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UNDERSTANDING THE CAREER CHOICE FOR UNDERREPRESENTED MINORITY DOCTORAL STUDENTS IN SCIENCE AND ENGINEERING

Audrey J. Jaeger,¹,* Karen J. Haley,² Frim D. Ampaw,³ & John S. Levin⁴

¹ Department of Leadership, Policy and Adult & Higher Education, North Carolina State University, Raleigh, NC 27695

² Department of Educational Leadership & Policy, Portland State University, Portland, OR 97207

³ Department of Educational Leadership, Central Michigan University, Mount Pleasant, MI 48859

⁴ Graduate School of Education, University of California Riverside, Riverside, CA 92521

* Address all correspondence to: Audrey J. Jaeger, E-mail: ajjaeger@ncsu.edu

This study explored the career choices of underrepresented science, technology, engineering, and mathematics minority graduate students through the lens of identity theory. Twelve participants from a research university in the West participated in in-depth interviews. Themes were developed using work from Holland et al. (Identity and Agency in Cultural Worlds, Cambridge, MA: Harvard University Press, 1998) including figured worlds, positionality, self-authoring, and agency. Positionality, as described by students’ roles in academia, appeared to be influenced by the nature of “doing” science and engineering. Graduate students in this study found the world of academia in conflict with their own values and identity. What they wanted as a career was often inconsistent with their perceptions of what they observed in a faculty role at a research university.

KEY WORDS: agency, career choice, doctoral students, faculty, graduate students, identity, self-authoring

1. INTRODUCTION

“People tell others who they are, but even more important, they tell themselves and then try to act as though they are who they say they are” (Holland et al., 1998, p. 3). These self-understandings, Holland et al. (1998) suggest, are identities. One of the goals of doctoral study is to socialize students into a discipline as well as a profession (Golde, 2000, 2010). For many
doctoral students who aspire to be faculty members, graduate school is the place to begin to develop this identity, which is often based on observations of their own faculty members. This may prove difficult in many cases because research suggests that some graduate students may experience “tensions in adapting to the values embodied in higher education and the mixed (or ambiguous) messages they receive about priorities in the academy” (Nyquist et al., 1999, pp. 19–20). Furthermore, recent work proposes that graduate programs continue to use models of professional socialization that do not take into account the unique aspects of underrepresented minorities (Tuitt, 2009).

These tensions may be even more pronounced for underrepresented minorities in the science and engineering fields. Minority students are more likely to interact with faculty of similar race and ethnicity; these relationships support decisions to continue graduate study (Swail et al., 2003). The low numbers of minority faculty in science and engineering fields may indicate that many minority students have completed a bachelor’s degree or graduate degree with limited or no access to faculty members that look like them (Nelson, 2007). High-achieving minority students are more committed to their science fields when they have support in the form of role models and advisors who share similar backgrounds (Grandy, 1998). As graduate students acquire the skills needed to become faculty and are socialized to the role of faculty, underrepresented minorities may be challenged by the lack of connection in the academy to their own cultural and personal identity. “Identities are a key means through which people care about and care for what is going on around them” (Holland et al., 1998, p. 5). Graduate students’ lack of an association and relationship with faculty of similar backgrounds may affect their eventual choice of whether to remain in the academy and follow an academic career path.

This shaping of career decisions for underrepresented minorities has considerable significance for the present and future profile of the professoriate. More specifically, if there is a dearth of underrepresented minority (URM) faculty in science, technology, engineering, and mathematics (STEM) fields, increases in this population are unlikely without first understanding the ways in which identity and interpersonal interactions in graduate school shape career decisions. On average, less than 8% of the faculty members in these fields are comprised of underrepresented minorities (Snyder and Dillow, 2012). Low minority faculty numbers have been attributed to low numbers of minority students enrolling in doctoral programs (Antony and Taylor, 2001). However, according to the National Science Foundation (NSF), whose stated goal is to increase the number of minority faculty within the science and engineering fields, the percentage of underrepresented minorities enrolling in science and engineering graduate programs increased by approximately three percentage points between 1996 and 2006, (NSF, 2007). Over 20% of all doctoral degrees conferred in 2008 went to URM students (NSF, 2007, see http://www.nsf.gov/statistics/wmpd/minwomen.cfm). These increases have not been reflected in faculty placement, which suggests that new doctoral recipients are choosing alternate career paths.

