male currently employed in a postdoctoral position who desires to remain in academia, discussed his concerns with pursuing a professorship:

> I am concerned with the attrition of individuals who begin programs with aspirations of earning an PhD and becoming a professor. I feel that we always hear there are limited jobs and after so long of hearing this, it makes sense that we start looking elsewhere for

> employment rather than competing for a job that may not exist. These stats discourage students, and industry becomes more appealing.

The participants appeared to be concerned about the possibility they may be unsuccessful in the tenure-track job market, which could have served as a self-fulfilling prophesy because many believed they were reaching for an unattainable goal.

Three others shared stories of their aspirations for a career in the professoriate and that the competitive nature and limited job market "forced them" into considering a career in the private sector. As described by an Asian American male who shared his job searching journey:

> I applied for some academic jobs during my postdoc and, at that time, I felt like I still was a strong candidate. I didn't get any of those jobs. I had a few phone interviews at best, no second rounds, or campus interviews. And I felt like maybe this was not a successful track for me, so I'm finding I'd be more successful in a nonacademic setting.

Another Asian male currently employed in industry noted similar sentiments: "Students are realizing on their own, oh, I'm not likely to become faculty . . . that the real chances are sort of low. So, I'm going to hedge my bets and apply and do these other things." Finally, a White male currently employed in industry commented:

> So, it's pretty slim chances of getting it, I guess, and I've heard a lot of people that have been trying to pursue that for a really long time and most of them eventually get it. But yeah, so that's another not super appealing thing that, you kind of have to throw yourself into it, and really pursue that and it almost seems kind of cutthroat competitive and I'm not sure that I necessarily want to engage in that.

The lack of available positions was a common theme across the interviews and a factor that deterred engineering postdoctoral scholars from pursuing a career in the professoriate. These individuals were discouraged after limited success in the job-hunting process, leaving them to consider positions in industry as more realistic.

The overarching theme of competition was discussed relative to its influence on the working environment and work relationships within the academic setting. Specifically, participants focused on the way in which the competitive nature of the field and the limited number of tenure-track faculty positions breeds competition among individuals, within labs, and across institutions. The competitive nature of academia was consistently mentioned as one reason a position in the professoriate was unappealing. One African American female postdoctoral scholar who is aspiring to become a professor said, "It's a space that it seems like it can be a highly competitive in a nasty way, where people aren't supportive or collaborative of one another. That's a place that I don't want to be." An African American male who is currently employed as a postdoctoral scholar discussed his view on the role of competition in academia:

> I've been in environments during my PhD where it felt very competitive, not overtly but between faculty where it didn't seem quite as collaborative as I hoped it would be because people working in the same departments would be applying for the same kind of grants. So, there wasn't that much incentive that I observed among those professors to kind of work together and write things together.

The competitive environment of academia appeared to sway some postdoctoral scholars away from pursuing a career as a professor, a finding that was especially salient among the URM participants.

An Asian American male who is currently employed as a postdoctoral scholar and desires to remain in academia added the following regarding the unappealing components of a career as a tenure-track faculty member: "I think competitiveness . . . to write papers, to get a position, pitch your work to make it a hot topic, and then get money from [federal agencies] is exhausting." This participant shared that his drive to be successful in this environment, through increasing his publication record, created strife within his lab and led to a misunderstanding among his peers:

> It was kind of reported to the supervisor that I was not helpful, or I was pushy, and I was demanding papers . . . if I did not have that pressure, I would not have run into the trouble with my colleagues and my supervisor. So, I feel they're interconnected. They [colleagues] may not have understood that I was driven to write papers because of the requirement from faculty hiring committees.

This individual believed his career goals and relationships with his peers were at cross-purposes, which resulted in a competitive, unproductive working environment.

