Running Head: URM GRAD STUDENTS IN STEM

Underrepresented Racial and/or Ethnic Minority (URM) Graduate Students in STEM Disciplines: A Critical Approach to Understanding Graduate School Experiences and Obstacles to Degree Progression

Tanya Figueroa, Sylvia Hurtado

University of California, Los Angeles

Association for the Study of Higher Education
November 2013
St. Louis, Missouri

Contact: Tanya Figueroa, (310) 825-1925, tfigueroa.wisc@gmail.com

This study was made possible by the support of the National Institute of General Medical Sciences, NIH Grant Numbers 1 R01 GMO71968-01 and R01 GMO71968-05 as well as the National Science Foundation, NSF Grant Number 0757076. This independent research and the views expressed here do not indicate endorsement by the sponsors.

Abstract: This study examines the obstacles domestic underrepresented racial and/or ethnic minority (URM) students experience as they navigate their graduate educational journey through STEM. Results from focus group interviews with 23 participants demonstrate students contended with three overarching challenges within their formal academic environments: 1) what students saw as the negative consequences of being “underrepresented” in their program; 2) exclusion and conflict, and the ambiguous nature of these experiences; and 3) less ambiguous experiences of discrimination.

Every year tens of thousands of talented students begin science, technology, engineering, and math (STEM) graduate programs motivated and determined to succeed in their respective fields (MacLachlan, 2006). The research they conduct as aspiring members of the STEM workforce contributes to knowledge in critical areas such as energy and health, and ultimately enhances the United States' ability to remain competitive in a global market (George & Malcolm, 2011; PCAST, 2010). Further, the perspectives and creativity of a diverse group of individuals is needed to more flexibly address 21st century challenges (PCAST, 2010). Despite these realities, U.S. born Black, Latina/o, and American Indian students continue to be severely underrepresented within STEM graduate programs (NSF, 2011; U.S. Census Bureau, 2009). The issue is exacerbated by the fact that URM students are also the least likely to complete a PhD within ten years of entry into their doctoral program, with degree completion being as low as 40% in some doctoral STEM disciplines (George & Malcolm, 2011).

To increase degree completion among graduate students in STEM disciplines, STEM graduate departments will have to better support students and dismantle unnecessary barriers to degree completion which will require more targeted and active measures than those currently in place. Informed action necessitates rigorous investigation of the graduate experiences of STEM students. A recent examination of extant literature on graduate education revealed that scholars have commonly placed a heavy emphasis on the inadequacies of individuals to explain differential experiences and outcomes among students (Flynn, Sanchez, & Harper, 2011). These 'inadequacies' include low GRE scores, low self-confidence, less rigorous preparation prior to graduate school, and an individual inability to adjust to the STEM culture (Gardner, 2008, 2010; Gonzalez, 2006; Lott et al., 2009). By attributing incidences of drop out largely to individual factors, this body of research diminishes the important role institutions and departments play in student departure during graduate school and absolve them of responsibility for finding solutions (Noguera, 2001).

Encouragingly a small body of research has recently emerged demonstrating that although student characteristics help students persist in the face of challenges during graduate school, other elements over which students have less control matter as well (Soto & Yao, 2010). Indeed practical factors (i.e. financial support) along with the educational environment and the relationships student have with others within those environments shape students' educational experiences and subsequent decisions to stay or leave their programs (Golde, 2005; Millet & Nettles, 2006; Justin-Johnson, 2004; Soto & Yao, 2010). However much less is known about the experiences of URM graduate students pursing STEM degrees specifically, since this area of research has not garnered much attention by mainstream researchers (Brown, 2000; Gardner, 2010). Attention to the experiences of URM students in STEM education is critical given that barriers to success often affect these students "first and most severely" (George & Malcolm, 2011, p. 10). Further an overwhelming majority of studies on graduate students use quantitative methodologies, which do not provide a nuanced description of the multi-faceted challenges students face within their educational environments in graduate school (Flynn et al., 2011). This study contributes to this under-researched area in the literature.

A variety of challenges are likely to exist during one's graduate program in STEM. However, the purpose of the study is to gain a deeper understanding of the challenges URM graduate students face in formal academic spaces that are unique to their membership as a racial/ethnically underrepresented minority. The guiding research questions are as follows: what challenges do URM students face in the formal academic environment that make progression through their STEM graduate program difficult? Further, how do students of color respond to these challenges? Findings will hopefully inspire new ways of understanding the experiences of a critical student population and address retention in STEM to diversify the workplace. Findings are intended to spark a critical examination of the individual behaviors and departmental practices in STEM that may undermine the success of students from disadvantaged backgrounds and also their responses of resistance to these practices.

Theoretical Perspectives

The experiences of racial minority students are unique because they come from ethnic and racial communities historically excluded, oppressed, and marginalized in American society (López, 2003; Peña, 2012). Critical perspectives from multiple scholars (Omi & Winant, 1994; Bonilla-Silva, 2001) provide a nuanced lens in understanding the experience of these students. According to critical scholars, race is embedded within American institutions, and existing structures work to normalize and reinforce racial inequity, social hierarchy, and White privilege (Omi & Winant, 1994; Bonilla-Silva, 2001). As such, there is a stark power differential between individuals of different racial backgrounds which perpetuates very different lived experiences across racial lines (McQuillan, 1998; Harper, 2012; Espino, 2012).

Power (who has a significant amount of it and who has a great deal less) plays an important role in critical perspectives. Abrams (1993), a critical feminist scholar, advances two important notions regarding dominant groups in society and the power they hold in shaping perceptions and the treatment of people from subordinate groups. First, she asserts that people who hold positions of dominance have the power to make their perspective normative; that is, their perspectives are accepted as objective and accurate portrayals of life (Abrams, 1993). Similarly those in the dominant group have the power to characterize those in subordinate groups in ways that are marginalizing and disempowering. Dominant perspectives and definitions of people are perpetuated precisely because they are treated not as a point of view, but as fact. Translated to the context of STEM graduate programs faculty, and to a lesser but still significant extent students, hold varying positions of power.

Second, Abrams (1993) argues that individuals in dominant positions talk about people as being either similar or dissimilar to themselves. Those considered to be dissimilar are subsequently “othered.” Those considered to be an “other” are regularly characterized as being non-normative and having less value (even if this isn’t explicitly stated), and as such are held at a distance. Such characterizations also have the potential to become shared truths (Abrams,

1993). Exclusionary practices that set the “others” apart from everyone else send a message that the others are not only different, but do not belong. Such practices along with other seemingly inconsequential habits and customs serve to stigmatize those that are deemed to be the “other” and create a larger pattern of oppression for excluded groups (Abrams, 1993). In STEM graduate programs, students with identities that are dissimilar from the dominant group – by race, gender, and intersections of identities - are likely to be characterized as the “other” and to subsequently encounter challenges that those belonging to the dominant group do not.

Literature on workplace climate provides more insight into the consequences that seemingly trivial practices and behaviors can collectively exert on the outcomes of people (Rowe, 2008; Wylie et al., 2007; Sandler, 1986; Brennan, 2013). Indeed institutional practices and interactions between people can be informed by either intentional discrimination or implicit biases that occur below the threshold of conscious decision-making. Nonetheless such practices and interactions can result in great opportunities and benefits for some people and great disadvantages for others. Those who are deemed “different” or the “other” regularly encounter unjust practices that single-out, overlook, discount, exclude, or ignore them (Sandler, 1986). When considered in combination, small acts of disrespect or devaluation – referred to as micro-inequalities – can help explain larger scale inequalities in academia (Brennan, 2013).

