Adjustment to the Graduate Environment: A Focus on URM Students in STEM

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Abstracts: This mixed methods study investigates the key factors that impact the ability of URM students pursuing STEM graduate degrees to adjust to the graduate environment in comparison to their White and Asian peers in STEM and their URM peers in non-STEM disciplines. Given that the primary focus of this inquiry is to explore the experiences of URM students in STEM that contribute to successful management of the graduate environment, qualitative narratives of students pursing graduate degrees are used to provide contextual information on findings from a large scale longitudinal survey of a cohort of graduate students. Three major themes of issues students face in graduate school emerged: General transition and context-specific issues; issues related to variability in faculty support; and race issues and how they matter in graduate education. Other important findings were that faculty support was essential to all students in graduate school, as was involvement in research, particularly in the context of less structured graduate programs. Further URM STEM students had unique experiences in the transition to graduate school compared to their non-URM peers and URM peers in other disciplines.

Minimal progress in increasing the production of domestic advanced STEM degree holders has put the United States at risk of not meeting national demand for scientific talent and jeopardizes the country's position as a global leader in technology and innovation (Olson & Riordan, 2012). In particular there is a shortage of graduate STEM degree holders from Black, Latino, and American Indian backgrounds – recognized as underrepresented racial/ethnic minorities (URM) by the federal government. Because the ability of a group to identify creative and effective solutions increases when more people from different backgrounds get together to solve a problem (Crosby, Iyer, Clayton, & Downing, 2003), a diversity of minds is a necessary component of attacking current societal, environmental, and health problems (George & Malcolm, 2011). Thus, the lack of URM individuals in STEM has contributed to the perpetuation of a largely homogeneous population of scientists and engineers and restricts the field's ability to draw from a diverse range of perspectives that are needed to flexibly meet 21st century challenges (Herzig, 2004a). Further, considering the impressive academic profiles of students who are admitted to graduate programs, each student who does not finish their degree represents a great loss of talent for the country (Olson & Riordan, 2012).

In the last three decades, many scholars have attempted to demystify student persistence in graduate education. Although older research placed a heavy emphasis on background characteristics of the student to explain for differential experiences and academic outcomes, more recent research places more prominence on the importance of interactions with others and educational context (Flynn, Sanchez, & Harper, 2011; George & Malcolm, 2011). However despite a growing body of research on graduate education in general (Golde, 2005; Millet & Nettles, 2006; Lovitts, 2001), there is a dearth of research that has sought to understand the transitional experiences of URM graduate students in STEM disciplines. Because successful adjustment to the graduate environment is critical to retention in graduate school (Nettles & Millet, 2006), a closer examination of the graduate school experiences that affect adjustment is therefore warranted. This mixed methods study investigates the key supports and challenges that impact the ability of URM STEM students to adjust to the graduate environment.

This research is necessary for identifying and sharing practices that can better position students to

make the academic transition to graduate school during those first crucial years, which is especially needed as institutions enroll an increasingly diverse population of students and are expected to meet the needs of those students (Guillory, 2001). Further, a firm commitment to improving approaches that help students manage the academic environment will likely improve persistence to degree completion and be beneficial for all graduate students irrespective of racial background (Mitchell, Dancy II, Hart, & Morton, 2013). Finally educational leadership and policy makers will likely be interested in the findings as a considerable amount of institutional resources at state and federal levels continue to be directed to the recruitment, training, and financial support of STEM graduate students resources despite a fiscal climate of scarce resources (Smallwood, 2004; Bair & Haworth, 2004).

Conceptual Framework

In creating a conceptual framework of the factors that influence students' ability to manage the graduate environment, this study adopts key constructs from Nettles and Millet's (2006) conceptual model of doctoral student experiences and Nora, Barlow, and Crisp's (2005) integration model. We also apply general literature on graduate students to lend further support for the different constructs we adopt. The model offered by Nettles and Millet (2006) suggests that background characteristics (gender, race), admission attributes and criteria (whether the student is pursuing a Masters or PhD upon entry) are important input characteristics to control for when looking at graduate student outcomes. Previous research confirms that factors related to the student themselves such as demographic characteristics, prior educational experiences, and external demands affect students' experiences in the academy (Eissen-Wood, 2010; Tinto, 1993; Becks-Moody, 2004; Henderson & Milstein, 2003; Richardson, Neiger, Jensen, Kumfer, 1990). For example, students begin graduate school with different levels of prior knowledge and skills which make a difference with respect to outcomes like persistence (Gardner & Holley, 2011). URM students, in particular, are more likely to be the first in their families to attain a doctoral degree (National Science Foundation & National Center for Science and Engineering Statistics, 2012) and to come from families in which parents have lower incomes and less knowledge about the graduate school process (Hoffer et al., 2002). This contrasts with the majority of doctoral students who have family members who

not only have undergraduate degrees, but advanced degrees, and who use this cultural capital and the accumulated knowledge to guide their experiences (National Science Foundation, 2010). Nettles and Millet's model of doctoral student experiences also posits that a variety of experiences in graduate school (e.g. time in doctoral program, peer and faculty interaction, mentorship), satisfaction with different areas of one's program, and research productivity also influence student outcomes.

Although the integration model by Nora and colleagues (2005) was not specifically created for graduate students per say, like Nettles and Millet, the integration model centers academic and social experiences occurring within the college environment – such as encouragement and validation from faculty, peer interactions, and mentoring experiences – to indirectly and directly influence student outcomes. Other research shows that the relationships and interactions students have in the social and academic environments of graduate school and their perception of those relationships/interactions impact degree progress (Golde, 1996; Girves & Wemmerus, 1988; Herzig, 2004a), especially among minority graduate students (Vaquera, 2007).

Research also firmly establishes that the most important relationship doctoral students have is with their advisor (Baird, 1995), as advisors are the prime contributor to students' socialization into the disciplinary community (Nettles & Millet, 2006; Lovitts, 2001, 2004) and represent critical sources of reliable information (Barnes & Austin, 2009), resources, and academic advising (Stanton-Salazar, 2010). Thus, it is important that students connect to their advisor and find additional faculty and who take an active interest in them (Sweitzer, 2009; Lovitts, 2001).