Increasing the numbers of minority faculty not only supports the matriculation and completion of minority students in science and engineering fields (Armstrong and Thompson, 2003; Cheatham and Phelps, 1995; Davidson and Foster-Johnson, 2001) but also benefits all students by having a diverse faculty (Gurin et al., 2002; Milem, 1997, 2003; Singh and Cooper, 2006). The understanding of the career choices of URM graduate students in STEM—that is, why they are making the choices they are making—is rarely described or articulated in the literature. The purpose, then, of this research is to understand the influences of identity on the STEM graduate experience and the ways in which this graduate experience shapes career decisions.
2. LITERATURE REVIEW AND CONCEPTUAL FRAMEWORK

Identity is a concept that combines the personal world with the collective space of culture forms and social relations (Holland et al., 1998). Levin and Shaker (2012) used the writings of Holland and her colleagues to explain the experiences of full-time non-tenure-track faculty. In their research, they note, “Identity brings together personal experiences and expectations with the social-cultural environment, specifically the university, including its structures, norms, and practices” (Levin and Shaker, 2012, p. 1465). Similar to Holland et al. (1998), Levin and Shaker (2012) focused on the development of identities and agency and their representation within the context of “historically contingent, socially enacted, culturally constructed ‘worlds’” (Levin and Shaker, 2012, p. 1465). The figured worlds to which Holland et al. (1998), as well as Levin and Shaker (2012), refer include figures and characters who carry out tasks and who have particular styles of interacting. These figured worlds include colleges and universities who have actors such as faculty, administrators, and students and actions including teaching, research, and service (Levin and Shaker, 2012). Significance is attributed to each of the actions and some outcomes are valued over others (Holland et al., 1998).

For full-time non-tenure-track faculty, their worlds were multiple and divided between discipline, program, department, and university (Levin and Shaker, 2012). The figured world of these faculty members was “characterized by dissonance, where one set of values or norms is not congruent with another” (Levin and Shaker, 2012, p. 13). A different type of dissonance was alluded to in the Haley et al. (2010) study of graduate students between the doctoral student’s cultural social identity and his or her professional or academic identities. They suggested a student’s cultural social identity may conflict with common aspects of the faculty career such as research agenda and work setting.

How doctoral students fit within the world of the academe—or in the case of Levin and Shaker (2012) how full-time non-tenure-track faculty fit within their figured world with respect to the status and roles—is called “positionality” (Holland et al., 1998; Levin and Shaker, 2012). “Self-authoring” [or “authoring self” according to Holland et al. (1998)] reflects how actors engage in their worlds. Self-authored individuals actively construct, evaluate, and interpret judgments to develop their internal belief systems (Baxter Magolda and King, 2007). These individuals have the internal capacity to identify, explore, and choose values to form their identities (Kegan, 1994). This ability to define one’s beliefs, identity, and social relations is what Baxter Magolda (2008) defined as self-authorship. We often associate identity development with undergraduate students, whereas Gardner (2010) suggested that graduate students may be again confronted with development challenges that compel them to reconsider issues related to their identity.

Levin and Shaker (2012) suggested that full-time non-tenure-track faculty members position themselves differently depending on the roles they play and the worlds in which they exist. They are both outsiders in the departments where they serve as faculty and insiders if they also hold an administrative position in addition to their faculty role. Levin and Shaker (2012) add that these faculty members are conflicted in their definitions of self, which may suggest their ability to self-author is challenged by the worlds in which they are engaged.

Conflict may also exist for URM doctoral students. Such students are actively recruited to research universities and sought out for their expertise; however, curricula are often gender biased and Eurocentric (Anderson, 1990; Gasman et al., 2010), lack a sense of social relevance (Busch-Vishniac and Jarosz, 2004; Gasman et al., 2010), and are competitive and non-inclusive (Anderson, 1990; Busch-Vishniac and Jarosz, 2004; Gasman et al., 2010). That is, curricula are
not aligned with student characteristics, including their social backgrounds, belief systems, and self-understandings. As URM students develop their internal belief systems and reflect on who they are, what they want from a doctoral program, and where they intend to pursue a career, they encounter feelings of isolation and frustration (Johnson-Bailey et al., 2009). These students attempt to define both their place and expected accomplishments in a world where the norms and ideals are not always stated (Nyquist et al., 1999), and their own values and ideas about their doctoral experience and impending career may conflict with the traditional role of a faculty member within the academy (Haley et al., 2010). Doctoral students may experience this idea of positioning within the figured worlds of higher education differently from full-time non-tenure-track faculty (Levin and Shaker, 2012) because they may not view themselves as an “insider” in any of their worlds, including the classroom, the laboratory, or within the faculty.