Continued exposure to micro-inequalities are harmful in that, as a collective, they represent large deficits of support for victims (Wylie et al., 2007) and can have wide-ranging effects on those victimized including impaired performance, diminished self-esteem, and in some cases voluntary removal from the context in which micro-inequities are enacted (Sandler, 1986). Compounding the problem, micro-inequalities and their cumulative harms are easily overlooked by both the perpetrator and victim because of their small size (i.e. they are not full-blown inequities) and their ambiguous nature in which they are not clearly racist or sexist (Brennan, 2013). Even when micro-inequities are recognized, they are easily given an

alternative interpretation or explanation for there occurrence or the significance attached to inequitable events is denied (Brennan, 2013).

When applied to higher education and graduate school experiences, the theoretical perspectives described above would posit that power plays a large part in who is considered an "other" in academic spaces and how people are treated. Those who are deemed different from the dominant group (i.e. URM students) will encounter inequities, both large and small, as part of their everyday experiences in academia. Some inequities, especially the smaller ones, will not be clearly biased or discriminatory, but nonetheless when considered in their aggregate form will effectively harm students. As analytical tools, critical perspectives frame the challenges that URM graduate students encounter at predominately White institutions as social, structural, and institutional inequities rather than a problem primarily stemming from the deficiencies of individuals.

Literature Review

URM students in STEM graduate programs represent a unique population. However the limited amount of research available that focuses exclusively on their experiences forces the author to delve into a more general literature base in order to contextualize this study. With this in mind, the next section draws on the limited research on URM students in *STEM* graduate programs, but also incorporates literature on URM students across graduate disciplines and on STEM graduate students broadly (i.e. participants are not disaggregated by race). This next section seeks to examine the nexus between race and/or ethnic background, experiences in STEM graduate programs, and the decision to either continue in or drop out of one's graduate program.

Discrimination and Cultural Disconnect

URM students have distinct experiences in graduate school as they confront a number of stressors that go over and beyond those experienced by their white peers, with one of the most salient stressors being discrimination based on race or ethnicity (Ibarra, 2001; Golde,

2005; MacLachlan, 2004). Indeed survey research on over 1,300 doctoral graduate students, showed Black and Latino students perceived their institutions as more racially discriminative than their White peers (Nettles, 1990). Although instances of overt racist behavior are less common, qualitative inquiries on URM students reveal the multiple manifestations of discrimination within the graduate learning environment (Castellanos, 1996; Gonzalez, 2006). These manifestations include low expectations and marginalization from faculty (Solórzano, 1993), tokenization, perceived double standards, a lack of respect from others in the academic community, and a lack of identifiable mentors or collegial support, all of which lowers the confidence URM students have in their academic abilities (Gonzalez, 2006). In short as non-White individuals attending predominately White institutions, URM students must "continuously brace themselves against possible attacks" because of their race and/or ethnicity (Holmes, 2003, p. 52).

Research on URM students in STEM specifically notes that they also contend with a lack of minority faculty role models (Hoffman, Llaga, & Snyder, 2003), teacher centered-pedagogical approaches that do not acknowledge diverse learning needs (Bayer Corporation, 2012), a Eurocentric curriculum that does not recognize the contributions URM individuals have had to science (Seiler, 2001; Brown, 2000), unfounded accusations of academic dishonesty (Essien, 2007), and little encouragement within their programs to persist (Rohlfing et al., 2010). Students also commonly perceive they are being judged by their race instead of their intellect (MacLachlan, 2006). The aforementioned factors also contribute to a diminished academic self-confidence (Essien-Wood, 2010) and ultimately act as barriers to their persistence and success in higher education (Nerad & Miller, 1996). URM women face additional challenges due to being the most underrepresented in STEM and having two identities that are historically undervalued in STEM (Brown, 2000).

The challenges URM students face in academia are not only due to race, but can also be attributed to cultural dissonance resulting from a conflict between the culture of students'

families and that of the university (González et al., 2001; Ibarra, 2001). In a qualitative study on Latina graduate students, Gonzalez (2006) found that participants, especially those with stronger cultural identities, sometimes coped by resisting academic socialization, disengaging socially, or distancing themselves from colleagues. These coping strategies further exacerbated feelings of isolation. Other Latina students ceased resisting and conformed to White norms, which dictated the expected behavior in academia. A handful of students equated the process of becoming an academic to giving up their cultural ways of life. URM students are especially vulnerable to feelings of isolation and loneliness (Ibarra, 2001; Hamilton, 2001). Students report that in programs where there was an extremely small population of other URM students, a welcoming and nurturing educational environment that was supportive of their cultural identity helped them ward off feelings of isolation (Gonzalez, 2006). Exposure to a curriculum that acknowledged the contributions of scholars of color was also crucial to increasing the satisfaction of URM graduate students (Gonzalez, 2006).

Relationships with Peers and Faculty

Irrespective of racial and/or ethnic background, graduate students tend to complete their degrees at higher rates in programs where supportive peers and faculty are easily identifiable as these individuals represent key sources of guidance, provide intellectual stimulation, and contribute to satisfaction in graduate school (Gardner, 2008; Golde, 2005). Alternatively a lack of a sense of community within one's program contributes to attrition (Gardner, 2010). Research on Black graduate students in the biological sciences attending a PWI, demonstrates that participants commonly lacked support in their relationships with faculty, experienced exclusion and isolation with regards to coursework and social life, and had difficulty in cultivating and establishing relationships with other students and faculty (Justin-Johnson, 2004). Other research on URM graduate students show that they have poorer social environments compared to their white peers (Turner & Thompson, 1993). Not surprisingly URM students in STEM perceived their campus environment as unwelcoming and unsupportive and noted that this

made degree completion more difficult (Justin-Johnson, 2004). The findings from these studies are troubling given the role positive interactions and affiliation with peers and faculty play in reassuring students and bolstering confidence in their ability to perform well (Hamilton, 2001). For students in the sciences, caring advisors helped students cope and minimized demoralization in the face of challenges (Barnes & Austin, 2009). Likewise supportive relationships with similar raced peers helped URM graduate students in STEM cope with feeling "different" after having had interactions with majority peers in their program (Soto & Yao, 2010).

Supportive relationships with peers and faculty are also crucial to the socialization of students into their field of practice and help graduate URM students persist in STEM (Soto & Yao, 2010). Faculty, as the primary socializing agents in students' academic lives (Girves & Wemmerus, 1988; Lovitts, 2001), facilitate the acquisition of necessary skills and dispositions needed to become a researcher and scholar (George & Malcolm, 2011) and assist in integrating students into the fabric of graduate life (Herzing, 2004b). In a comprehensive review of literature on the advisor-advisee relationship, advisors were found to serve as student advocates, role models, mentors, and gatekeepers of important resources, information and networks (Barnes & Austin, 2009). Poorer relationships with faculty may be a contributing reason as to why URM graduate students have fewer professional socialization opportunities and less mentoring experiences compared to their white peers (Turner & Thompson, 1993).

Methods

Applying critical perspectives to a constructivist methodology, this study seeks to identify the challenges URM graduate students face in formal academic spaces that make it difficult to progress through their STEM graduate program. The study also seeks to understand how students respond to these challenges. Focusing on the perspectives of URM students is an approach that honors their "voice" in a graduate educational process in which they are typically considered an outsider (Weiss & Green, 1992).