The quality and quantity of advising students receive in their degree program has important consequences to student outcomes (Minor, 2003). High quality, close, frequent, and positive relationships with supportive and caring faculty and faculty advisors who offer good advice and career sponsorship is related to persistence (Bair & Haworth, 2004). Validating experiences from faculty, and other students, are also immensely important as they reinforce a sense of self-worth and self-efficacy in students' abilities (Rendon, 1994). It is noteworthy that even successful students who are persisting may deal with obstacles with respect to self-esteem in STEM (Graham, 2013). Recognition from faculty can either draw

students further into the field or keep them at the margins depending on whether students perceive the recognition to be positive or negative (Carlone & Johnson, 2007). Poor social interactions with faculty have consequences to other academic experiences such as reduced research productivity (Nettles & Millett, 2006).

Positive interpersonal student-to-student relationships are also very important in graduate school (Herzig, 2002). Peer relationships characterized by moral support and friendship have been found to protect students from loneliness, increase students' satisfaction with their graduate experiences, and help students persist through their program, especially in the first few years of coursework (Gardner, 2007; Golde, 1996; Bair & Haworth, 2004; Lovitts, 2001; Austin & McDaniels, 2006). Peers additionally represent excellent sources for students to discuss and test intellectual ideas (Lovitts, 2001). Chemistry doctoral students, for example, overwhelmingly spoke about the importance of peers - particularly more advanced students - for important information, guidance, and support, which were especially important in the face of infrequent feedback from faculty (Gardner, 2008a).

Nora and colleagues' integration model is also useful in that it recognizes unique areas of influence that must be considered when studying diverse student populations such as environmental pull factors (family or work obligations) and perceptions of the climate of the learning environment. Previous research on graduate students of color show that the difficulty in completing a graduate degree is exacerbated by a lack of structural diversity in many graduate programs in which URMs are one of a few people of color in their programs and classes (Fries-Britt et al., 2010a; Palmer et al., 2011). Where there are few URMs in a given space, there is a greater likelihood that they will be subject to negative stereotypes about their ability and qualifications (Gay, 2004; Hurtado et al., 1998). A dearth of faculty of color in STEM also contributes to the social stigma of URMs (Cole & Griffin, 201). Unfortunately, negative stereotypes about people of color appear to be a universal experience in higher education (Taylor & Antony, 2000) and may contribute to URM students' perception that they have to be more academically successful than their peers to show they belong (Gasman et al., 2004). From this literature we can hypothesize that while transitioning into academia is important for all graduate students, it is

likely to be especially challenging for those from URM backgrounds who are also pursuing STEM degrees (Justin-Johnson, 2004; Oden, 2003) due to poor racial dynamics, low levels of structural diversity, negative perceptions of the racial and disciplinary climate, all of which can reinforce a belief of an incompatibility with academic life and make it harder to persist (Gasman et al., 2004). Such experiences have already been shown to influence students' assessment of whether they fit within their academic programs (Sweitzer, 2009), can affect the extent in which they feel empowered to achieve success (Dowd, Sawatzky, Rall, & Bensimon, 2013).

Another factor not mentioned in Nettles and Millet (2006) or Nora and colleagues model (2005) that likely impacts students' ability to navigate the graduate environment is the institutional context of students' undergraduate institution. Among other institutional attributes that likely matter is the designation of an institution as a predominately White institution (PWI) or minority serving institution. Of all the institutional types, the success Historical Black colleges or universities (HBCU)s have in graduating minority students in STEM and ushering them to seek advanced degrees in the sciences is unparalleled (Hubbard & Stage, 2010; Thurgood et al., 2006). This success is attributed to their ability to provide a safe and affirming educational environment in which students are put first, held to high expectations, and given the support and encouragement they need to succeed (Hrabowski, 2013)**,** especially in STEM disciplines (Hurtado et al., 2008a; Palmer et al., 2010a; Perna et al., 2009; Seymour & Hewitt, 1997). We conceive of all of the above factors as likely contributors to students' success in managing the academic graduate environment.

Methods

This mixed methods study began as an exploratory multi-phase design (Creswell & Plano Clark, 2011). Specifically, focus groups across seven institutions were conducted the year before the design of the 2011 Post-Baccalaureate Survey (PBS), which is the seven-year follow-up survey of a longitudinal cohort of students who began undergraduate college in 2004. After intensive analyses, the qualitative narratives proved to be quite rich repertories of information identifying a number of pertinent issues in graduate education and subsequently had great explanatory implications for survey results. We found that

individually, each phase of data collection provided only a part of the story on graduate education. Together, along with analyses across the results of the two phases, a mixed design provided both transferable findings across graduate school populations and evidence regarding how URM STEM students uniquely experience the transition to graduate school. We thought it was important to allow students to express their lived experiences in their own words. The next sections provide details of each phase of the study design.

Qualitative Sample

Forty-one focus groups were conducted with 150 participants graduate students across seven universities across the United States: three Hispanic serving institutions (HSI), one historically Black college/university (HBCU), and three predominantly White institutions (PWI). These institutions were selected to conduct focus group interviews because they represented a diversity of geographic locations, institutional characteristics (i.e. control, size, racial composition of students), and had high rates of STEM graduate enrollment and degree completion among URM students. The sample included 35% African Americans, 21% Whites, 25% Latino/as, 9% Asian Americans, and 5% who marked "other"; 50% were women. Of the 150 students interviewed, the majority (n=71) were studying some form of chemistry or biology, while nearly one quarter (n=36) were studying engineering. To ensure racial diversity in the sample, we purposefully recruited a majority of the participants through structured programs specifically targeted at supporting URMs in STEM (e.g. NSF AGEP). Solicitation emails were sent to directors of campus graduate divisions focused on diversity and/or STEM faculty to obtain student contact information. An open invitation for participation was then emailed to these graduate students, who often referred their friends.

Focus group interviews. We employed a semi-structured, in-depth interview technique to gain a better understanding of how student participants made meaning of their graduate school experiences. This method of data collection involves a conversation between the interviewer and interviewees that requires both active asking and listening and yields exploratory, descriptive, and explanatory data. Further focus groups offer the distinct advantage of being socially-oriented and tend to increase participants' comfort

level, while allowing them to reflect on their own ideas as they listen to those expressed by others (Krueger & Casey, 2009; Marshall & Rossman, 1995; Patton, 2002).

Procedure. Prior to the 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). Once questionnaires were completed, the moderators introduced themselves and asked students to describe the pathway to their current educational position, their year of study and major (Malone & Barabino, 2008). This descriptive question served to establish rapport and ground our later questions. For the larger study, we asked students a series of nine questions (see Appendix A for the interview protocol), with those under the thematic heading "Graduate Experience" being most useful for the purposes of this study. Students were asked to describe their transition when they initially entered graduate school, the key factors that helped them feel prepared, and anything that could have better prepared them. They were also asked to describe their interactions with faculty including their principal investigator (PI)/advisor and whether these persons provided adequate mentoring and advising. An additional question asked about the quality of instruction and curriculum. Within this section of the interview, students were asked to describe their interactions with peers and about the culture of interaction in their respective programs.