Overwhelmingly, participants did not feel they "published enough to be competitive in the job market" during their postdoctoral appointment, although they believed they gained new engineering skills that would benefit them in the professoriate. When faced with limited prospects and unsuccessful interviews they turned to industry for their next career step. While most continued to be interested in the professorship, they voiced concern about the competitive nature of the field and questioned their interest in a career that appeared to be "full of pressure" and lacking collaboration and collegiality. In reference to SCCT, postdoctoral scholars clearly viewed the learning experiences related to their postdoctoral appointments as positive in terms of bolstering their self-efficacy and professoriate career interests. Yet, their outcome expectations diminished because they felt unprepared for the tenure-track job market, believing they had not attained the performance metrics necessary to be a competitive candidate. This realization, along with the competitive environment of academia, led the participants to question their career goals.

Unachievable work-life balance. The majority (77%) of the postdoctoral scholars spoke of their desire for a work-life balance when making career decisions. A White female participant who plans to pursue a career as a professor stated, "Work-life balance plus a positive work environment are really big, I think those two things together are what will lead to overall happiness in my life." The sentiment was echoed by an African American female currently employed as a postdoctoral scholar who is currently pursuing a tenure-track faculty position:

> In general, if I could have a happiness balance and a health balance in my work . . . especially when you consider deadlines, you overlook that and people become unhealthy, which makes them unhappy. So, if I could be somewhere that you know, endorses that, that's really important.

Work-life balance was an important factor mentioned by almost all participants in terms of influencing their career decisions. While some viewed it as achievable in the professoriate, most witnessed their mentors, supervisors, and themselves, lacking work-life balance, which was perceived as a negative factor when choosing to remain in academia. One White female stated:

> I saw that a lot of the faculty that I interacted with on the tenure-track were very stressed about finding money and stressed about getting a certain number of publications to get promoted. And that just wasn't something that really appealed to me.

Similar sentiments were shared by a White male who is currently employed as a postdoctoral scholar and pursuing a career in industry:

> I briefly considered a career in academia and I may still pursue that at some point . . . but at this point, I feel like it would be something that may require a lot of hours and I'm just recently married and we're looking to start a family pretty soon, and so the thought of having to commit to all of those hours on the early end, right as I'm starting a family and trying to build my life, my personal life, I tend to shy away from that.

Other participants indicated their family and friends questioned the hours they dedicated to their postdoctoral appointment. An Asian American postdoctoral scholar who intends to pursue a tenure-track faculty position shared that his partner was unsupportive of his desire to become a professor because her father was a professor who appeared to be unhappy with his career choice. This individual shared the following regarding his career trajectory:

> Now, my significant other and her mother don't want me to take an academic path because they have seen enough of her father's struggles in the academic world. It's unfortunate, I know. She and her mother think that the life of an academic is very hard . . . Overall, she feels that she has seen her father be unhappy as an academic. She doesn't want me to become an academic and be unhappy. She's in industry, and she feels like I'll be happy if I join industry, rather than academia.

Thoughts of stress, pressure, and constant work demands were echoed in the sentiments shared by an African American male who is currently employed in a tenure-track faculty position:

> Okay, so when I did my postdoc, I had the mentality of a PhD student where you go in and you work and you're working for the deadline, and you're not really pacing yourself. Then, when I transitioned to the postdoc, I didn't want to disappoint so I worked nonstop, nonstop. All day, all night, until whenever, to try to be productive. When I was doing that, I saw my supervisor doing the same hours as me and I did not like that. I didn't want to see myself working and sending emails at 2 O'clock, 3 O'clock in the morning and still having to come in during the day and work and be productive. That just didn't seem like something I wanted to do, and I ended up doing it anyway.

When questioned whether his life and career goals were in alignment, he stated, "No, I only have career goals, life goals will be on the back burner until tenure." Similar themes were noted by another former postdoctoral scholar who is now in a tenure-track faculty member role: "I'm working on a home, life, and work balance, but it's difficult and I often feel pressure to be working or at least be reading papers on the weekends and you know, that's probably the hardest aspect of it."

The absence of work-life balance was consistently noted as an inevitable component of the professoriate, examples were commonly shared that imbalance was exacerbated in academia compared to other career fields. A Latinx female currently employed as a postdoctoral scholar and planning to pursue a tenure-track faculty position added, "This pressure to work all the time . . . just publishing to publish and raising funds to raise funds. And that even though you have freedom, sometimes you don't." A While female currently employed as a postdoctoral scholar indicated work-life balance may be a reason to not pursue a career in academia:

> I think that if I were to not go for it [a tenure-track position], it would be somewhat because of feeling like I wouldn't be able to have a work-life balance. And maybe being afraid. . . that sometimes you feel like you're judged for not making your work the only thing you care about.