Data Sources and Sample

The data for this study come from a larger retention project conducted by the Higher Education Research Institute located at the University of California Los Angeles. The larger study conducted focus groups comprised of graduate students at seven institutions: three Hispanic-serving institutions (HSI), one historically Black college/university (HBCU), and three predominantly White institutions (PWI). These institutions were selected based on their high rates of STEM degree completion among URM students. Focus group interviews were collected from December 2009 to April 2010. To ensure racial diversity in the sample, the majority of the focus group participants were purposefully recruited from structured programs designed to support URM students in STEM. Purposeful sampling captures cases that provided rich information about the phenomenon of interest (Jones, Torres, & Arminio, 2006). Solicitation emails were also sent to directors of campus research programs and/or STEM faculty to obtain student contact information. An open invitation for participation was next emailed to graduate students who often referred their friends for participation in the study. Prior to the focus group interviews, participants were asked to complete a brief biographical questionnaire, which gathered data on a range of relevant background characteristics (e.g., demographic information, educational attainment, and research experience).

A semi-structured focus group interview technique was utilized with the goal of understanding how students made meaning of their graduate school experiences. In particular students were asked about their interactions with others in their department, the extent to which they felt supported, and how their identities intersected with being a scientist. (See Appendix A. for the interview protocol.) On average, focus group interviews lasted between 60 and 90 minutes and included up to six participants per session. Discussions were audio taped, then transcribed verbatim with the names of participants changed to maintain participant confidentiality.

Due to specific interest in the experiences of URM students in STEM, and considering most students pursuing graduate work in STEM attend PWIs, the data of focus for this study

were from Midwestern University (MU). Among the three PWIs in the larger retention project MU had the highest percentage of domestic URM students participating in focus groups. MU is a selective state flagship institution that enrolls roughly 42,000 students annually, of which 15,500 are graduate students.

The sample for this study includes 22 URM graduate students across nine focus groups who were at different points in their STEM graduate program. More than half of the sample (13 students) identified as African American, four students as multi-racial, and five students as Latina/o. (See Appendix B. for demographic break down of the participants.) Fourteen students identified as male. Students' age ranged from 25 to 36 years old. Eleven participants majored in engineering, six had a chemistry- or biology-related major, and the remaining six students were in some other STEM-related discipline.

Data Analysis

Excel spreadsheets were used to organize the data and aid in the analysis of transcripts. In developing the coding architecture pertinent data were group coded into salient themes supported by the text. Constant comparative analysis (CCA) (Glaser, 1978) was used to compress large amounts of data into smaller and more meaningful units of analysis. Following CCA, themes were gathered and compared across focus groups (Patton, 2002). The researcher continued to look for instances that represented each category, until the data did not provide further insight into a theme (Creswell, 2013). At a later occasion, three random sections of focus group text were coded again and subsequently crosschecked with previously created codes. After this exercise, new codes and sub-codes were added where necessary. To ensure rigor in analysis and reliability of the data, the coding architecture was refined in an iterative process until coder agreement reached 80% consistency (Miles & Huberman, 1994). In comparing the codes in this study with the codes for the entire dataset in the larger project, no major discrepancies were found between the two sets of codes. Preliminary findings were also shared

with external colleagues to ensure that the author's perspective and personal biases were not unduly influencing the creation of codes and the interpretation of the students' narratives.

Positionality of the First Author

Qualitative research requires that the researcher analyze and interpret the data, all of which is influenced by the researcher's values, backgrounds, and history (Creswell, 2009). As such the first author's interest in pursuing this line of research is tied to three experiences. First, in high school she was always academically successful in math and science and thought she'd pursue a STEM major in college. Tanya ultimately never did because of negative overall academic experiences in her first introductory calculus class. Second, as a Latina Tanya is familiar with the experiences of marginalization, alienation, and undervaluation that can coincide attending a predominately White institution where deficit notions of URM students are embedded within the campus environment. Finally, as a current doctoral student in education, Tanya knows that the path to the Ph.D. can be a painfully arduous undertaking. With access to the right people and resources however, pursing a graduate degree can also be a wonderfully rewarding task and a time of personal and professional growth. Although these experiences drive Tanya's motivation for this line of inquiry, they also represent her personal biases, which may have an impact on the analysis and interpretation of this study (Patton, 2002).

Limitations

Despite rigor in data analysis, there are some limitations that must be considered. Although focus groups offer the distinct advantage of being socially oriented (Kidd et al., 1996), it is possible that some students felt hesitant to share additional experiences if they differed greatly from the group. Moreover the use of prompts in the semi-structured interviews may have privileged the importance of some topics over others. Because data was collected as part of a larger project, interview questions and probes were not specifically tailored to answer the research questions in this study. The use of secondary data may have limited the authors' ability to capture the complexity of students' experiences. Finally while the goal of qualitative

research is not to generalize personal narratives (Charmaz, 2006), the experiences students recount in this study may not be characteristic of URM students attending other institutions.

Findings

The URM student participants in this study appeared to share a number of experiences within the formal academic context as they pursued graduate degrees in STEM. Three overarching challenges they encountered were: 1) what students saw as the negative consequences of being "underrepresented" in their program; 2) exclusion and conflict, and the ambiguous nature of these experiences; and 3) less ambiguous experiences of discrimination. The way students negotiated challenges will also be discussed thematically and within the context by which the challenges occurred.

Feeling "Different": A Phenomenon of Underrepresentation

Students' narratives indicated that being underrepresented along race lines made them feel lonely and different within academic spaces. Dominique stated:

> I'm used to being the only African-American in class So for example [in my graduate department], I walk into a class and everybody just looks at me and they're like, "Oh, okay." But I just try to play my part and be like, "Yeah, I understand what's going on. I'm not here to copy from you. – *Dominique, electrical engineering*

This quote suggests that Dominique perceived her presence within STEM graduate spaces as unexpected and perhaps even threatening to her majority peers. Participants perceived that others questioned their ability and commitment to do science and the merits by which they were admitted:

> Here in [Midwestern University] there's not a lot of African American or Hispanics walking around. So whenever a minority enters the engineering department I feel as if there's already some kind of, I don't want to say stigma, but there's always... he or she has to prove himself kind of deal. You know, "I wonder how he or she got here?" kind of thing. Are they filling some quota or whatever the case may be? It's very subtle. I don't think the university flaunts it. But I definitely know it's there. – *Austin, mechanical engineering*

Few URMs in one's department meant that those present were hyper visible. As such participants did not want to give peers or professors any reason to believe that they were not academically worthy of their place within the program.

> Race is a big [factor precisely] because you just don't see a lot of African Americans in engineering or anything like the STEM fields I always feel the need to work harder and outperform other people because I'm aware of the fact that there are some professors, there are some people who question am I supposed to be here, can I really measure up? – *Sean, mechanical engineering*

By working hard to excel in their programs, students were not just trying to signal that they belonged within academic spaces, but were also trying to disprove negative stereotypes about students of color:

> As far as being in class... sometimes I feel that as an African-American you have to do very well in the courses, perform very well because you're representing your race. You're trying to dismiss myths that other people have [of you] So I feel a little bit of pressure that way. – *Maria, biomedical engineering*

According to the participants it was highly problematic and offensive that others would think they were not deserving of their place within a STEM program at a selective institution. As Isiah, a biracial student in biomedical engineering, commented, "I consider the kind of path that I took here to be a series of choices that I made, and I don't want to give the impression that any of this was handed to me or anything like that." This quote is a prime illustration of the different treatment students experienced in academic spaces with STEM education.