Analysis. The transcribed audio recordings of the focus groups interviews were imported into NVivo 8 software to organize the data and aid in the analysis of transcripts. In order to develop the coding architecture, each transcript was open coded by examining the raw data and identifying salient themes supported by the text. This constant comparative approach followed an inductive process of narrowing from particular (text segments) to larger themes. While using the constant comparative approach, "the researcher attempts to 'saturate' the categories—to look for instances that represent the category and to continue looking (and interviewing) until the new information obtained does not provide further insight into the category" (Creswell, 2008, p.195). A team of six researchers each read transcripts from two institutions, gathering and comparing themes across focus groups and institutions, while having different researchers reading and re-reading the same data set, enabled analytical triangulation (Patton, 2002).

Once we felt that we had reached saturation in generating themes, we developed several iterations of coding schemes, wherein codes were created, expanded, defined, and refined. These categories/themes in the raw data were then labeled as "nodes." Six researchers thematically coded three randomly-selected sections of text and inter-coder reliability ratings consistently ranged between 80-85 percent (Miles & Huberman, 1994). Following inter-coder reliability exercises, the coding was re-validated and we were able to add new codes and sub-codes where necessary. Once the coding structure was finalized, we utilized 24 primary nodes, 111 secondary nodes, and 86 tertiary nodes in NVivo 8 to code the data by selecting relevant text segments representing each node, and dragging and dropping these selections into the free node section of the program. The data selected were stored under the node with the link to the full record being maintained. Once these bins of relevant data were created, we re-read the data repeatedly, in order to ensure data based decision-making regarding the significance of findings. The multi-institutional analysis allows for validation of the findings across sites, whereas the multiple focus groups per school allows for cross-validation of findings within institutions. We noted differences between institutions in the issues or forms of support that students mentioned. We returned again to the qualitative data after analyzing the quantitative data to identify areas to cross-validate as well as points of departure to construct a coherent set of themes, opting to focus on telling the story of transition from the primary issues that graduate students themselves identified.

Quantitative Data Source and Sample

Drawing from merged data from several national databases including student data from the 2011 Post-Baccalaureate Survey (PBS), as well as institutional data from the Integrated Postsecondary Educational Data System (IPEDS), we identified individual- and undergraduate institutional-level factors that predict success at managing the academic environment. Our baseline sample came from the PBS, which was administered by the Higher Education Research Institute (HERI). The PBS survey collected information on participants' undergraduate experiences, experiences in graduate school, and their perceptions of the graduate environment. This survey was sent to all respondents of the 2004 Freshman Survey, which asked freshman students about their precollege activities and achievements. Of the 57,790

reachable participants, a total of 13,671 participants located across 500 undergraduate institutions responded to the PBS, which resulted in a response rate of 23.7%. Additionally, in order to examine the relationship between undergraduate institutional characteristics and students' subsequent ability to manage the academic environment in graduate school, this study uses institutional data from IPEDS, which provides the most comprehensive data available on higher education institutions in the U.S. From the longitudinal sample, we identified students who reported on the 2011 PBS that they went to graduate school and removed cases wherein students were not pursuing a discipline in STEM *and* did not identify as a URM. Our final sample included 2,846 students across 387 institutions: 320 students were URM students pursing STEM degrees, 1364 were non-URM students pursing STEM degrees, and 1162 were URM students pursuing non-STEM graduate degrees.

Dependent variables. The outcome variable - success at managing the academic environment - is a nine-item factor that is a self-reported measure of how successful students felt at conducting a variety of essential academic-related tasks since enrolling in their graduate program, including students' success at understanding what professors expected of them academically, managing their time effectively, developing research skills, mastering course content, collaborating with peers, pursuing personal intellectual interests related to their discipline, writing academic papers, developing contacts in their field of study, and presenting academic material. We derived this dependent variable from the PBS data using principal axis factoring with promax rotation so that the mean of the variable was set at zero and the standard deviation was one.

Student-level variables. The analyses accounted for several student-level independent variables, including demographic characteristics, prior undergraduate experiences, perception of the graduate environment, and graduate school experiences. (See Appendix B for a complete description of the variables and their coding schemes). With respect to input characteristics of students, we controlled for students' gender, undergraduate experiences (worked with a faculty member on research, received mentoring from a faculty member, participated in a structured undergraduate research program, participated in an academic club or professional association), perception of the degree to which their

undergraduate experience prepared them to write effectively, whether the student was pursuing a masters or PhD, environmental pull factors (i.e. family and work responsibilities) and student identity (academic self-concept and social justice oriented STEM identity). All constructs were created using principal axis factoring with promax rotation. Refer to Appendix C to see the items comprising factors and factor loadings. With respect to the perception of the graduate climate, we controlled for students' perception of the racial climate as hostile, experiences with intimidation from faculty and different forms of discrimination, sense of belonging, and satisfaction with the representation of women in their programs. We also control for the length of time in years students were in their graduate programs, a variety of interactions with peers and faculty, experience conducting research, and satisfaction with coursework.

Undergraduate institution-level variables. The analyses additionally accounted for a number of institutional characteristics from students' undergraduate institution. This data was collected in 2006. We controlled for selectivity as measured by percent admitted, size (as measured by full-time student equivalent enrollment), control, percent of total enrollment that were URM, and expenses per FTE spent on research. We used a dichotomous variable to represent an institution's status as private (compared to public) and examined the predictive power of Carnegie classification (master's comprehensive institutions compared to baccalaureate colleges and doctoral/research universities). We also control for the instruction/research full-time equivalent staff as a measure of the human capital available at the institution.