The nonexistence of work-life balance in academia was characterized as a constraint to entering the tenure-track job market by most of the postdoctoral scholars.

The reason many postdoctoral scholars do not enter the tenure-track job market is apparent when considering their desire to achieve work-life balance. The perception that a work-life balance is unattainable in academia, and the intense pressure to sacrifice everything for one's work, appears to lure hopeful academics to a career in the private sector where they assume this balance is more manageable. According to SCCT, the learning experiences related to work-life balance during their postdoctoral appointment serve as a warning against a career in the professoriate because it adversely influences career interests and goals despite the indication there is a level of freedom and autonomy in academia that cannot be matched in industry.

Research autonomy. When considering the appeal of becoming a professor, participants consistently discussed the positives associated with an autonomous career field. Postdoctoral scholars repeatedly spoke of a future in the professoriate that allowed them to set their own career goals, pursue their own research interests, design their own scholarly projects, and be "their own boss." One Latinx female postdoctoral scholar intending to enter the tenure-track faculty job market noted, "I'm personally kind of tired of being a trainee, and not being fully independent to make my own decisions . . . from conferences to attend to how much time I spend in the lab." A White male who is considering a career in industry, echoed the sentiments of autonomy in the following statement:

> I think that'd be really nice to have the flexibility to explore the science that you want to explore. I know that when you're an investigator let's say at a private company, like a for-profit company, you obviously have an agenda that may or may not be what you really want to do research on. So, being a professor at any academic institution, I know that there's just a lot of flexibility.

A Latinx female reiterated the value of autonomy: "For me it's the independence and flexibility, you can study whatever you want and not be tied by, you know, what a company thinks is interesting or what will be the most profitable." Similarly, an Asian American female indicated she plans to pursue a tenure-track faculty position because it fits with her long-term career goals:

> I am going to stay in academia because there are less constraints, I feel like I might be able to be more independent and be more self-motivated. Basically, your Dean or your department head wouldn't really tell you what to do. So, then I feel like there's more flexibility in that. I feel like maybe I get the sense that I can be better able to decide what I want to do. So that is what I feel like right now, I'm going to try to stick to academia.

Contrary to the previous statements, a Latinx male postdoctoral scholar doubted the autonomy of the professoriate when he shared a lack of autonomy in his current work: "Some of the projects or ideas that I suggested never came through because either it wasn't of interest, or maybe because the approach, or the budget. It has been a tough learning curve into lowering my very high expectations."

Other participants discussed the ways in which autonomy bolstered their interest to remain in academia. A White female postdoctoral scholar shared the reason she believes academia is more attractive than industry: "When I was considering industry versus academia, I just had a lot more freedom in academia and I can work on the things that I'm interested in as long as it's on a funded project." Two individuals currently employed in tenure-track positions shared that

autonomy is one of the most pleasing components of the professoriate, as evidenced in the following statement: “The most appealing part is being able to really set my own research questions. Then decide what it is I want to figure out. Then try to figure it out.” The other participant simply stated, “Freedom is great.”

Research autonomy was a major driver for the appeal to pursue a career as a professor among postdoctoral scholars. One such postdoctoral scholar, an African American male intending to remain in academia, shared that as he is completing his application package, he consistently finds that his career goals moving forward are "to run my own lab, to develop independent research ideas. Do things that I'm curious about doing." The perceived degree of autonomy in the professoriate served as an important learning experience that influenced postdoctoral scholars’ desire to pursue a tenure-track faculty position because it shaped their choice actions as described by SCCT. They found autonomy and freedom as attractive aspects of the field that could not necessarily be replicated in the private sector, which strengthened their career interests, goals, and outcomes expectations.