When students did not see others like themselves across racial or gender lines in their department, they sometimes concluded it was because their department did not value diversity or care to include people from diverse backgrounds within the academic community. Jasmine, a student in the computer sciences, had two identities that were in opposition to the norm in STEM contexts: that of being female *and* Black (Ginther and Kahn, 2012; Liefshitz et al., 2011). Jasmine's identity as a woman was particularly salient:

> [In computer science there is] exactly one woman. Exactly one. So I can only go by what I see. But I just feel like they don't want women in the department. I mean that may very well not be the case, but I don't know. – *Jasmine, computer science*

Students also perceived that their underrepresented status negatively affected their ability to form study groups and made it harder to receive adequate mentorship and guidance from upper level students. For example, after seeing more advanced international students mentor novice international students and white students help other white students, Dominique assumed that navigating graduate school would have been more manageable had she had access to advanced URM students in her department:

> It's not like I can go to another graduate student who is a minority and ask him about [a question I have]. In my department, I don't think there were any students [that were] minorit[ies] ever before. Me and a friend of mine are like the first ones. So it's hard to find advice in that particular field from another student [that is a] minority. – *Dominique, electrical engineering*

Participants claimed they were accustomed to being the only underrepresented racial and/or ethnic minority student in their programs and tried to minimize the significance of chilly reactions from faculty and peers. Nonetheless the narratives suggest that underrepresentation in their department *did* matter. When departments received URM students with indifference, avoidance, negativity, or downright hostility, URM students were likely to feel like outsiders looking in and tolerated instead of truly embraced or welcomed.

Exclusion

The difficulty associated with being one of a few racial minorities in one's program was exacerbated by exclusion from both international and American peers. This exclusion made learning, completing class work, and passing qualifying exams more difficult. Sean recounted how his colleagues did not permit him entry into an existing study group:

> [The department] recommended that to prepare for exams, that you form a study group and work together. And I do remember it was a Korean guy I asked, cause he said he had a study group and I didn't have one yet. And I was like, well, could I join your group to study? And he politely declined. And I was kind of like, "oh, okay." And this was my first year so I really didn't know a lot of other students. So I was like okay, "I might be on my own here." That was a little bit frustrating. - *Sean, mechanical engineering*

Similarly Chase spoke of Korean classmates who were repeatedly unresponsive to his inquiries to meet for research purposes and were unwilling to collaborate despite studying with each other frequently:

> They get together and they work on their projects with each other all the time and they collaborate. I kind of feel like, 'well, I need some help too man.' Then you ask a question and you get the one line answer. - *Chase, chemical engineering*

In describing this experience Chase said that although he "felt kind of excluded," he "didn't really directly feel like, oh it's a race thing." Instead both Sean and Chase attributed the rejection or unresponsiveness they encountered from Asian peers to cultural misunderstandings. Maria also echoed the sentiment that international students appeared to study and socialize primarily, and in some cases exclusively, with others of the same nationality. Maria maneuvered around possible exclusion from study groups by actively pursuing personal relationships with them before asking to be part of their study circles. She also figured that by interacting with the international students, she could identify areas of convergence and divergence in regards to their respective racial backgrounds and thus dispel mutually held stereotypes:

> And for me I just take it as an opportunity to learn about their background and see how we're different and those sorts of things to maybe to dispel certain myths or whatnot that we might have about each other. So for me, I just take it as an opportunity to learn. - *Maria, material science and engineering*

Perhaps more demoralizing was being rejected by domestic peers. Dominique shared a particular experience partnering with a white male student for a lab project. Even after collecting data and closely working with her lab partner, he was still unwilling to discuss homework answers with Dominique. The fact that the partner was distrusting and closely guarded the knowledge he possessed was both surprising and upsetting:

> If I went to a random person and asked the person this question, I'd have understood, but I'm like, this is someone who's in my lab group we're trying to solve the same project together. We're meant to be in the same lab project. We're supposed to have some kind of bond. And then he said that [he wouldn't discuss the homework with me] and I was like, "Hmm, maybe I have to rethink working with this guy." If he's as individualistic as he is then [he's] probably not the kind of person I want on my team. – *Dominique, electrical engineering*

Dominique attributed the poor treatment she experienced from classmates to negative stereotypes about URM students, stating:

> I understand what's going on. I'm not here [in graduate school] to copy from you. Cause even most of the time when I try to ask somebody else for help [in my classes], the first impression is, "Okay, I don't know how to do this," or they don't want to help me. [They think] I'm going to piggyback off of them. And when they hear me speak, their impression kind of changes. But it's something I've become accustomed to. – *Dominique, electrical engineering*

Dominique soon learned that to protect herself from future discomfort and disappointment, she had to be strategic and careful about whom to ask for help:

> Now when it comes to academics, I have to choose my friends wisely. I can't just go up to somebody, who's also in my lab and also taking the same class with me, and say, "Okay, I need help," because sometimes they won't be interested in helping you. And unless you choose your friends wisely, then you may end up just being on your own for like a long period of time. – *Dominique, electrical engineering*

Even students who did not have much experience with rejection, noted they intentionally selected specific peers for the purpose of creating study groups. One student reported that among her peers she only sought out those who she already knew to be collaborative and supportive. Others learned not to take it personally when classmates did not care to study with them:

> I'll go out of my way to – if I know someone is really smart in the class and I'm having trouble, I'll introduce myself and say, "Hey, when are you going to study? We should meet up together." If they say no, I move on to the next person. – *Jasmine, computer science*

If students were not satisfied with their interpersonal relationships within their departments, another strategy utilized was to branch out and participate in groups specifically tailored for underrepresented racial/ethnic minority students pursuing STEM degrees.

> There's another group [for underrepresented students] . [Through the group] I've sort of been able to click with other people who may be the only one in their department or the only one of three. So we all come together. And that sort of – that's once a week where I'm like, "Ah, okay. They get me." – *Jasmine, computer science*

Involvement in diverse groups granted participants access to other students with whom they could study, gain professional socialization, and cultivate friendships. Students noted that participation in these groups made them feel more comfortable in academia. When reflecting upon their involvement in these groups, one student stressed, “I *needed* this.” Further by connecting with minority students from other STEM departments, participants warded off feelings of isolation and satisfied their needs for belonging.

Conflict

In general the peers of participants were not only occasionally uncooperative in the classroom, but also in laboratory settings. Although lab mates were typically friendly on the surface, it was not uncommon for the collegiality to end abruptly:

> On the face of it [my lab mates] were very nice, but when it came to if you did something wrong in the lab or whatever, they wanted to tell the PI (primary investigator) about it. And so that made you look stupid and then you had to go and defend yourself to the PI. It was a very bad situation. - *Cooper, chemistry*

Confrontational lab situations were not unusual. To successfully manage passive-aggressive and unprofessional behavior in the lab, Cooper used “some common sense and professional and personal communication skills to deal with people who don’t [have these skills].” It also helped to have peers that could offer a listening ear and to whom one could vent frustrations:

> My transition for the first year was pretty difficult. I was very lucky to have another lab mate who was African American as well, and she understood a lot of things I was going through, and that really helped and it’s really good to identify those people... I think that was very important for me to survive because I think other people would have quit. And I knew I wasn’t gonna let some people who had their own issues [with me] stop me from getting my degree. – *Cooper, chemistry*

Cooper noted that conflict with his lab mates was less distressing because he had a positive relationship with his advisor. He also reflected that he had more confidence to deal with problems and to deal with them in an appropriate manner, precisely because he knew his advisor supported him. Students also reported consulting with peers or other faculty to gain

advice or perspective before reacting. In this way, students were able to make more informed decisions when navigating conflict.