Research that addresses minority students’ experiences suggests that these students experience discomfort within the academic world (Ellis, 2001; Gay, 2004). In their research, Antony and Taylor (2001) suggested that Black students face an identity crisis in their graduate educational experiences. Adopting the academic cultural norms while not losing their racial identity in the process is problematic (Haley et al., 2010). URM students also battle “stereotype threat conditions” (Antony and Taylor, 2001, p. 193) that cause anxiety and decreased self-confidence, which lead to unsuccessful outcomes. Their interactions with faculty tend to be more formal and do not evolve into mentoring relationships that are essential to their continued success in graduate school (Ellis, 2001; Nettles and Millett, 2006).

To the conversation of identity, figured worlds, and authoring of self, Holland et al. (1998) and Levin and Shaker (2012) add the concept of agency. Agency is “the ability to act on behalf of goals that matter to [oneself]” (Sen, 1985, p. 203, as cited in O’Meara et al., 2013). All faculty, and we suggest doctoral students, need agency to be successful in their work as teachers, researchers/scholars, and institutional citizens (O’Meara, et al., 2008). O’Meara et al. (2008) noted that various inputs or influencing factors affect agency (e.g., individual awareness, desired outcomes, and internal resources). In addition, agency is a process of strategic and intentional behavior and is about self-direction and intentional choice making (O’Meara et al., 2008). Finally, according to O’Meara et al. (2008), agency is related to outcomes—those positive changes in well-being, in organizations, and in society. We suggest URM doctoral students enact agency by seeking what researchers suggest is a socially relevant curriculum (Gasman et al., 2010) and degrees that are clearly beneficial to society and involve a high level of interaction with others (Haley et al., 2010). Busch-Vishniac and Jarosz (2004) stated that students of color seek opportunities to explore issues that are relevant to their own cultural subgroup. Haley et al. (2010) described students who culturally connected themselves to their community through their research (health, anthropology), vocation (teacher to other students of color), and service (role model to young people).

The framework of identity has not been used to investigate graduate student career choice within the literature. However, these ideas have been used to explore career choice of undergraduates. Creamer and Laughlin (2005) showed in their study that students who have no personal experiences of certain careers require self-authorship to interpret their experiences and advice, and make informed decisions about their career choice. Other researchers have noted that individual differences in career decision making develop from a student’s agency (Rotberg et al., 1987), personal experiences, and reactions to environmental factors (Lent et al, 1994 and Lent et al., 2000).

Research has suggested there are various reasons that attract students to an academic career, including the intellectual challenge inherent in the profession (Bowen and Schuster, 1997; Corco-
3. METHODS

This research sought to explore the following research question: In what ways do underrepresented graduate students in science and engineering make their career choice? We employed a basic interpretive qualitative research design because the study involved answering a “how” question addressing a contemporary phenomenon in its real-life context (Burgess, 1982). This method supports the in-depth look into the experiences of graduate students and allows the researchers to explore the meanings participants assign to their experiences (Merriam, 1998).

The research site was a western U.S. public comprehensive doctoral institution with very high research activity. The research site included an undergraduate population of 15,000 (80% URM) and 2,000 graduate students (23.8% URM as well as 34.8% international). Nearly 230 graduate students at the institution identify as Asian, 182 as Chicano/Latino, 46 as African American, and 14 as Native American. The research team included a faculty member, administrator, and graduate student from the research site as well as several other members from other institutions. The team included two members from underrepresented backgrounds. The diverse team allowed for multiple perspectives on data collection and analysis, which helped assure credibility during the research process (Marshall and Rossman, 1999; Miles and Huberman, 1994). The research team members interacted on an ongoing basis for over a 2-year period. Data collection occurred on four separate site visits. During data collection, the research team members compared perspectives before and after each interview. The team members kept field notes and research journals, which allowed for the refinement of the data collection techniques. During the data analysis phase, the team members came together again to carefully review transcripts. Three research team members completed the final stages of analysis through electronic communication.