A call to teach and mentor. All 15 of the postdoctoral scholars aspiring to become a professor perceived it as a calling to teach and mentor the upcoming generation of engineers. Several discussed their desire to teach from an early age, as was the case with an African American male: “In school, I would tutor, I always enjoyed teaching, so I always thought I wanted to go down that path.” An Asian American male indicated, “I had this idea about my career from an early age, I love to teach and wanted to teach and be a professor.” An African American female remarked about the rewarding experience of tutoring middle school children:

> I used to teach math to students on Saturdays . . . a year later having children who are now in their young teens come and say, you know, I understand algebra now because of you. And they are now high performing in their school, that was really rewarding for me.

Many participants had instructional experiences while undergraduates, in graduate school, or in their postdoctoral appointments that solidified their decision to base their career around teaching, as was noted by a Latinx female who shared:

> The other thing I did in undergrad that I think cemented my love of teaching, and is the main reason why I continue to be on that academic path as opposed to say doing research at a company or a national lab is that . . . I tutored at our learning center. And I always enjoyed that. And so that was also like, "No, this is what I'm supposed to do. I want to research, and I want to teach."

The desire to teach and the “sheer joy” they received from teaching was a strong factor for each of the postdoctoral scholars as they considered their career trajectory moving forward.

The potential to mentor future engineers also served as an attraction to the professoriate. An African American tenure-track professor shared his experience in identifying the importance of mentoring others during graduate school:

> My PhD program advisor was going through a lot of personal stuff in his life at the time. And, at the time when he had taken me in, he had three students, myself as a PhD student and two master's students, and then one day he up and disappeared and he was gone for almost a year. And, I was the surrogate advisor for these students, and we stuck together, we fought through, worked through projects, tried to get stuff done, tried to be productive. Once the advisor came back, . . . we were able to pick back up with very little

> lost time. It was that experience that was like, wow, I can't believe we did it. We still talk about it today. It was to the point where other faculty members were saying, "Hey, you might as well just pick up and go somewhere else because who knows if he's coming back." And, I was like, "Well, we got to finish, we got to do it." He came back and we made it through. But that's when I said, "Wow, this is what I want to do."

While others did not have a moment of mentoring epiphany, many shared that teaching and mentoring was a deep passion they hoped to continue in their careers. A White female postdoctoral scholar, shared, “I would like to teach in the future. I don't know if that's more lecturing undergrad or more mentoring graduate students or mentoring postdoc assignments.”

Other participants were interested in teaching to a greater degree than conducting research; they were aware it may affect their prospect of a tenure-track faculty position and receiving tenure, as described by one White female postdoctoral scholar:

> The teaching aspect is what I want to focus on long-term. So right now, I'm still trying to decide after I finish my postdoc whether I want to do tenure-track at a smaller teaching, focused school or if I want to do just instructor/lecturer type, non-tenure-track positions. But definitely interacting with students, the curriculum development, the teaching aspect of higher ed is what draws me to that career path.

Her positive teaching experiences drew her to an academic position that would allow her to emphasize teaching in her career. Even those intending to pursue a career in industry expressed enjoyment in teaching, as was stated by a Latinx male postdoctoral scholar leaving academia: “Experiences that I had during my PhD were very rewarding in terms of teaching others, like being a mentor for all the undergrads and also being a mentor for all my lab mates.” Despite these positive experiences, he found industry to be more attractive, as he believed he could reproduce these teaching and mentoring opportunities across any career field.

The prospect to work with others and to collaborate through teaching and mentoring were noted as the principal reward for persevering through graduate school and postdoctoral appointments. This theme was particularly true for the two participants who were tenure-track professors, both stated emphatically the teaching and mentoring aspects of their positions along with their ability to influence the next generation of engineers continued to fuel their passion for the professoriate. The learning experiences the postdoctoral scholars gained from teaching and mentoring distinctly solidified their desire to become a professor. As noted by SCCT (Lent et al., 1994), these experiences are a main incentive to enter the tenure-track job market because they bolstered their career interests and goals, causing them to take career actions to remain in close proximity to students and postdoctoral scholars who could benefit from their expertise.