Weights. To account for any potential non-response bias present in the data, non-response weights were calculated and applied to adjust the 2011 PBS sample of respondents upward to look more like the original target sample of 2004 TFS respondents. The non-response weighting process occurred in multiple steps. First, the EM algorithm was used to account for missing data on key variables from the 2004 Freshman Survey as these variables were used in the creation of the weights. Then, a logistic regression was conducted to predict the probability of responding to the 2011 Post-Baccalaureate Survey (PBS) using predictors from the 2004 Freshman Survey. The products of variables' values and their predicted log odds were included in the regression equation to calculate the probability of responding to

both the 2004 Freshman Survey and 2011 Post-Baccalaureate survey. The general formula for developing a non-response weight is: weight= 1/(probability of response)

Once these weights were calculated, the weighted 2011 PBS respondent sample was compared with the un-weighted target sample from 2004 to determine whether the weight inappropriately skewed any of the 2004 Freshman Survey variables. This comparison confirmed that that the weight had not inappropriately skewed distributions of variables from the 2004 Freshman Survey. Finally, a normalized weight, which accounted for sample sizes, was created to prevent the inflation of any *t*-statistics calculated in regressions or other analyses on the weighted sample.

Missing data. After weighting the data, we addressed cases with missing values by using multiple imputation. Providing a single imputation for missing values does not account for the possible variance of missing data (Sinharay, Stern, & Russell, 2001). Multiple imputation of missing data may provide a more precise estimate of standard errors of parameter estimates (Little & Rubin, 2002). We used the Markov chain Monte Carlo method in SPSS to execute the multiple imputation procedure. After addressing issues with missing data we examined our data with univariate descriptive statistics.

Analysis. We first employed descriptive statistical analysis to examine students' academic adjustment in graduate school. (See Appendix D for a full list of the descriptive statistics for each variable.) Means were calculated for each sample group (i.e. URM science students, White/Asian/"Other" STEM students, and URM non-STEM students) (see Table 1) and compared using ANOVAs (Table 2) and Bonferonni's post-hoc tests (Table 3). One-way analyses of variance (ANOVAs) were used to establish significant mean differences between the subgroups on each outcome measure. Investigations of more specific between-group differences among the subgroups of interest were performed using Bonferonni's post-hoc test of mean difference. This test is useful for comparing mean differences across independent samples when the sample sizes are not equal. With respect to race, the post-hoc tests display only those between-group differences that resulted in statistically significant mean differences. We also conduct three separate independent sample t-tests (one comparing URM STEM majors to everyone else, another comparing URM non-STEM majors to everyone else, and the final one comparing White and

Asian STEM students to everyone else) to determine whether major choice and/or race makes a statistically significant impact on success in managing the academic environment. (See Table 4 for t-tests). These within- and between-group difference tests were employed as descriptive tools with which to establish significant differences among key groups of students on the outcomes of interest.

We initially tried to use hierarchical linear modeling (HLM) on each of the outcome measures for the three sample groups due to the clustered, multi-level nature of our data. However the use of multi-level techniques was not justified as a majority of the undergraduate institutions represented in the sample only had between zero and one URM STEM survey participants who earned their bachelor's degree there. A larger number of URM STEM graduate students within each institution would be necessary to demonstrate that the variance on the outcome measure for URM STEM students was due to differences between institutions. Thus, we preceded with ordinary least squares regression and forced entered conceptual blocks of variables into the regression relative to their temporal order of occurrence. (See Tables 5, 6, and 7 for the regression tables for each student group). Finally, to allow for comparisons of the effect of independent variables on the outcomes of interest, we use the equation offered by Paternoster and colleagues (1998) for independent sample to statistically test for the equality of regression coefficients across unequal sample sizes to draw systematic comparisons of the predictors of academic adjustment in graduate school between the URM STEM student group and the other two student groups. (See Table 8 for z-scores from the equality of regression coefficient test).

Limitations

This study has several limitations. First, there was a relatively low longitudinal response rate for the student surveys. Although methods were used to try to account for non-response bias by using analytic weights, the low response rate for the 2011 PBS may still inappropriately bias the data and results. Similarly, despite the fact that the qualitative sample is relatively large at 150 participants across seven institutions, the study obviously cannot represent the views and experiences of every graduate student or every URM graduate student in STEM. Additionally it is important to note that the students participating in the focus group interviews were not necessarily respondents of the PBS (the survey

instrument). Indeed, some focus groups participants were more advanced students and had a wider range of work experiences than the younger cohort used for the quantitative results. Finally the dependent variable was measured at the same point in time as many of our independent variables. Therefore, we cannot assume a causal relationship between the dependent variable and many of the independent variables measured in 2011. Our purpose is to identify the experiences that are associated with a higher score on ability to manage the graduate academic environment; thus the establishment of causation is not necessary to address the focus of our study. As stated earlier, this study utilized an exploratory mixed methods design.

Results: Transitional Experiences in the Graduate Program

In this section, we present a "mixing" of results, drawing from the qualitative data first to identify issues and then using quantitative data to affirm results across groups, identify issues as specific to URMs (or not), and raise new questions. After reviewing the codes and prevalence of graduate student experiences across campuses, three central themes emerged that include: general and context-specific transition issues (within the classroom and lab), issues relating to the variable faculty support and guidance, and race issues and how they matter in graduate education. Subthemes were also identified, analyzed, and integrated with central findings, which were then reinforced by the survey results. We provide the tests of significant coefficients across groups in Table 8; full analyses can be found in the appendices.

Transition Issues – General and Context-Specific

Lack of program structure. Many students reported feeling "lost" and not knowing expectations during their first and second years of graduate school:

> I had no idea what I needed to do. [Laughs] I was really lost - even right now. Like today, I found out three new things about the program that I didn't know before…. And I realize a lot of my colleagues [also] don't know. We're kind of learning as we go along. – Alexandra, HSI West Coast State, Math Education, Masters, Asian

Not knowing what to do was, in part, attributed to a lack of transitional support. For example, several students reported that there was no orientation for new students. This made transitioning especially

difficult in programs that lacked a cohort system (courses for first year students or sequenced classes) because students could not identify who their graduate peers were or who they could lean on for support. Students also felt lost when there was not a sufficient amount of structure built into the graduate programs. Multiple students reported that upon entering their programs, they were simply told how many units or classes that were needed for a degree – and that was it. From students' accounts, several departments seemed to have adopted a 'sink or swim' approach to guiding graduate students. Students reported not having any indication on the proper sequences of classes to follow or which electives to take that would be beneficial to their research or later skill development. Brianna, a Latina student pursuing a master's degree in industrial engineering at Southwestern HSI, describes her experience:

> One of the things that surprised me [in grad school] is there seems to be no structure at all… [to] know which classes count and which ones don't. Which ones you should have or you shouldn't have [taken]. How to link them to future research… You kind of learn that you have to be chasing people around [to find out] something and that's not easy.