Participant selection began with an email message sent to all graduate students at the institution with an invitation to, and explanation of, the study. Those interested in participating followed a link to a short demographic survey and were then invited to participate in individual interviews if they were an URM. In addition to self-selection, we asked participants for referrals of other students to contact—snowball sampling (Bogden and Biklen, 1992)—and asked faculty and administrators to identify URM graduate students in STEM disciplines, a form of targeted sampling to meet the criterion (LeCompte and Preissle, 1993).

A total of 24 URM students were interviewed, 12 of which were in science and engineering disciplines. The demographic breakdown of the 12 participants included five enrolled in engineering and seven in the sciences; six male and six female; six Hispanic, four multiracial, and three Black students. Due to our Institutional Review Board requirements at the participating institution, we are unable to identify other background characteristics for each of our participants.
Students may or may not have self-identified in their choice of pseudonym; however, we could not confirm gender, race, or other background information unless the students self-identified in their interview.

Interviews were face-to-face meetings using a semi-structured interview protocol lasting approximately 90 min in length. Each participant gave of their time and offered their stories without reward, which helped address self-selection bias. Our interest was to obtain information-rich narratives (Patton, 2002). The types of open-ended questions included the following: How did you decide to pursue this discipline? How would you describe the culture in your department (discipline)? What role has race or gender played in your graduate school experience? What career path are you considering and what has influenced you to choose this career path? What role has race or gender played in your career decision?

The stories of our participants were vital to understanding their graduate school experience; therefore, interview data were analyzed using ideas and concepts relating to identity as developed by Holland et al. (1998). We conscientiously integrated these ideas into our research process. We coded the data to the themes of figured worlds, positionality, self-authoring, and agency. Specifically, we searched the data for regularities, outliers, patterns, and connections to the themes (Miles and Huberman, 1994; Patton, 2002; Strauss and Corbin, 1998).

We identified two limitations within our study. The analytical framework used in this study provided a deep and comprehensive lens through which to examine our data. However, using an analytical framework can trap a researcher by leaving other relationships in the dark and blocking a researcher from considering new insights (Jaeger and Bryant, 2011). Thus, care was taken in using an existing theory as our analytical framework. In addition, we interviewed participants only once, although we triangulated the data during the research process through research team interview debriefings and field notes as well as ongoing research team deliberation regarding the data coding and themes (Bogdan and Biklen, 1992).

4. KEY FINDINGS AND DISCUSSION

The key findings in this study are presented around the four major themes of figured worlds, positionality, self-authoring, and agency (Holland et al., 1998), as applied by Levin and Shaker (2012) in their study of full-time non-tenure-track faculty.

4.1 Figured Worlds

The figured world of academia, specifically in a research-oriented university, is described differently by different graduate students. The primary differences fall into categories based on the student’s career goal; i.e., faculty at research universities, faculty at teaching institutions or other academic-related positions, as well as private industry. Those graduate students who were seeking positions within private industry or research laboratories for their first position after attaining their doctorate were the most critical of academia and faculty roles. Graduate students who were focused on faculty positions at research universities were the least critical of academic life, and those who had aspirations of academic administration or teaching at a 4-year institution other than a research university or community college fell in the middle. Graduate students in science and engineering who sought tenure-track faculty positions within research universities viewed the academic world as formal and somewhat static; however, they also viewed a full-time
faculty “lifestyle” to be flexible and self-directed, allowing for creativity and intellectual growth. This is consistent with what researchers (Bowen and Schuster, 1997; Corcoran and Clark, 1984; Schuster and Finkielstein, 2006; Lindholm, 2004) offer as reasons why graduate students choose careers in academia. These graduate students spent less time talking about the figured world of academia as they expressed a general understanding of the culture and environment of the university more so than students who were looking for careers outside of the research university or the academy in general. Shakina articulated the challenges of a faculty career but kept coming back to the real reason she wanted to be in academia, “I guess the reason I ended up going to grad school and wanting to be a professor is that I have raised some questions that I’d like to answer that I don’t think I can answer in any other career.”