Discussion

Broadening participation in STEM fields, and particularly in the engineering discipline, is of paramount importance to the scientific and educational communities, as the U.S. is deficient in the human capital necessary to be competitive in the field in the 21st century. This reality will continue until underrepresented groups in STEM are more effectively engaged in the discipline (NSF, 2019). Reporting the viewpoints and insights of postdoctoral scholars who are best in line to assume tenure-track faculty roles may provide direction and guidance on the positive and negative aspects of the career field to those invested in increasing the number of URMs and

women entering the professoriate and earning tenure. This study adds to the call in the literature regarding the need to better understand the arc of the career for professors (Jaeger et al., 2017; St. Clair et al., 2017; Su, 2013) through employing an interpretivist lens that emphasizes empathy when conducting research (Patton, 2015). Each of the researchers found themselves affected by the perspectives and experiences shared by the postdoctoral scholars, which enabled the researchers to relate to the participants' stories within their own frames of reference and develop a sense of cognitive, emotional, and somatic closeness with the participants.

The findings of this study provide unique standpoints on facets that discourage engineering postdoctoral scholars from continuing their careers in academia and pursuing tenure-track faculty positions. Specifically, most of these individuals were disenchanted with the limited number of available tenure-track faculty positions and the competitive work environment of academia. An area for further research and exploration could focus on the fact that all URM participants reported "unsupportive" or "hostile" environments during their graduate work and/or postdoctoral appointment, which resulted in uncertainty regarding their stamina and resiliency "to make it as a professor." This finding is supported in the works of Burt (2019) and McGee et al. (2019) both of which highlight the importance of the PhD socialization process and how this experience can negatively affect an individual's desire to continue toward a career in the professoriate. Concern also was voiced regarding the competitive nature of the field, leading to an unhealthy work-life balance for the participants, as well as for their mentors and supervisors. The work-life imbalance that was modeled for the participants sent messages of balance being unachievable and even disparaged in academia; therefore, a career in the private sector was assumed to be more amendable to their intended work-life balance pursuits. This research emphasizes that the competitive and compressed job market depresses interest in the professoriate, as noted by other scholars (Andalib et al., 2018; McGee et al., 2019; Silva et al., 2016; St. Clair et al., 2017; Waaijer et al., 2016). However, this research also highlights other aspects that negatively influence postdoctoral scholars' career choices away from the professoriate, particularly the antagonistic academic environment in which hopeful academics are uncertain they want to traverse.

Moreover, this research highlights the aspects of the career field that draw engineering postdoctoral scholars to seek a professorship. Participants consistently reported their attraction to the autonomous nature of academia, and the ability to determine their own research agenda and follow their scholarly interests, a finding supported in the work of Gibbs and Griffin (2013) and Lindholm (2004). While autonomy is certainly a component of the professoriate, some postdoctoral scholars possessed an unrealistic view of autonomy as often it is coupled with managing a heavy workload and chronic stress around publishing and securing external funding. All participants who indicated their intent to remain in academia shared a deep desire to teach and mentor the next generation of engineers. Each shared stories of mentors and supervisors who shaped their interest in engineering and helped to bolster their STEM identity (the ways in which individuals come to believe they belong and can succeed in a STEM field; Collins, 2018). These experiences profoundly influenced the postdoctoral scholars, as each noted their desire to give back and pay forward the mentorship and guidance they received, which suggests further study in this area is warranted. These findings support the work of Gibbs and Griffin (2004) who noted that individuals with career aspirations in the professoriate wanted to use the academic platform to help others. Additionally, more research is needed to understand the nuances of these

attractive aspects of the professoriate to ensure an appealing and meaningful transition from postdoctoral scholar to professor particularly among URMs (Davis, 2006). It would also be noteworthy to better understand why the most well-positioned postdoctoral scholars are choosing to not enter the professoriate ranks and instead choose a career in industry.