Unfortunately, in many of the graduate programs, there appeared to be the notion that the student should be self-directed and an independent problem-solver; therefore, guidance was not a priority. Most students, however, desired more structure in their program during that first year; some made a point to strategically schedule meetings with faculty to make sure they were making good transition decisions. Although a small number of students appreciated the lack of structure because it freed them to pursue their own academic/scholarly interests, most lamented the fact that the lack of structure in their program led them to feel like they were making decisions by what "felt right" and hoping that they didn't "fall on [their] face" while doing so.

Managing coursework and material. Students encountered several challenges in the classroom that made transitioning into academic life more difficult. As expected, a common theme among STEM graduate students was the difficulty of coursework. Students who struggled the most with classes either did not have sufficient prior exposure to the material taught in graduate school or had been out of school for an extended period of time. Indeed, a few students had an academic background that differed from the area of their graduate work or did not have the opportunity to take foundational classes during their

undergraduate career due to little variety in the types of STEM classes offered at their undergraduate institution. As a result, a great deal of course content was new to them and so they struggled academically the first year:

> I don't have a background in industrial engineering. I don't really understand where this is really going. I spend a lot of time at my lunches, or what not, on the internet trying to research what operations really is…Even taking two courses it's very stressful. Now this semester I've actually learned like okay, this class I have no clue what's going on. It's a whole other area that I've never heard of. So I need to sit back and really just spend all my time focusing on that – Benjamin, Southwestern HSI, Industrial Engineering, PhD, Latino

A similar difficulty students reported was having to fill in the gap between the content knowledge covered at their undergraduate institution and what they were expected to know as incoming graduate students, which made several feel ill- prepared for the rigor and pace of grad school.

Students who had been out of school for a long period of time also had to transition to graduate student life. Isiah describes his experience adjusting from being an engineer for a company that designed equipment for measurement and evaluation to being an engineering student:

> No, [my transition to graduate school] really sucked. I'd been out of school for five years. By that time I couldn't take an integral [in an equation] anymore. (Laughter) Yeah, and going from a job where at the end of the day you're like, "Hey, see you guys tomorrow," and I'm just completely not gonna think about this, and then going to school, where you're kind of – you know, you've always got to be thinking about the work. And if you're not doing it, you're probably thinking about it at the time. Yeah, that was an adjustment. – Isaiah, Midwestern PWI, Biomedical Engineering, PhD, Multi-racial (Latino & White)

Across all student groups, students with the highest academic self-concepts tended to report successful transition to graduate school (Table 8). Other useful qualities to process was being a strong writer and being persistent in mastering material; students reported that both were absolutely necessary to hit the ground running. Those who entered graduate school with undergraduate experiences that focused on writing and critically analyzing texts, reported faring quite well in their graduate classes. Alternatively, those who did not have strong skills in these areas struggled to find ways to build these skills:

> I'm kind of getting [content] okay, but how am I going to learn how to formally present and to be a technical writer and express my ideas in concise and clear ways?… I feel behind in that sense. I want to play catch up, but it's just like where do I find the time to learn how to do that? – Benjamin, Southwestern HSI, Industrial Engineering, PhD, Latino

> In the immunology class they give you primary articles to go along with their lectures. The first time I tried to read one it took me like three hours. And I was like, "Holy crap. What'd I get myself into?"… I mean I couldn't even read the title. I didn't know how to pronounce the words. But then I think you just sort of train yourself to do it, to pick up things and to learn things and so that was probably the most difficult part for me. – Alexander, North Eastern PWI, Immunology, PhD, Black

Although quantitative findings indicated that URM STEM students who had spent more time in graduate school (those in their second and third year of school) felt greater ease in their transition (Table 8), the difficulties associated with adapting to graduate academic life were evident in subsequent years. For example, students in their second year admitted to a continued struggle with the work load. The narratives of other students, like Camryn who was in the second semester of her first year as a doctoral student, demonstrate that the pace and rigor of graduate classes sometimes felt like too much to handle:

> From undergrad to grad, it was just a shock. It was just like all the work covering one – a whole textbook in one semester, that was just like, wow…But biochemistry, we learned that [book] cover to cover, and it was just like, oh, okay. And plus all the other responsibilities. So I don't know what to tell you. You know, and those are the types of things you just have to do… But now I – I find myself mentally not wanting to go back there, because I was seriously stressed out last semester. I mean, seriously like crazy, like I like wanted to crawl under something and just stay there for years. Like that's how bad it was. The transition is difficult. – Camryn, East Coast HBCU, Pharmacology, PhD, Black

The importance of teaching quality. The quality of teaching students received in graduate classes was another important aspect to students' transitional experiences. Students reported learning best in classrooms where faculty were excited about sharing their knowledge and appreciated pedagogical approaches wherein professors held students to high academic standards and challenged them. Students were also deeply appreciative of professors who cared whether students learned the material and went to great lengths to ensure deep learning:

> I actually had [a professor] that was just really good. I don't know if it's just because maybe he still teaches a lot of undergrad classes, too. But the way he broke down things was just like very fundamental. It was like, wow. I haven't had too many professors pretty much ever do that, especially not at a graduate level. And it was very helpful. And his tests, you know he still pushed us with the tests and challenged us. But I felt like I came away from those courses with a very solid understanding of what the material was that he taught. So, he was probably one of the better professors I've had. – Sean, Midwestern PWI, Mechanical Engineering, PhD, Black

Part of being a good teacher, according to students in the focus groups, was making sure that coursework was relevant. Indeed for many students, satisfaction with the first years of their graduate program was to some extent impacted by whether they thought their classes were immediately relevant to their career interests. The survey data further illustrate this and show that the relevance of coursework was significantly related to success in transition for all three graduate student groups. The tests of significant coefficients indicate that the relationship between relevance of classes and transition ability is most pronounced among URM STEM students compared with their peers in the other two groups (Table 8.) Students also appreciated when professors connected theoretical paradigms and research to current issues, because such connections helped them think differently about concepts and questions that were relevant for science.

It is notable that Black students pursing STEM degrees at East Coast HBCU appreciated that their professors taught science in ways that connected science to Black history and discussed the implications of scientific concepts to the present day Black community. In talking about his graduate classes at the HBCU Issac, a chemistry doctoral student, reflected, "it's preparing us to go out into the world and be Black scientists. And so if [the instructor] had never talked about malaria and sickle cell, he would have done [us] an injustice." The students indicated that this culturally relevant approach to teaching was used despite the fact that most professors at this particular HBCU were not Black. Students attending East Coast HBCU for their graduate work also spoke favorably of their lab and research experiences because they were taught to conduct research with social responsibility. In contrast, none of the other STEM graduate students from other institutions mentioned that science was taught in ways that connected their cultural backgrounds to science.