Unfortunately it was sometimes the case that the individual behaving unfavorably towards the URM students was the students' very own graduate advisor. Austin recounted having an advisor who discouraged him from taking a course because the racial composition of the class differed from the racial background of the student:

> The [professor] in mechanical [engineering], he was the one I was referring to earlier who was telling me to maybe stay away from some classes because there's some Asians in there and you know whatever, they might bust up the [grading] curve for me or whatever the case may be. – *Austin, mechanical engineering*

Understandably, Austin was offended by his advisor's assumption that he could not compete with peers who were presumably smarter. Other students had more volatile relationships with their advisors characterized by confrontation and distrust. Carson, a biracial student who strongly identified with his Native American Indian heritage, had a falling out with his advisor after she refused to recognize the importance of his engagement in culturally relevant activities during graduate school:

> My first advisor actually was pretty awful– we fought about whether I should engage in [minority recruitment] activities. We just never worked out and eventually she cut my funding and told someone else to cut my funding. It was a really ugly thing. So then I was without an advisor for about a month or so near the end of my second year - *Carson, bioinformatics*

Another participant established an informal mentor relationship with a different professor who he perceived as being more supportive in response to mild conflict with his advisor. Before seeking guidance and advice from other faculty in one's department or establishing close working relationships with them, it is interesting that students noted having to understand departmental politics so as to not offend their current advisor. However a more tumultuous relationship with an advisor sometimes required students to formally change advisors to ensure their self-preservation.

The Ambiguous Nature of Experiences

The burden of being a member of a group that was not well represented in one's department was that students sometimes struggled with deciding whether it was fair to attribute negative experiences with others to racism or whether it was a reflection of something entirely different. Maria for example, a Black student in material science and engineering, described a situation in which she wanted to take a class that her advisor counseled her not to take given her supposed limited prior preparation in the subject area. After taking the class and later finding herself doing poorly, Maria tried to drop the course, but her professor would not allow her to do so. Maria was disappointed at the lack of concern and encouragement she received from her advisor, especially since she was used to a high level of care from professors as an undergraduate:

> I know that I'm capable to do well but I probably did make a mistake by taking a course that I didn't have the background for but usually when I take a course that I've never taken before or that I want to challenge myself, the professors would encourage me to take it and say, 'Well stay in here for a few months. If you don't do so well, then we can [tell you] if you should drop it or not' For any other course that I've taken, if I voiced my concerns, the professors were very understanding - *Maria, materials science and engineering*

This situation was complicated by the fact that Maria did not know if her advisor's lack of encouragement was due to an assumption about her academic ability based on race or because he genuinely believed she was not prepared for the class. The former would have qualified this case as an incident of racism whereas the latter would have demonstrated that the advisor was only looking out for her best interests. Similarly, students perceived differential treatment from their peers. However, it was difficult for them to tease out the extent to which different treatment was a reaction to their race, gender, or something else:

> Well it's very hard if you know that you're different and you feel as though you've been treated differently. It's very hard to say, "Oh, I attribute that to the fact that I'm a woman, or I attribute that to the fact that I'm Black." I can't pinpoint exactly why everybody got their test passed out to the left of them and I got mine passed out to the – it's just really hard to isolate the one specific reason that something might have happened. - *Jasmine, computer science*

Less Ambiguous Experiences of Discrimination

The challenges students described up to this point appear to be of a racialized nature simply because they are byproducts of students' severe underrepresentation *across racial lines* in their program. Whether such experiences are undoubtedly racist is less clear, although some level of racial bias within STEM graduate programs appears to be at play. Nonetheless participants easily offered a number of experiences with blatant racism without being specifically prompted to do so. For example one student, encountered individuals who *openly* stated that they did not believe the participant rightfully earned his award for financial aid, despite his impressive skill set and previous accomplishments.

> So I've had someone look me in the face and basically say that the reason why I've gotten the fellowships I've gotten is because I'm Black. So I've had to deal with that. – *Austin, mechanical engineering*

Students also encountered racist statements coming from faculty:

> I was trying to talk to [a professor] about his research and his response was, "Well, I didn't think your kind would be interested in this kind of research." And I stopped and asked myself do I really want to go into this or not? So, of course, me being the way I am, I just decided I'd challenge him. "What do you mean my kind?" And I think a lot of it comes from ignorance – and I don't even think he thought about what he said. – *Brandon, applied physics*

Jasmine recounts a similar experience:

> I had a teacher call me "one of you" before. He was like, "I've never taught one of you before." And I was like, "You've never taught a student before? Never taught a softball player?" [I was] trying to figure out what he meant by, "one of you." And he finally came out and said, "I've never had a black student before." It was just very, very uncomfortable. I know he didn't mean anything like, negative by it. – *Jasmine, computer science*

Brandon and Jasmine exercised agency by challenging their professors and seeking clarification for the meaning of what they stated. Interestingly, despite challenging their professors, both reduced the blame they placed on the offending professors by reasoning that they were not intentionally malicious. Alternatively, another student challenged insensitive words, not so much to seek clarification for what was said, but to transform the incidence into a teachable moment:

> I'm one those people that if I see something [insensitive], I'm gonna tell you. I'm gonna call you on it, 'cause if you say something and I don't say anything, you might do it again. Cause sometimes [people] say things without really thinking about them, and sometimes if we just educate them a little bit they may not do it again. – *Colin, biological systems engineering*

In the face of debasing comments from others, student engaged in self affirmation to mitigate self-doubt. Amelia noted, "You get through [a tough situation] and you just have to tell yourself, "Okay, I'm here for a reason. They let me in so I'm going to do the best I can." Likewise Austin admitted, "I'm constantly self-motivating myself." However as both Brandon and Jasmine explained, instances of racism made them question whether they wanted to continue in their graduate programs.

Discussion and Implications

This study extends previous research by demonstrating that considerations of race are hardly absent from student experiences in graduate education. Likewise STEM educational environments, which are commonly presumed to be neutral and objective spaces, are in reality environments whereby power and how it is exercised bestows systematic disadvantages for certain student groups while advantaging others. In this study power played an important role in the interpersonal relations URM students had with others and the subsequent difficulty they experienced progressing through their STEM graduate programs. From the participant narratives, it appeared that faculty and more highly represented student groups (white students and Asian students) occasionally used their power in inequitable ways, irrespective of intention, that ultimately led URM students to believe that they received differential treatment from teachers and peers, to feel excluded from peer circles, and to question whether they belonged intellectually and socially in STEM academic spaces. Some of the enactments of power by fellow students and faculty appeared to have racialized undertones at best, and at worst seemed to occasionally be motivated by more apparent forms of

discrimination. These findings are sadly unsurprising considering the exclusionary and racist histories of many PWIs (Stanley, 2006).

Previous research explains why discriminatory experiences are bad for students: encounters with discrimination is related to more dissatisfaction with one's graduate experiences and a higher likelihood of degree non-completion in STEM (Brown, 2000). Even subtle, seemingly innocuous acts of racial discrimination have been shown to induce damage above and beyond simply immediate stress. In the long term such acts can have an accumulative effect whereby the self-confidence and mental health of victims are seriously eroded (Pierce, 1998).

Participants responded to the challenges arising from underrepresentation, inequity, and discrimination in multiple ways: by directly or indirectly challenging unambiguous racist acts, acting in ways that reduced the likelihood of being the target of racial bias, not acknowledging differential treatment, believing that most people they encountered were not intentionally malicious, and/or by focusing on productive ways of coping like seeking validation outside of the departmental community. These responses demonstrate that students exerted their own power to struggle against inequity and to resist internalizing the external judgment of others as the value they place on their own academic worthiness. These responses are also a testament to the resilience of URM students as they continue to persevere in graduate school and achieve academically despite being subject to seemingly differential treatment. Although participants successfully managed and defended themselves against the inequities (and at times racism) they encountered in graduate school, it is important to note the act of doing so required a tremendous amount of time and psychological energy that could have been directed elsewhere (Pierce, 1998). Further, not all URM graduate students in STEM are as resilient as the students participating in this study. A large proportion of talented URM students majoring in the sciences simply run out of energy to continue degree programs that take "no interest in mentoring or encouraging them" (Ibarra, 2001, p. 148). Counter to the dominant narrative, URM students are

not dropping out, but are being pushed out of their STEM graduate programs by academic environments that lack full acceptance and encouragement of diverse students.