SCCT (Lent et al., 1994) was a useful theoretical framework for the study, as it provided context with which to recognize the ways in which the learning experiences during engineering postdoctoral appointments influenced their view of the professoriate, and consequently, the career decision-making process for those intending to enter the tenure-track job market. Knowledge of the factors that negatively deter engineering postdoctoral scholars from entering the job market and aspiring to become professors, and perhaps more importantly, the factors that encourage and inspire them into this career field, is an essential means to broaden participation and to diversify the engineering professoriate. The relationships and pathways described by SCCT shed light on the intersection of learning experiences; person inputs; background and proximal environmental influences; self-efficacy and outcome expectations; and career interests, goals, choice actions, and performance. For example, postdoctoral scholars who achieved professional and personal success in mentoring and in supporting undergraduate and graduate students in the classroom or in the laboratory found this to be a positive learning experience that bolstered their self-efficacy and desire to continue this work in their careers as a professor. This experience was particularly salient for those who received high-quality mentoring as students; therefore, the idea of "giving back" was not only attractive and personally fulfilling, but also directed their career interests and actions. The idea of nurturing the next generation of engineers solidified their career goal of securing a tenure-track position because they believed mentoring and teaching relationships were more naturally developed, and even rewarded, in higher education settings over the private sector.

Conclusion

This embedded, multiple-case study design (Yin, 2018) grounded by SCCT (Lent et al., 1994) provides a deeper understanding of the nature, meaning, and ways in which a diverse set of engineering postdoctoral scholars describe the appeal of the professoriate, as well as the learning experiences that influence their career decision-making process. Applying an interpretivist lens to this study ensured empathy was a key consideration in collecting, analyzing, and interpreting the meaning of the postdoctoral scholars' experiences and perspectives. The findings indicate that those intent on pursuing a career as a professor are deeply motivated by the enticement of research autonomy and the opportunity to teach and mentor future engineers. Individuals who either departed academia or now question their initial desire to enter the tenure-track faculty job market are impacted by the competitive nature of the job market and the academic environment, as well as the lack of perceived work-life balance in the professoriate. A more nuanced understanding of what makes the professoriate attractive across the lines of race/ethnicity and gender, as well as the career decision-making process of postdoctoral scholars, may be an avenue to aid in diversifying the engineering professoriate.

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References

Allen-Ramdial, S.-A. A., & Campbell, A. G. (2014). Reimagining the pipeline: Advancing STEM diversity, persistence, and success. *BioScience, 64*, 612–618.

Andalib, M., A., Ghaffarzadegan, N., & Larson, R. C. (2018). The postdoc queue: A labour force in waiting. *Systems Research and Behavioral Science, 35*(6), 327–348. http://doi.org/10.1002/sres.2510

Anfara, V. A., & Mertz, N. T. (Eds.). (2014). *Theoretical frameworks in qualitative research* (2nd ed.). Sage Publications.

Babbie, E. (2015). *The practice of social research* (14th ed.). Cenage.

Bandura, A. (1986). *Social foundations of thought and action: A social cognitive theory*. Prentice-Hall.

Bandura, A. (2005). The evolution of social cognitive theory. In K. J. Smith & M. A. Hitt (Eds.), *Great minds in management* (pp. 9–35). Oxford University Press.

Burt, B. A. (2014). *The influence of doctoral research experiences on the pursuit of the engineering professoriate* (Publication No. 3672724) [Doctoral dissertation, University of Michigan]. ProQuest Dissertations and Theses Global.

Burt, B. A. (2019). Toward a theory of engineering professional intentions: The role of research group experiences. *American Educational Research Journal, 56*(2), 289–332.

Cawyer, C. S., Simonds, C., & Davis, S. (2002). Mentoring to facilitate socialization: The case of the new faculty member. *Qualitative Studies in Education, 15*(2), 225–242.

Collins, K. H. (2018). Confronting color-blind STEM talent development: Toward a contextual model for Black student STEM identity. *Journal of Advanced Academics, 29*(2), 143–168. http://doi.org/10.1177/1932202X18757958

Davis, G. (2006). Improving the postdoctoral experience: An empirical approach. In R. Freeman & D. Goroff (Eds.), *The science and engineering workforce in the United States: An analysis of markets and employment* (pp. 99–127). NBER/University of Chicago Press.

Enders, J. (2005). Border crossings: Research training, knowledge dissemination and the transformation of academic work. *Higher Education, 49*, 119–133. http://doi.org/10.1007/s10734-004-2917-3

Gibbs, K. D., & Griffin, K. A. (2013). What do I want to be with my PhD? The roles of personal values and structural dynamics in shaping the career interests of recent biomedical science PhD graduates. *CBE-Life Sciences Education, 12*, 711–723.