The quality of instruction that students received varied widely. Some professors seemed to only teach to the most knowledgeable students in the class, which was to the detriment of everyone else who needed more thorough explanations:

Maybe it's just the department dynamic – we have a lot of international students.

> And…they've already learned what we're learning on the grad level. So I feel as though the professors teach as though everyone already knows it. But there may be a subsection of the class who this is review for. But for everyone else, it isn't. So there's a lot of catch up that needs to be played [by the rest of us]. The teacher will gloss over things like, "Oh, you've seen this before. You've seen this." And I'm like, "No, actually that's the first time I've seen it. So can we go more in depth into it?"– Jasmine, Midwestern PWI, Computer Science, PhD, Black

Some students acknowledged the brilliance of their professors, stating that they simply lacked the teaching skills to impart their knowledge:

> Some of these guys are really, really smart. And I think that can work against them. I don't know if they just can't sympathize with grad students, like they're so far removed from that level of their life that they just can't remember what it was like. I had this one professor - he would just come in and talk. Like he had his slides and he just talked. He didn't write on the board. He was just so smart he could look at a slide and talk about it for 20 minutes and he'd ramble. And you'd be like, "Dude, like what is this?" You know there's like no direction. But he was a smart guy. – Austin, Midwestern PWI, Mechanical Engineering, PhD, Black

Even still, some professors had teaching techniques that were ineffective – for example, students reported that they felt like they did not learn as much in classes where there was an over reliance on lecturing. Moreover, some professors were simply poor teachers evidenced by putting forth little effort in planning class, poor organization of course material, and lack of care about whether students learned in the class:

> The teachers in [my masters program] program were lazy. I recognize a teacher who didn't prep for his class. I recognize a teacher who doesn't read his book, and there's – I mean they've been teaching it for so long they don't think they have to do [the reading] and one actually admitted that, "Yeah, I looked this up on Wikipedia and I learned this." And I'm like, "What?" – Gianna, HSI West Coast State, Mathematics, Masters, Latina

> We had one professor, specifically, who I did not think was a good professor and I ended up getting two classes with him. And it ended up being kind of the same class. One was like special topics and one was, you know an actual normal class that's been offered for a few years…he used the same material almost for both classes. And so I felt like I got kind of ripped off in the class selection kind of because of that. But also there's not a lot of [course] selection [in our graduate program]. – Chase, Midwestern PWI, Electrical Engineering, PhD, Latino

Learning lab culture. Another major factor in students' transitional experiences was learning how to become a researcher. The culture within the lab mattered because it affected how steep the learning curve was with respect to conducting research. Those who worked in labs with a collaborative culture spoke favorably about their lab experiences and reported a high level of research productivity:

> [My lab] is certainly collaborative more than competitive…We have common interests so we get together. Kind of in my lab… you latch onto something and you do research and then people just naturally group up. Then the groups dissolve after they publish something and then other groups will form and they'll do research on something else. We're just sort of playing with problems and publishing... – Hayden, Midwestern PWI, Chemistry, PhD, Black

Both qualitative and survey data demonstrates that learning within a supportive and collaborative graduate environment matters. Graduate students, for example, scored significantly higher on adjustment when they more frequently discussed course content with students outside of class. Amelia – a second year Latina doctoral student in microbiology and immunology at Midwestern PWI – provides insight into why a supportive and collaborative peer environment is so helpful while in graduate school:

> I chose to come out here…because I felt that everyone was so collaborative. I've heard horror stories where people are so competitive that they'll sabotage other peoples' experiments. Or they won't want to share their knowledge with someone else because they want to get ahead. But I don't feel like it's like that here at all. I feel like you can walk down the hall and ask someone for advice on how to do a certain technique or whatever it may be. And everyone's really, really willing to help and share what they know with you. So it's really good.

Not everyone was fortunate enough to work in a collaborative lab atmosphere like Amelia and Hayden. In labs where peers had an individualist mindset, asking for help was not useful because more advanced students were simply not willing to take the time to teach less experienced students. Further some students talked about adjusting to the culture and personalities in a lab:

> The biggest transition issue that I had was going into a lab culture… you really have to learn how to mesh your personality with other people's personality and you have to work with them quite a lot…so 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 that because I think other people would have quit in that situation. – Cooper, Midwestern PWI, Chemistry, PhD, Black

Learning research skills. Learning research skills was another major transitional task for STEM students. Students who entered graduate school with limited or no prior experience planning and conducting what would become long-term research projects reported having a poor grasp of experimental techniques and feeling lost a majority of the time:

> Some classmates of mine, they came in after working for a few years. So they have a lot of lab experience that I don't have, and they have like a better grasp of understanding experimental techniques ... So maybe at some point – hopefully, actually, not maybe – I will at some point have a better grasp of those things. – Charlotte, Midwestern PWI, Biomedical Sciences, PhD, Latina

Even students who had experience conducting research either in the workplace or as an undergraduate reflected on how conducting research was much different in graduate school because it required that students design their own study, instead of assisting someone else on research that was already planned, which was a far easier task. Some lamented not taking full advantage of their prior research experiences:

> I did research as an undergrad student, but I had the perception [that] this is a hobby sorta thing or I didn't take much more of a front seat with it as I should have – I don't know if I even had an individual project. I don't remember. But it wasn't a driving thing in my life. It was just something on the side. So when I got to grad school, to be the leader of something involving research was like a whole new concept to me. And it was a muscle I'd never exercised before… It was more thinking, developing, and processing and then actually doing experiments myself. That was totally foreign to me, so in that realm I felt like I wasn't prepared. It took me outta my comfort zone and I started to feel like this was the first time that I was really being challenged more than I had ever been. – Ella, North Eastern PWI, Biochemistry/biophysics, PhD, Black

Making matters worse, there was seldom someone making sure students were being productive with their research. To get up to speed, students had to be quite persistent in asking for help:

> I'll say, at first, I kinda had to prove myself, show them like I'm interested in what they're doing, 'cause I came in not having all the skills that they tend to do in the lab. So, that required like [me] nagging people like "how do you do this? How do you handle this?" So, I had to show them that I'm really interested and am proactive as well. That way, they kind of paid more attention [to my learning]. – Ava, West Coast PWI, Molecular and Medical Pharmacology, PhD, Black