The extent to which students are able to withstand negative events depends on the number of protective factors (both internal *and* within the environment) to which students have access that will mitigate the tension of negative events (Henderson & Milstein, 2003; Richardson, Neiger, Jensen, Kumfer, 1990). As such, there are a number of recommendations for practice resulting from this study and supported by current literature that can help STEM graduate programs protect URM students from dropping out before completing their graduate degrees. First, STEM graduate programs should be more intentional in recruiting additional URM students to send a message that URM students are valued and desirable members of the STEM academic community. As URM students gain a larger representation within the graduate student body, it is possible that the power differential will lesson in their interpersonal relationships with others within the academic community - especially peers. It is also expected that a greater proportion of URMs within STEM graduate programs will grant URM students greater power in their ability to redefine how they are labeled (and therefore reduce treatment as an “other,”) and help them have more positive graduate experiences. Increasing the numeric representation of URM students is not *the* solution to a creating a more positive educational environment for diversity, however, and must be used in conjunction to other changes in practices (Hurtado et la., 1999).

Second, graduate programs should assume the responsibility of accommodating students from diverse backgrounds instead of having the expectation that new students will embrace existing practices and cope with the inequities, large and small, they might encounter as they navigate their graduate educations. Department must therefore take careful and intentional measures to ensure that they are providing a nurturing and collaborative educational environment, which in turn can strengthen students’ self-perceptions of their abilities and curb

student non-persistence (Golde, 2005; Gardner, 2010). Part of creating this environment entails, creating interventions that positively shape interpersonal relationships, encourage collaboration, and promote trust between peers. For example, departments can better include URM students in academic spaces by intentionally connecting students to one another via small formal study groups offered to students in their first and second year and formal mentorship programs by which older students (especially those from URM backgrounds) mentor newer students. In creating these interventions, departments should stress the importance of diverse perspectives for learning (Denson, 2009) so that students will recognize how they can at least practically benefit from working with students who are unlike themselves.

Although STEM departments cannot feasibly control the behavior of every individual, they can certainly encourage positive interactional behaviors and work towards creating an environment whereby individuals from less-dominant groups are affirmed and welcomed. A study of workplaces that were successful in increasing the participation and retention of females (the non-dominant social group in that context) attributed improved outcomes to the readily presence of micro-affirmations (Rowe, 2008). Micro-affirmations are the opposite of micro-inequities. Specifically, they are:

> "*Small acts which are often ephemeral and hard-to-see, events that are public and private, often unconscious but very effective, which occur wherever people wish to help others to succeed. Micro-affirmations are tiny acts of opening doors to opportunity, gestures of inclusion and caring, and graceful acts of listening. Micro-affirmations lie in the practice of generosity, in consistently giving credit to others—in providing comfort and support when others are in distress, when there has been a failure at the bench, or an idea that did not work out, or a public attack. Micro-affirmations include the myriad details of fair, specific, timely, consistent and clear feedback that help a person build on strength and correct weakness*" (Rowe, 2008, p.46).

In light of this research, perhaps it would be worthwhile for STEM departments and programs to instruct their faculty and staff on ways they can more intentionally and equitably distribute micro-affirmations. Faculty and staff can also make the academic environment more welcoming by being trained to become what Scully and Rowe (2009)

call “proactive bystanders.” A proactive bystander is a person that witnesses or becomes aware of a positive or negative event and responds/reacts to it, even if they are not personally impacted by the event. In this way the bystander highlights positive events (commending a colleague’s achievements for example) and deescalates but addresses socially undesirable behavior or negative events.

Because the power dynamics in STEM programs and departments is such that faculty and administrators hold a great deal of authority (which is largely inherent to their positions), they reinforce negative interactional behaviors and stereotypes of URM students when they engage in silent nonintervention. Alternatively, faculty represent a wonderful vehicle of change when they model appropriate interactional behavior between members of the academic community and reinforce positive perceptions of diverse students. In short faculty and administrators can shape students’ experiences via what they establish as acceptable practices.

Third, a concern for justice and fairness requires that graduate departments and programs substantially scrutinize practices for their potential in perpetuating inequalities however small (Abrams, 1993) so that underrepresented minority groups are no longer recognized and treated as unequal members of their academic community. As such, departments must make a concerted effort to recognize discrimination when it happens and subsequently take action to both address it and prevent it from occurring in the future (Chang, 2007). Department can also create activities that help students and faculty alike recognize their own racial biases (Morales, 2006) and reflect on how these biases may unintentionally create distrustful and unwelcoming learning environments (Bensimon, 2005). Because pockets of innovation exist, STEM departments should also engage in dialogue with peer departments and institutions, so that they can learn about practices that have been successful at retaining URM students. By taking these steps, graduate programs signal to URM students that they

disapprove of exclusionary and/or discriminatory behavior and are invested in retaining URM students.

Future inquiry can benefit from using longitudinal data collection procedures to better connect student experiences to outcomes and demonstrate how challenges in graduate school evolve. Further future studies should research STEM departments and programs situated in predominately white campuses that have successfully increased the participation and persistence to degree completion of URMs. Perhaps most importantly the story that remains untold is what occurs when challenges in graduate school become overwhelming for URM students, and they are no longer part of the STEM academic community. Therefore, there is a need to understand the ways graduate programs do not provide the necessary support for degree attainment and what can be done to reverse these trends.

The stories of resilience and resistance in this study demonstrate that persistence in STEM graduate programs *is* within reach. However, experiences with multifaceted challenges connected to underrepresentation, differential power levels, and varying levels of racial bias undermine academic success and unnecessarily burden URM students. As one student noted, “the little things add up and make me question whether this department is where I want to be.” STEM programs therefore have a responsibility to not only ensure degree attainment, but also to provide academic learning environments that are supportive and inclusive of *all* students. Until graduate programs exemplify such support, URM students will remain a marginalized group in academia and underrepresented among STEM graduate degree holders. Moreover, without intentional educational practices of support, URM students will continue to be an underutilized source of talent in a nation that is rapidly losing its position as a leader in technological and scientific innovation.

References

Abrams, K. (1993). Gender in the military: Androcentrism and institutional reform. *Law & Contemporary Problems, 56*(4), 217-241.

Barnes, B. J., & Austin, A. E. (2009). The role of doctoral advisors: A look at advising from the advisors perspective. *Innovative Higher Education, 33*(5), 297-315.

Bayer Corporation. (2012). Bayer facts of science education XV: A view from the gatekeepers-STEM department chairs at America's top 200 research universities on female and underrepresented minority undergraduate STEM students. *Journal of Science Educational Technology, 21*, 317-324.

Bensimon, E. M. (2005). Closing the Achievement Gap in Higher Education: An Organizational Learning Perspective. *New Directions for Higher Education, 131,* 99-111.

Bonilla-Silva, E. (2001). *White supremacy and racism in the post-civil rights era.* Bolder, CO: Lynne Rienner Publishers.

Brennan, S. (2013). Rethinking the moral significance of micro-inequities: The case of women in philosophy. In F. Jenkins & K. Hutchison (Eds.), *Women in Philosophy: What Needs to Change?* Oxford University Press.

Brown, S.V. (2000). The preparation of minorities for academic careers in science and engineering. In G. Campell, R. Denes, & C. Morrison (eds.), *Access denied: Race, ethnicity, and the scientific enterprise.* New York: Oxford University Press, Inc.

Castellanos, J. (1996, November). *The relationship between the Chicana/Latina value system and higher education: An ethnographic study.* Paper presented at the annual meeting of the American Educational Studies Association, Montreal, Quebec, Canada.