Gordon, J., Haynes, C., & May, G. (2015, June). *Impact of mentoring and focused enrichment activities in facilitating persistence and academic careers among underrepresented STEM doctoral students* [Conference session]. American Society for Engineering Education Annual Conference & Exposition, Seattle, WA, United States.

Griffin, K. A. (2019). Redoubting our efforts: How institutions can affect faculty diversity. In L. L. Espinosa, J. M. Turk, M. Taylor, & H. M. Chessman (Eds.), *Race and ethnicity in higher education: A status report* (pp. 273-279). The American Council for Education. https://www.equityinhighered.org/resources/ideas-and-insights/redoubling-our-efforts-how-institutions-can-affect-faculty-diversity/

Hayes, N. (Ed.). (1997). *Doing qualitative analysis in psychology*. Psychology Press.

Higgs, C. F., Graham, S., & Mattei, N. J. (2006). Development of new faculty: Summary of the NSF-CMS WEE Workshop. *Journal of Professional Issues in Engineering Education and Practice, 132*(2), 133–137.

Horta, J. (2009). Holding a post-doctoral position before becoming a faculty member: Does it bring benefits for the scholarly enterprise? *Higher Education, 58*, 689–721.

Jackson, J. (2004). The story is not in the numbers: Academic socialization and diversifying the faculty. *NWSA Journal*, *16*(1), 172–185.

Jaeger, A. J., Hudson, T. D., Pasque, P. A., & Ampaw, F. D. (2017). Understanding how lifelong learning shapes the career trajectories of women with STEM doctorates: The Life Experiences and Role Negotiations (LEARN) Model. *The Review of Higher Education, 40*(4), 477–507.

Kosoko-Lasaki, O., Sonnino, R. E., & Voytko, M. L. (2006). Mentoring for women and underrepresented minority faculty and students: Experience at two institutions of higher education. *Journal of the National Medical Association, 98*(9), 1449–1459.

Lechuga, V. M. (2014). A motivation perspective on faculty mentoring: The notion of "non-intrusive" mentoring practices in science and engineering. *Higher Education*, *68*(6), 909–926.

Leggon, C. B., & Pearson, W., Jr. (2009). Assessing programs to improve minority participation in the STEM fields: What we know and what we need to know. In R. G. Ehrenberg & C. V. Kuh (Eds.), *Doctoral education and the faculty of the future* (pp. 160–171). Cornell University Press.

Lent, R. W., Brown, S. D., & Hackett G. (1994). Toward a unifying social cognitive theory of career and academic interest, choice, and performance. *Journal of Vocational Behavior*, 45(1), 79–122.

Levy, R. (2014). Postdoc mentorship can launch careers. *American Scientist, 102*, 418–421.

Lincoln, Y. S., & Guba, E. G. (1985). *Naturalistic inquiry*. Sage Publications.

Lindholm, J. A. (2004). Pathways to the professoriate: The role of self, others, and environment in shaping academic career aspirations. *The Journal of Higher Education, 25*(6), 603–635.

Main, J. B., & Wang, Y. (2019, June). *Is postdoctoral training linked to faculty careers and higher salaries among engineering Ph.D.s?* [Conference session]. American Society for Engineering Education Annual Conference & Exposition, Tampa, FL, United States.

McGee, E. O., Naphan-Kingery, D., Mustafaa, F. H., Houston, S., Botchway, P., & Lynch, J. (2019). Turned off from an academic career: Engineering and computing doctoral students and the reasons for their dissuasion. *International Journal of Doctoral Studies, 14*, 277–305.

Melin, G. (2004). Postdoc abroad: Inherited scientific contacts or establishment of new networks? *Research Evaluation, 13*(2), 95–102. http://doi.org/10.3152/147154404781776455

Miles, M. B., Huberman, A. M., & Saldaña, J. (2019). *Qualitative data analysis: A methods sourcebook* (4th ed.). Sage Publications.