Conducting research was also a daunting task for new students who independently collected their own data, rather than working collectively, because there were a number of ways things could go wrong. Further experiencing research difficulties combined with an unsympathetic advisor created a great deal of stress:

> I do a field season every summer. I'll be doing it this summer and just the pressures of my advisor saying, 'You need to get this done. This needs to be done now. If you don't get it done now then you're pretty much [screwed].' Like that kind of pressure…that's not good. If I can't get a certain amount of data within a certain amount of time, then yeah, I'm [screwed]. So yeah; that pressure is the hardest part of being in grad school…

> [And] sometimes things are out of your control…Then you're frantic, but you don't really know what you're doing 'cause it's your first semester of field season…I didn't feel I was prepared for my first field season and I didn't know what to expect. Now this field season I'm pretty sure I do [know what to do]. – John, Southwestern HSI, Wildlife Studies, Masters, Latino

Despite the frustration of collecting data and failed experiments, students reported enjoying the pursuit of knowledge and sense of accomplishment in conducting research:

> I think grad school is like a series of disappointments punctuated by moments of when you discover what to do for this thing to work and that's what keeps you going. I think that's what keeps you going as a graduate student… I was talking to someone who was interested in grad school and he said, "None of you seem happy." And I was like, "That's because you didn't – if you saw us in the moment where we're analyzing the data or we're giving a talk you would see the excitement come through." – Alexander, North Eastern PWI, Immunology, PhD, Black

The survey data show that graduate students across all three groups who report conducting experiments and collecting data in their early graduate years were also the most successful in their transition to graduate school (see Table 8). Most significantly, URM and non-URM STEM students who were frequently given the opportunity to write for publication were also more likely to be successful in their transition. There was no similar affect, however, for URM non-STEM students perhaps because such opportunities are more limited.

Variability in Faculty Guidance and Support

Receiving mentoring from a faculty member as an undergraduate was particularly important to feeling more successful in transitioning to the graduate environment for URM STEM students; the same effect however was not evidenced among URM non-STEM or White/Asian STEM students. (See Table 8.) In contrast, the survey data indicate that provision of faculty guidance and support at the graduate level was significantly related to feeling successful in the transition to graduate school for all student groups. Indeed a great deal of faculty guidance is a necessary component of successfully getting though classes and learning the skills and dispositions of a developing researcher and scholar. Unfortunately, students told stories about advisors that did not seem to provide proper guidance, due to a lack of awareness about important aspects of the program (e.g. scholarships available in the program, where to get important information) or basing their recommendations on incorrect information (e.g. which classes

would be best to take etc). In effect, students did not receive the same messages compared to peers and had to figure out many things on their own:

> Nobody in the physics department, not my advisor or the general graduate advisor for students who don't have a professor to work with, knew the process of graduating and getting all your forms. I'd ask them and they'd be like, "Oh, go ask the grad school." So I go and ask the grad school and they're like, "Your professor should have told you this." [I said,] "They told me to come to you." They're like, "There's something wrong [with advising in your department]." – Alexis, Southwestern HSI, Physics Masters, Latina

Other faculty did not give proper guidance simply because they were not available, accessible, or around enough. In some cases students were upset that they were courted into their program with the impression that they would be given a great deal of faculty support.

Indeed students gave accounts of being placed into a lab without much guidance from their PIs or without being paired with a more advanced student for training; as a result, they were confused about what they should be doing and didn't know what was expected of them. As a result of little direction, several reported that their research productivity was minimal. Some were not even aware of the importance of early research engagement on their careers as graduate students; others wasted valuable time and resources making mistakes that could have easily been avoided.

Without meaningful guidance from advisors or faculty, a few students contemplated leaving graduate school altogether but later changed their minds after learning to rely on peers, more advanced students, and carefully selected professors for advice or research collaboration:

> I've been lucky enough to find faculty on campus that I've become friends with and who I can talk to. And who, sometimes, I just go and talk to whatever I want to talk about with them, whether it be science or not. So, I do have friends on campus that are faculty. And they're not necessarily in the department, but they're all in the sciences. And so, with them, I keep in contact with fairly often. – Logan, West Coast PWI, Molecular Biology, PhD, Latino

Asking guidance from another faculty member was a political minefield in some STEM departments. For example, in talking about the difficulty in getting the information he needed from his PI on important questions, Cooper describes the tight rope act of asking another professor for guidance, balancing proactively advocating for one' self on the one hand and risking upsetting his professor on the other:

> You have to realize there are other people you can talk to – other professors that are much more helpful. But you have to be very careful because everyone's friends in that department so they might say, "Oh, Cooper came and talked to me about this" and it's gonna get back to her and make her feel like crap. So like understanding your departmental politics when you ask questions [is important] – and I kind of feel like I shouldn't have to be put in that type of position. – Cooper, Midwestern PWI, Chemistry, PhD, Black

Several students, especially those at PWI institutions, without prompting, spoke about having to navigate the politics of their department, wherein it was difficult identifying whom to trust for help and whom to confide in because they risked upsetting their advisors, which was dangerous territory. These politics were described as stressful for students and are a consequence of the great variability in faculty guidance and support in graduate school.

It is noteworthy that guidance from an advisor was necessary not only in the first critical year, but also in the second year and beyond:

> When I came in, the first year I spent with my advisor, he was very good. We would meet once a week. I have papers I read and if I didn't understand this and this, he'd explain. He had me go to a conference right away. The second semester [I was here] I went to a conference and… he would have me practice my presentation over and over and over until I had it perfect… I felt like he was very proud at the end of my presentation… But [then] he got a ton of money to go to [another city] and do research. And all of a sudden, all his time and energy went that way and… he didn't have time to meet with anybody at all… So all of a sudden, it was like 'no you do it by yourself'. And so it's been hard. – Alexis, Southwestern HSI, Physics Masters, Latina

Students also didn't want their advisors to be overly involved in everything they did:

> I really like the PI, … I think we have a good relationship because…I wouldn't say he's like a micromanager. The rope is loose enough where I can kinda do my own thing and then talk to him when I need help. – Ella, North Eastern PWI, Biochemistry/biophysics, PhD, Black

Overall, a balance between feeling supported and challenged appeared to be instrumental in successful adjustment during the first year of the graduate program as reflected by Sean – an African American mechanical engineering doctoral student:

> I would say for me one other thing that helped too was that my advisor, he's just a good advisor. Like he's just very personable. I mean he definitely sets the bar high, you know for all of us. But he's a guy that I feel pretty comfortable with. And so I guess he's – I don't know. It's easy to kind of talk to him… And he was kind of willing to kind of, you know be patient with me as I was going through that process.