Chang, M.J. (2007). Beyond artificial integration: Re-imagining cross-racial interactions among undergraduates. *New Directions for Student Services, 120*(Winter), 25-38.

Charmaz, K. (2006). *Constructing grounded theory; A practical guide through qualitative analysis.* Thousand Oaks, CA: SAGE Publications.

Creswell, J.W. (2009). *Research design: Qualitative, quantitative, and mixed method approaches,* 3rd edition. Thousand Oaks, CA: Sage Publications, Inc.

Creswell, J.W. (2013). *Qualitative inquiry and research design: Choosing among five approaches,* 3rd edition. Thousand Oaks, CA: Sage Publications, Inc.

Davis, P. (1989). Law as microaggression. *The Yale Law Journal,* 98, 1559-1577.

Denson, N. (2009). Do curricular and co-curricular diversity activities influence racial bias? A meta-analysis. *Review of Educational Research, 79*(2), 805-838.

Espino, M. M. (2012). Seeking the "truth" in the stories we tell: The role of critical race epistemology in higher education research. *The Review of Higher Education, 36*(1), 31-67.

Essien, I. R. (2007). African American females in the sciences and the existence of Afrocentric and feminist pedagogy. Unpublished master's thesis, California State University, Sacramento.

Essien-Wood, I.R. (2010). Undergraduate African American females in the sciences: A qualitative study of student experiences affecting academic success and persistence. Unpublished doctoral dissertation, Arizona State University.

Flynn, A. M., Sanchez, B., & Harper, G. W. (2011). An ecological analysis of research examining the experiences of underrepresented racial and/or ethnic minority in graduate school. *Journal of Diversity in Higher Education.* Advance online publication. doi: 10.1037/a0021506

Gardner, S. K. (2008). "What's too much and what's too little?" The process of becoming an independent researcher in doctoral education. *The Journal of Higher Education, 79,* 326–350.

Gardner, S. K. (2010). Contrasting the socialization experiences of doctoral students in high- and low-completing departments: A qualitative analysis of disciplinary contexts at one institution. *The Journal of Higher Education, 81*(1), 61-81.

George, Y. S., & Malcolm, S. M. (2011). *Measuring diversity: An evaluation guide for STEM graduate school leaders.* Washington, D.C.: American Association for the Advancement of Science.

Ginther, D.K. & Kahn, S. (2012). Education and academic career outcomes for women of color in science and engineering. *Paper presented at the conference for the Committee on Women in Science, Engineering, and Medicine*, Washington, DC, June 2012.

Girves, J. E. & Wemmerus, V. (1988). Developing models of graduate student degree progress. *The Journal of Higher Education, 59*(2), 163-189.

Glaser, B. (1978). *Theoretical sensitivity: Advances in the methodology of grounded theory.* Mill Valley, CA: Sociology Press.

Golde, C. M. (2005). The role of the department and discipline in doctoral student attrition: Lessons from four departments. *Journal of Higher Education, 76*(6), 669-700.

Gonzalez, J. C. (2006). Academic socialization experiences of Latina doctoral students: A qualitative understanding of support systems that aid and challenges that hinder the process. *Journal of Hispanic Higher Education, 5*(4), 347–365.

Hamilton, K. (2001). Doctoral dilemma. *Black Issues in Higher Education, 18*(11), 34-37.

Harper, S. R. (2012). Race without racism: How higher education researchers minimize racist institutional norms. *The Review of Higher Education, 36*(1), 9-29.

Henderson, M., & Milstein, M. (2003). *Resiliency in schools: Making it happen for students and educators.* Thousand Oaks, CA: Corwin Press.

Herzig, A. H. (2004b). 'Slaughtering this beautiful math': Graduate women choosing and leaving mathematics. *Gender and Education, 16*(3), 379–395.

Hoffman, K., Llaga, C., & Snyder, T. D. (2003). *Status and trends in the education of Blacks.* Washington, DC: National Center for Education Statistics.

Holmes, S. L. (2003). Black female administrators speak out: Narratives on race and gender in higher education. *NASPA Journal, 6*(1), 45–65.

Hurtado, S., Milem, J.F., Clayton-Pedersen, A.R., & Allen, W.R. (1999). *Enacting diverse learning environments: Improving the campus climate for racial/ethnic diversity.* ASHE/ERIC Higher Education Report Series.

Ibarra, R. A. 2001. *Beyond affirmative action: reframing the context of higher education.* Madison: University of Wisconsin Press.

Jones, S. R., Torres, V. & Arminio, J. L. (2006). *Negotiating the complexities of qualitative research in higher education: Fundamental elements and issues*. New York: Brunner-Routledge Publishing.

Justin-Johnson, C. (2004). *Good fit or chilly climate: An exploration of the persistence experiences of African-American women graduates of predominantly White college science programs.* Unpublished doctoral dissertation, University of New Orleans.

Kidd, P., Scharf, T., & Veazie, M. (1996). Linking stress and injury in the farming environment: A secondary analysis of qualitative data. *Health Education Quarterly, 23*(2), 224-237.

Liefshitz, I., C. Wright, A. Hodari, L. Ko, & M. Ong. (2011). *Life stories of the double bind: Women of color in physics, astrophysics and astronomy.* Unpublished manuscript. Boston, MA: TERC.

López, G. (2003). The (racially neutral) politics of education: A critical race theory perspective. *Educational Administration Quarterly, 39*(1), 68-94.

Lott, J. L., Gardner, S., & Powers, D. A. (2009). Doctoral student attrition in the STEM fields: An exploratory even history analysis. *Journal of College Student Attrition,* 11(2), 247-266.

Lovitts, B. E. (2001). *Leaving the ivory tower: The causes and consequences of departure from doctoral study.* Lanham, MD: Rowman and Littlefield.

MacLachlan, A. J. (2004). *A longitudinal study of minority Ph.D.s from 1980-1990: Progress and outcomes in science and engineering at the University of California during graduate school and professional life*. Report to the Spencer Foundation, Nr. 200000265. Berkeley: Center for Studies in Higher Education.

MacLachlan, A. J. (2006). *Developing graduate students of color for the professoriate in science, technology, engineering, and mathematics.* Berkley, CA: Center for Studies in Higher Education.

McQuillan, P. (1998). *Educational opportunity in an American high school.* Albany: State University of New York.

Miles, M.B. & Huberman, A. M. (1994). *Qualitative data analysis: A sourcebook of new methods.* Thousand Oaks, CA: Sage.

Millet, C. M., & Nettles, M. T. (2006). Expanding and cultivating the Hispanic STEM doctoral workforce: Research on doctoral student experiences. *Journal of Hispanic Higher Education, 5*(3), 258-287.

Morales, D. I. (2006). *A Matter of Rhetoric: The Diversity Rationale in Political Context.*

National Science Foundation (NSF), National Center for Education Statistics. (2011). Graduate Students and Postdoctorates in Science and Engineering: Fall 2009. TABLE 30. Graduate students in science, engineering, and health fields in all institutions, by field, citizenship, and race/ethnicity of U.S. citizens and permanent residents: 2003–09 . Retrieved November 14th, 2012 from http://www.nsf.gov/statistics/nsf12300/pdf/nsf12300.pdf

Nerad, M., & Miller, D. S. (1996). Increasing student retention in graduate and professional programs. In J. G. Haworth, ed., *Assessing Graduate and Professional Education: Current Realities, Future Prospects*, pp. 61-76. San Francisco: Jossey-Bass.

Nettles, M. (1990). Success in doctoral programs: Experiences of minority and white students. *American Journal of Education*, 494 - 522.

Noguera, P. (2001). Racial Politics and the Elusive quest for excellence and equity in education. *Education and Urban Society, 34*(1), 18-41.