National Science Foundation. (2019). *Science and engineering indicators 2020: State of US S&E labor force.* https://ncses.nsf.gov/pubs/nsb20198/

Patton, M. Q. (2015). *Qualitative research and evaluation methods* (4th ed.). Sage Publications.

Pyke, J. (2013). Women, choice and promotion or why women are still a minority in the professoriate. *Journal of Higher Education Policy and Management, 35*(4), 444–454. http://doi.org/10.1080/1360080X.2013.812179

Recotillet, I. (2007). PhD graduates with post-doctoral qualification in the private sector: Does it pay off? *Labour, 21*(3), 473–502.

Robinson, W. H., McGee, E. O., Bentley, L. C., Houston, S. L., & Botchway, P. K. (2016). Addressing negative racial and gendered experiences that discourage academic careers in engineering. *Computing in Science & Engineering*, *18*(2), 29–39.

Roy, J. (2019). *Engineering by the numbers*. American Society for Engineering Education. https://ira.asee.org/wp-content/uploads/2019/07/2018-Engineering-by-Numbers-Engineering-Statistics-UPDATED-15-July-2019.pdf

Scott, S. V. (2017). *The struggle is real: Black doctoral students' perceptions aspiring to the professoriate* (Publication No. 10267165) [Doctoral dissertation, Temple University]. ProQuest Dissertations and Theses Global.

Shaw, A. K., & Stanton, D. E. (2012). Leaks in the pipeline: Separating demographic inertia from ongoing gender differences in academia. *Proceedings of the Royal Society, 279*, 3736–3741.

Silva, E. A., Des Jarlais, C., Lindstaedt, B., Rotman, E., & Watkins, E. S. (2016). Tracking career outcomes for postdoctoral scholars: A call to action. *PLoS Biology, 14*(5), e1002458. http://doi.org/10.1371/journal.pbio.1002458

Silverman, D. (1993). *Interpreting qualitative data.* Sage Publications.

St. Clair, R., Hutto, T., MacBeth, C., Newstetter, W., McCarty, N. A., & Melkers, J. (2017). The "new normal": Adapting doctoral trainee career preparation for broad career paths in science. *PLoS ONE, 12*(5). http://doi.org/10.1371/journal.pone.0177035

Stake, R. E. (1995). *The art of case study research*. Sage Publications.

Stephan, P., & Ma, J. (2005). The increased frequency and duration of the postdoctorate career stage. *The American Economic Review, 95*(2), 71–75. http://doi.org/10.1257/000282805774669619

Su, X. (2011). Postdoctoral training, departmental prestige and scientists' research productivity. *Journal of Technology Transfer, 36*, 275–291.

Su, X. (2012). International doctoral science and engineering students: Impact on cohorts' career prospects. *Journal of Studies in International Education, 17*(5), 590–606. https://doi.org/10.1177/1028315312467354

Su, X. (2013). The impact of postdoctorate training on scientists' academic employment. *Journal of Higher Education, 84*(2), 239–265.

Waaijer, C. J. F., Macaluso, B., Sugimoto, C. R., & Larivière, V. (2016). Stability and longevity in the publication careers of U.S. doctorate recipients. *PLoS ONE, 11*(4), e0154741. http://doi.org/10.1371/journal.pone.0154741

Watt, D. (2007). On becoming a qualitative researcher: The value of reflexivity. *The Qualitative Report*, *12*(1), 82–101.

Webber, K. L., & Yang, L. (2015). The career path of the postdoctoral researcher. *Change: The Magazine of Higher Learning*, *47*(6), 53–58. http://doi.org/10.1080/00091383.2015.1089760

Yang, L., & Webber, K. L. (2015). A decade beyond the doctorate: The influence of a US postdoctoral appointment on faculty career, productivity, and salary. *Higher Education*, *70*(4), 667–687. http://doi.org/10.1007//s10734-015-9860-3

Yin, R. K. (2018). *Case study research and applications: Design and methods* (6th ed.). Sage Publications.

Zambrana, R. E., Ray, R., Espino, M. M., Castro, C., Douthirt Cohen, B., & Eliason, J. (2015). "Don't leave us behind." The importance of mentoring for underrepresented minority faculty. *American Educational Research Journal*, *52*(1), 40–72.