Over a third of the students viewed their career goals as more aligned with an institution of higher education other than a research university. They expressed anxiety and nervousness about the actuality of designing a project that entailed the development of a research laboratory and then ultimately attaining the resources necessary to fund a laboratory. Hector’s comments illustrate this anxiety:

You have all these responsibilities of bringing in money, writing grants, it is really stressful. I think it [would] just entail too much energy on my part and the pay wouldn’t be great. I [would] have to definitely be thinking about my work literally when I wake up till I go to sleep and I will be under pressure. If I am going to be under pressure, I [would] like to be paid a little bit more. It isn’t worth it.

Hector wrestled with the incongruence of his well-being and the demands of a career in the academy. These students were critical of the figured world of academia noting such conditions as the lack of balance in faculty lives, similar to other studies of doctoral students (Mason and Goulden, 2006; Mason et al., 2009). Our participants perceived that faculty had a limited view of the needs of students and of the larger institution because faculty time was often focused on research, laboratory-oriented work, and obtaining funds to support their laboratory. Ahmad’s perception was that “If I told them [faculty] I don’t want be sitting here doing research, that will make them mad, and they would say ‘no, we brought you here because we want you to discover something amazing and make us look good.’” This absolute focus on research had deterred students from a career at a research university. Students were interested in teaching and exploring other options as well as conducting research. Students in this group were overly concerned that setting up a laboratory and funding a laboratory would not allow them time to work with students, teach, and “live their life.” Previous research has often suggested that doctoral students are disenfranchised with the demanding work load of faculty (Johnsrud, 1993, Mason and Goulden, 2006; Mason et al., 2009). At the same time, graduate students in science and engineering in our study talked almost exclusively about the demands of a laboratory environment that were not relevant to other disciplines. The demanding life of the faculty member included attaining sufficient grant funding to support a laboratory and students/employees in that laboratory rather than on the publication demands often mentioned by graduate students outside of science and engineering.

Students who had identified private industry or government as their preferred work environment were the most critical of the academic world. They identified unappealing issues in the work of faculty as scientists and in the area of work/life balance as previously noted. Graduate students suggested that “faculty spend an inordinate amount of time at work and not enough time with their families.” They saw a lack of collaboration among faculty within science and engineering and a repetitive nature to the research conducted. The faculty served as negative aspects of
the figured world of academia. Holland et al. (1998) suggested that significance is attributed to actions within the figured worlds and some actions are valued over others. The student participants in this group offered clear testimonials to what actions they valued and how specific actions and behaviors of faculty persuaded them to choose one career over another. Students talked about their faculty as having to make choices to forgo a family because they needed to spend all their time in the laboratory or to move across the country for a particular postdoctoral position, which would then lead them to a more prestigious faculty position. They talked about the lack of mentors and role models in their disciplines. One student’s comments provide an illustrative example of when these URM students were not seeking faculty positions:

*I think in general the number is low because if you don’t have role models or mentors, then you don’t usually want to go that path. That’s probably why we have a lot of athletic superstars but we have less academic superstars. People are comfortable when they are around people like them. If you are never around people like you, then you are less likely to go into that field professionally.*

In a follow-up conversation with one of the research team members, Shakina noted, “It’s hard. I often ask myself why do I want to be the only black female scientist, I could choose to be a lawyer or a doctor or an engineer, like some of my cousins, and at least know I wasn’t the only one.”

This perception was similar to those students interested in teaching careers; however, this group of graduate students outright rejected the role of faculty as “demanding and insane.” The actions of faculty members at research universities were inconsistent with the values these students identified as important to their lives, both personally and professionally. Darius noted, “Because this is a major research university, [there are] a lot of professors aren’t here to teach. Sometimes when you have classes, it seems like the students care more than the professors, and it is a waste of our time.” Students’ sense of connection to life in the academy was limited and conflicted with their social identities—a distinction between what they valued personally and what they experienced in their academic environment (Holland et al., 1998). As Darius noted, there was no community within his discipline, and “[I] don’t have role models.” Jose agreed, “It’s kind of lonely” and there is “no group for me.” As these students reflected on their self-concepts and understandings, including their personal preferences, they did not see what they wanted in the academy.

### 4.2 Positionality

Students’ positionality, or how they described themselves within the context of the figured world of academia, was more than as a researcher or a teacher. Students’ identification with race and ethnicity issues and their relationship to their advisor, peers, and family contextualized their positionality.