Omi, M. & Winant, H. (1994). *Racial formation in the United States: From the 1960s to the 1990s.* New York: Routledge.

Patton, M. Q. (2002). *Qualitative research and evaluation methods,* 3rd edition. Thousand Oaks, CA: Sage.

Peña, L.M. (2012). Inquiry methods for critical consciousness and self-change. *The Review of Higher Education, 36*(1), 69-92.

Pierce, C. (1989). *Unity in Diversity: Thirty-Three Years of Stress. In G. Berry & J. Asamen* (Eds.), Black Students: Psychological Issues and Academic Achievement (pp. 296-312). Newbury Park, Sage.

President's Council of Advisors on Science and Technology (PCAST). (2010). *Prepare and inspire: K-12 education in science, technology, engineering, and math (STEM) for America's Future.* Washington, D.C.: Executive Office of the President. Downloaded November 1, 2012 from www.Whitehouse.gov/sites/default/files/microsites/ostp/pcast-stemed-report.pdf.

Richardson, G. E., Neiger, B. L., Jenson, S., & Kumpfer, K. L. (1990). The resiliency model. *Health Education,* 21(6), 33-39.

Rohlfing, J., Kube, E., Yabko, B., Murguia, E., Bekki, J., & Bernstein B. L. (2009). Improving STEM doctoral students' relationships with their advisors: Web-based training in interpersonal problem-solving skills. *Proceedings of the American Society for Engineering Education (ASEE) 2009 Annual Conference,* Austin, TX, June 2009.

Rowe, Mary. 2008. Micro-affirmations and micro-inequities. *Journal of the International Ombudsman Association, 1,* 45-48.

Sandler, B. (1986). *The campus climate revisited: Chilly for women faculty, administrators, and graduate students.* Washington: Association of American Colleges.

Scully, M. & Rowe, M. (2009). Bystander training within organizations. *Journal of the International Ombudsman Association, 2(1)*, 1-9.

Seiler, G. (2001). Reversing the "standard" direction: Science emerging from the lives of African American students. *Journal of Research in Science Teaching, 38(9),* 1000-1014.

Solórzano, D. G. (1993). *The road to the doctorate for California's Chicanas and Chicanos: A study of Ford Foundation minority fellows*. Report to the California Policy Seminar, a joint program of the University of California and state government.

Soto, M. & Yao, C. (2010). *Retention of women of color in STEM doctoral programs.* In Proceedings of the 29th Annual Midwest Research to Practice Conference in Adult, Continuing, Community, and Extension Education, East Lansing, Michigan, 207-213.

Stanley, C. A. (2006). Coloring the academic landscape: Faculty of color breaking the silence in predominantly White colleges and universities. *American Educational Research Journal, 43*(4), 701-736.

Sue, D.W., Capodilupo, C., Torino, G, Bucceri, J., Holder, A., Nadal, K., & Equin, M. (2007). Racial Microaggressions in Everyday Life: Implications for Clinical Practice. *The American Psychologist, 62* (4) 271-286.

Turner, C. S. V., & Thompson, J. R. (1993). Socialization women doctoral students: Minority and majority experiences. *The Review of higher Education, 16*(3), 355-370.

U.S. Census Bureau. (2009). Resident Population by Race, Hispanic Origin, and Age: 2000 and 2009. Retrieved November 14th, 2012 from http://www.census.gov/compendia/statab/2012/tables/12s0010.pdf.

Weiss, H. B. & Green, J.C. (1992). An empowerment partnership for family support and education programs and evaluations. *Family Science Review, 5*(1-2), 131-148.

Wylie, A., Jakobsen, J.R., & Fosado, G. (2007). *Women, work and the academy.* New York: Barnard Centre for Research on Women.

Yosso, T. (2000). *A critical race and LatCrit approach to media literacy: Chicana/o resistance to visual microagressions.* Unpublished doctoral dissertation, University of California, Los Angeles.

Appendix A: *Focus Group Questions*

Pathways

1. Can you please tell us your name, your program of study, how far along are you in your graduate program, and what your path here has looked like? Just as we described our own paths to graduate school, we are asking you to do the same. For example, did you come directly from undergrad to grad school, did you work for a while, etc?

Graduate Experience

2. Did you have any pre-college experiences at home or in school that influenced your decision to pursue studies in STEM?
    a. Was there someone in particular (e.g. family member, mentor) that had an influence on your decision?
3. What influenced your decision to attend or delay attending graduate school (e.g., financial concerns, time to degree, etc.)?
4. How would you describe your transition when you initially entered graduate school?
    a. In what ways was your undergraduate environment similar or different from what you encountered in graduate school?
    b. What were the key factors in your undergraduate experience that helped you feel prepared? (e.g., undergraduate research)
    c. Can you think of anything that was missing in your undergraduate experience that may have better prepared you for graduate school?
5. How would you describe your interaction with faculty members, your PI or committee members now?
    a. Do they provide adequate mentoring? Advising? Feedback and encouragement? Please give an example.
6. How would you describe the quality of instruction and curriculum in the courses you have taken so far?
    a. Is the quality of instructor important to you?
    b. Do you feel your instructors are strong teachers?
    c. Are you given any opportunities to teach? Encouraged? Discouraged?
7. How would you describe your interaction with peers in your department and the broader campus community?
    - How easy or difficult is it to find support from your peers? Please give an example.
    - Would you say the environment is competitive or collaborative? Please explain.
    - Where does most of your out-of-class peer interaction occur (e.g., student organizations, group projects, study sessions)? Please give an example.

Identity

8. Does being a scientist shape your identity?
    a. Can you think of the ways in which your identity as a scientist has an influence on your life? For instance, how does your identity as a scientist affect your relationships with family, friends, and community?
    b. Do you present yourself and your work differently to non-scientists? If so why, and in what ways?

c. Can you talk about ways in which your identity as a scientist intersects with your gender, religion, ethnicity or sexual identity?
d. Do you consider yourself a critical thinker? Do you think that you were this way prior to entering STEM or has being in STEM made you more of a critical thinker? Does this set you apart in any way?

Career Planning

9. What are your educational and career goal(s) both immediate and long term?
    - Are you given exposure to or support in pursuing multiple career paths?
    - Do you feel that you are receiving adequate professional development?
- What are the obstacles or barriers, if any, that might affect your immediate and long term career goals (e.g., family concerns, time to degree, financial rewards, etc.)?

Appendix B: ***Demographic Information for Students***

Pseudonym	Sex	Race	Discipline
Hayden	Male	Black	Aerospace Engineering
Brandon	Male	Black	Applied Physics
Aaron	Male	Black	Biological Chemistry
Cooper	Male	Black	Chemistry
Dominique	Male	Black	Electrical Engineering
Brady	Male	Black	Electrical Engineering
Colin	Male	Black	Industrial & Operations Engineering
Sean	Male	Black	Mechanical Engineering
Austin	Male	Black	Mechanical Engineering
Kate	Female	Black	Pharmacology
Jasmine	Female	Black	Computer Science
Sadie	Female	Black	Biomedical Engineering
Maria	Female	Black	Biomedical Engineering
Jordan	Male	Latina/o	Ecology & Evolutionary Biology
Chase	Male	Latina/o	Electrical Engineering
Max	Male	Latina/o	Biomedical Engineering
Charlotte	Female	Latina/o	Biomedical Sciences
Abby	Female	Latina/o	Pharmacology & Cellular and Molecular biology
Carson	Male	White & American Indian	Bioinformatics
Tristan	Male	White & Black	Physics
Isaiah	Male	White & Latino	Biomedical Engineering
Amelia	Female	Amer. Indian & Latino	Microbiology and Immunology