Race and gender were interwoven with students’ roles as scientist and engineer. Shakina identified issues of striving to be better than others so that she would not be perceived as securing an opportunity based on race, and Danielle suggested “sometimes you feel like you’re the only one [of my race].” Students acknowledged there were few other students similar to them; however, race was difficult to distinguish from their professional role. Haley et al. (2010) noted that students in the humanities, arts, and social sciences more readily identified race as a separate issue in the university. These URM science and engineering students actively explored and chose values to construct their own identity (Baxter Magolda and King, 2007) as scientists and
engineers. Students closely aligned themselves with “being a scientist,” as noted by a participant, rather than as faculty in the figured world of the academy. This idea of “being a scientist” may be explained by the “sacred spark” theory in which Cole and Cole (1973, p. 114) suggested faculty members (or, in our case, future faculty) have an inner drive to do science. This inner drive fuels their determination to engage in science research (Cole and Cole, 1973) and emerges from within a person’s soul (Rodgers and Rodgers, 1999). This inner spark may have been fueled early in their careers, as all but one participant cited undergraduate research work as important in their motivation to pursue a doctorate in their field. The connection to their undergraduate research mentor influenced their perspective of the field and career options. This socialization to science or engineering started during the undergraduate years and was reinforced in their current classes and laboratories.

Students positioned themselves low in the hierarchy of the laboratory, with postdocs playing not only a supervisory role but also a mentoring role. The actual laboratory supervisor was sometimes distant and sometimes present, which meant that students depended on their laboratory mates to show them the ropes and support them in difficult times. Students positioned themselves one or two degrees of separation away from faculty members; laboratory mates, laboratory supervisors, and postdocs were more central to their experience in academia. Hector positioned himself in relationship to his professors: “Sometimes talking to professors you kind of feel stupid, especially my advisor, he’s kind of rough when it comes to telling people how to do things.”

He was more likely to approach peers to find answers until he possessed confidence in his work to approach his advisor. This positionality was evident by the terms students used to describe their faculty advisor; several students referred to these individuals as the “PI” (principle investigator), “supervisor,” and “boss,” which highlights their status and role within the figured world (Holland et al., 1998; Levin and Shaker, 2012). Unlike part-time faculty who did view themselves as “insiders” at times (Levin and Shaker, 2012), these URM graduates students positioned themselves as outsiders in most, if not all, of their environments. Although students could define who they were in relation to their professional role of scientist or engineer, they struggled with how they fit within the academy even if they eventually wanted to work at a college or university. One student suggested that she was ready to leave academia in large part because she experienced isolation and lacked the support she needed: “I was ready to throw in the towel and just move on.”

Research suggests that faculty/student interaction is influential in the socialization process, particularly in relation to role modeling and mentoring (Antony and Taylor, 2001; Ellis, 2001; Keith and Moore, 1995). Graduate students are socialized to the discipline and profession by faculty (Austin, 2002; Golde and Dore, 2001); thus, if their connections to faculty are limited it is not surprising they would not position themselves in the figured world of academia. Students suggested that “people [faculty] get busy and get more focused in increasing their publications and getting to tenure and whatever and just forget that they are also at a teaching facility.”

Finally, the role of family in the lives of science and engineering URM doctoral students is important to the ways in which students position themselves within the academy. Research suggests that URM graduate students position themselves more closely within their family and community than White students (Haley et al., 2010; Whiston and Keller, 2004). Students articulated their connection to family and the desire to stay close geographically to both family and friends in their future career. However, the fields of science or engineering played an important role in students’ lives in their childhood and adolescent development because they had family members who had related jobs, either in academia or industry. Wanda articulated part of her motivation to continue her degree as “making my parents and family proud.” One-third of the full-time faculty
members in a higher education research institute study cited a parental role in their career decision making (Lindholm, 2004); this was even more significant for URM graduate students in this study because all participants noted an influential parental role. This is consistent with Haley et al. (2010) who concluded that “…the social identity of parent, spouse, or citizen was more salient to some students’ future identity than the role of faculty member.” For several students their position as a parent (or as a future parent) or family member was in conflict with the role of faculty.

4.3 Self-Authoring and Agency

Self-authoring in this context reflects how the students understood their values and beliefs and translated them into their figured worlds and eventual career choices. Not surprisingly, the students described their strengths by what they could contribute to the world of science and engineering in the areas of both research and teaching. Students who were looking at both research within industry and research-oriented university careers constructed their identity around a focus on research but not on teaching. Andria said, “I just don’t think I want to do that [teaching] for the rest of my life. So I cannot see myself here in twenty years teaching.” Those students who valued teaching and mentoring struggled because their definition of self was challenged by the worlds in which they were engaged—the research university. Faculty advisors suggested they seek research universities over other teaching environments and some showed disdain for primarily teaching environments such as community colleges. Julia invoked the idealized characteristics of teaching as follows:

I love working with students and helping them to master the material and figuring out a way to explain it to them so that they get the core idea and that they’re able to go off on their own and then apply it to their assignments and their lab work and then get it to work.

At the same time, Julia and others acknowledged that teaching was not a priority in their departments. Student reflections’ showed their commitment to the development of others through teaching and mentoring. Students believed it was important to support other students who “looked like” them because they may not have had role models who shared similar backgrounds. Calistro saw mentoring as a way to role model for Hispanic students:

When I came here, I saw a Hispanic professor, you know teaching Spanish but I never saw one in Sciences. I want to be a faculty member because I never saw anyone that I could relate to that made me feel that, oh, okay I could do that.

URM students attempted to define their success in a figured world where the norms were not consistent with what they saw or what they wanted. As URM students reflected on who they were and where they intended to work they were challenged by current expectations and practices of faculty. In spite of the conflicts in their views of self and others including the challenges already presented, these students were resilient and enacted agency.

Agency is “the ability to act on behalf of goals that matter to [oneself]” (Sen, 1985, p. 203, as cited in O’Meara et al, 2013). Self-authoring and agency are closely connected because those students who are able to explore, reflect on, and choose values to form an identity (Kegan, 1994) are more likely to be able to act on behalf of the goals that resonate with them. Students identified various internal resources (O’Meara et al., 2008) as critical to their success, including hard work, perseverance, and initiative. Shakina epitomized the concept of agency in how she viewed her abilities. “To look at all the options and not say that I can’t do something. Because personally I
think a lot of people don’t really realize how good their best is, because no one has ever pushed them that far.” Shakina recognized the value of peer relationships and demonstrated agency when she instigated a peer network:

Since I felt that there was no support in my lab between the different years and things like that. So we started meeting every week and I had an idea that we pick different journals and we go over it every week and we try to help each other through to our orals.

Students’ ability to articulate their desired path with clarity after the doctorate illustrated another source of agency. Students in this study reflected on three possible career options, which we have previously discussed as research faculty, teaching faculty, and private industry or government careers. These intentional career choices (O’Meara et al., 2008) were apparent even when the students perceived that the faculty members were unsupportive, as Ahmad noted: “I honestly will not tell them, what my plans are, even my PI.” Anthony knew he wanted to focus on teaching at a nonresearch university and recognized that his career goal was not aligned with others; however, he was determined to follow a teaching career. Students also expressed a willingness to make career decisions based on values of independence, job flexibility, and work/life balance. Their individual awareness (O’Meara et al., 2008) of what mattered to them and what career was most likely going to accommodate their values illustrate their agency. For example, Anthony was clear about the role of his career in his life:

My goal isn’t just to get a big job just for the sake of it, especially one that may make me move away from family and friends, definitely my career goal is to find that job, I don’t want to say career because that always has the connotation that that’s your life at that point, but for me, it’s part of my life, but it’s not my life, my life are my friends and family.

Calistro viewed the research faculty position as the best fit because he had the flexibility to pursue his work, have a family, and influence other underrepresented students. These agentic behaviors indicate the connection between the choices they have made, their current success, and the probability of future success.

Finally, O’Meara et al. (2008) suggested that agency is related to outcomes—those positive changes in well-being, in organizations, and in society. Students reflected on their particular choice of career as providing for a more “sane” and “well-balanced” life style. For Andria, this meant seeking a position in a private research laboratory; for Darius and Jose, an engineering position; and for Anthony and Wanda, teaching positions at a 4-year college or university. In addition, Calistro and Shakina specifically sought a faculty career and noted their responsibility to be a mentor and role model to others similar to them, thus making a difference in their organization and society.

5. CONCLUSIONS AND IMPLICATIONS

Employing the lens of identity theory, and more specifically the themes derived from the literature of Holland et al. (1998) and Levin and Shaker (2012), this investigation offered an alternate view of doctoral education for STEM students. The idea of academia as a figured world, as seen through the eyes of graduate students, provides insight into both their understanding of their discipline and how they understand their career choices. Positionality, as described by students’
roles in academia, appears to be influenced by the nature of “doing” science and engineering. In addition, the role of self-authoring and agency in student career choice is relevant in graduate students’ life and career choices.

The students in this study made career decisions based on the figured worlds of academia and industry as they perceived them. At the same time, none of the students indicated an in-depth knowledge or extended set of experiences in all the areas they were considering (i.e., various institutional types and industry/government). Thus, it is likely that they positioned themselves in one world and thought of a contrast, as one participant suggested: “It has to be better than this [another world—academia].” Graduate students are trained at research universities, and thus may have little or no opportunity to experience a teaching institution, a community college, or a government organization. Graduate training is focused and narrow in scope; and as Austin and McDaniels (2006) suggested, ineffective in preparing students for the multiple roles they have upon graduation. The students were able to differentiate between the various roles of faculty but did not recognize the various institutional types and how the roles may be different at various institutions.

The practical implications of this study suggest we consider doctoral student professional development. Providing doctoral students with cross-training opportunities would afford them opportunities to experience various career sectors. Internship opportunities with specific goals would allow students to learn about the culture and environment at entities such as government agencies, community college, liberal arts colleges, or research organizations. This may also address the concern of Austin and McDaniels (2006) that students are ill prepared for the multiple roles they encounter as faculty, as these experiences would provide concrete practice in teaching and research at a minimum.

Research suggests that persistence in science and engineering majors is affected by undergraduate research mentors (Rayman and Brett, 1995); however, this did not translate into students wanting to pursue the same kind of career as those undergraduate mentors who were often faculty members. Thus, we would assume that graduate mentors would be more critical to students in relation to careers after graduate school. This study suggests that students may be separated or isolated from their faculty in science and engineering because of the laboratory environment. Hector turned to his laboratory mates and laboratory supervisor more often for mentoring, and thus he missed an opportunity to understand the faculty role.

A second practical implication of this research focuses on the laboratory supervisor and/or postdoc. This investigation suggests that these supervisors, often postdocs, be afforded additional consideration. Postdocs are rarely provided training in the area of mentoring; in spite of recent NSF regulations (see Section II.C.2.d.i of http://www.nsf.gov/pubs/policydocs/pappguide/nsf09_1/gpg_index.jsp). Postdoctoral fellows may be the key in the mentoring and guiding of URM graduate students into faculty careers. The provision of cross training for graduate students would provide them with experiences in various sectors and a clearer picture of those various careers.

Three suggestions for future research flow from this study. First, future research should explore the role of industry on faculty careers. Why do students choose industry careers as an alternative to faculty positions? Is the role of a career in industry “easier” or “better” than the role of faculty, as our students would suggest, and what does that mean for faculty positions? What are the experiences of students in STEM industries, and what can be learned by better understanding this competing career? Would more collaborative professional development efforts between the academy and industry result in students making more informed career choices? Perhaps students would learn that “the grass isn’t greener” in industry.
Second, future research should involve more STEM disciplines to tease out any disciplinary
types of differences (Golde, 2000; 2010) in career decision making, particularly for URM stu-
dents. Are STEM disciplines with higher concentrations of women or men different from other
disciplines? Do URM students’ experiences differ by discipline?

Finally, race was interconnected with students’ professional views of themselves as sci-
entists and engineers. Replicating this study at an institution with less-diverse undergraduate
and graduate populations may even better illuminate how race affects career choices for STEM
graduate students. We suspect that an institution as diverse as the one in the study population may
have to some extent diminished the salience of race as an independent factor. Although additional
research may illuminate new connections between race and the role of the scientist, this investi-
gation suggests race influences students’ interest in academic careers, the strategic decisions and
perspectives they hold during their graduate work, and their ultimate career decision. Exploring
career choices of STEM graduate students is critical to understanding the composition of future
faculty in STEM disciplines. This research has furthered that conversation by exploring new
conceptual ideas such as identity, self-authoring, agency, and positionality.

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