Faculty as a source of support. Students wanted to feel that their advisors were invested in their success. They used words like "amazing," "phenomenal," and "incredible" to describe faculty advisors who checked in on them regularly to see how their progress was going with respect to classes and research, who were willing to talk though difficulties related to their research, who valued the students' scientific opinions on matters, and who took the time to give them timely feedback on papers and coached them on ways they could improve upon mistakes. All of these actions elevated the students' work and helped to make the students better researchers. Overall students seemed to have the smoothest transition when they found faculty to be approachable, when they sense the faculty member was willing to help, and when they felt that their inquiries were welcomed. Students also appreciated when their advisors informed them of other opportunities, helped students get publications by collaborating on research, and invited them to participate in all aspects of being a research including budget meetings and grant writing.

Some faculty even went beyond just caring about the students' academic well being and seemed to also care about their personal well being as well:

> It seems like [my advisor] wants to really get to know us and kind of just be our friend on a certain level. He is like almost a parenting figure because he just kind of wants to make sure we're doing okay. And I like that. I like him being hands off but at the same time getting to know us. I think that's really important. So he can definitely tell if something's wrong. He comes in. "I haven't talked to you for awhile. How are you doing? Like I'm just concerned. I just want to make sure everything is okay." And so it's been really, really great for me. I'm really happy with the decision I made… If you have a problem with anything…you can just send him an email and he will make time to talk to you. You can go in there and he will help you with any problem that you have. – Amelia, Midwestern PWI, Microbiology and Immunology, PhD, Multi-racial (American Indian and Latina)

Faculty as a source of stress. In addition to more faculty guidance, students wanted their advisors to offer solid support through challenges and a few talked about wanting advisors that they felt would go to battle for them if need be. Unfortunately a handful of students recounted stories where their advisors not only fell short of providing sufficient guidance, but were a major source of stress. For example, constant criticism in the face of little or no encouragement was a major barrier to developing a healthy sense of confidence as an emergent scholar and researcher: Hailey, a doctoral student in ecology

and evolutionary biology at West Coast PWI, describes the long-term detrimental psychological effects of negative comments made by an advisor and later her PI:

> I've considered leaving [the University] because of the lack of mentorship. I came in and I did a rotation with one professor through a summer research program and due to miscommunication, she eventually had a meeting with me and told me she didn't think I was cut out for the Ph.D. program… that was my first year…It's something that still gnaws at me in the back of my mind, that maybe she's right, so that's really been devastating and my actual PI has said similar remarks after looking at one draft of a proposal I submitted. He told me if I didn't do better he would recommend that I get kicked out of the department and he said that what I had done wasn't up to par and he threw examples of proposals on his desk at me of what it should look like and those proposals were written by students in their fourth year and this was my first year. And so two people that I had gone to with my guard completely down said that to me, and it really made me like clinch up and close up and totally like shut down.

Hailey's experience is demonstrative of two issues: Confidence in one's academic abilities is tested in graduate school and eventually has some influence on students' ability to successfully transition to the graduate environment. In particular, the perception of intimidation by faculty hinders adjustment in graduate school. Indeed, survey data showed that graduate students who more frequently felt intimidated by professors tended to have less successful adjustment in graduate school. This was true across race/ethnicity and discipline. (See Table 8).

Unfortunately, it was a highly political process for those few students who had significant issues with their advisors to switch to a different faculty advisor. Hailey, a Black doctoral student in ecology and evolutionary biology at West Coast PWI, added:

> I have [considered changing advisors], but it's such a big bridge to burn that – I mean he'll forever be in my field if I stay in this career, and so it's something that's really messy and so I haven't actually taken the plunge mainly because I have found an external mentor who can distract me and help me and be there for me; and so that's easier than cutting the rope.

A handful of students spoke about having to use the psychological services at their institutions to gain the support and compassion they needed to continue on in their graduate studies. Several students across different disciplines (both STEM and non-STEM) from the three PWIs in the sample reported experiencing varying forms of depression during their first years while in graduate school, even when doing quite well academically. These students lamented that there weren't resources built into their

specific graduate programs to help them through mild depression or to address other difficulties relatively new graduates students may have.

How Race Matters in Graduate Education

Diversity within the program. For a great deal of the URM STEM students, the diversity present within their respective institutions overall and within their programs specifically, mattered. Students at the minority serving institutions reported that seeing an abundance of racially diverse peers and faculty in their programs was encouraging as it communicated the message that people like them were able to succeed in STEM. It was easier to feel accepted at an institution that "takes pride in the diversities [of people]" and pursuing a degree in a department that "is really good about just being sensitive to the different types of students that are coming in." When asked how attending an institution that has a large number of URM students made him feel, Benjamin a Latino student pursing a PhD in industrial engineering at Southwestern HSI replied:

> I guess I just would say I felt normal. I don't know how else [to explain it] – I never really thought a lot about race or ethnicity so much. I just felt like growing up here (in the southwest) for the majority of my life and then going on campus and just looking around, and I just see it's just as diverse.

Similarly survey data shows that URM STEM students who saw themselves as part of the campus community were more likely to have successfully transitioned to graduate school; this sense of belonging was not a unique contributor (statistically) for graduate students from the other two student groups. Further, although no other climate measures had direct effects on graduate student transition (see Tables 6, 7, and 8), the stories students told were powerfully revealing.

Students pursuing their graduate work at one of the predominately White institutions reflected that the diversity present within the program was a major consideration in deciding which institution they would attend for graduate school; for these students the diversity of the program was a proxy for how comfortable they would be in their programs. This level of comfort was viewed as less achievable within a circle of simply "older White men." For Brandon a Black student pursing a PhD in applied physics at Midwestern PWI, the decision to attend his program was made at the final hour:

> So before coming here, I spent the summer in the physics department during one of those summer programs. I'd actually made up my mind I would not come to [this University] to graduate school because I felt really out of place in the physics department. It was one of the, 'we're glad you're here, but we don't really welcome you' kind of thing. Of course no one will tell you that to your face. So if it wasn't for running into another Black student… Then he told me about applied physics…when I talked to the director he put together a lunch of students of different backgrounds and right away I was surprised that I didn't feel like I was the only one. I felt like there were a few more people like me. And over the years, I have seen applied physics has, in fact, been one of the best programs in the university when it comes to diversity, especially recruiting minorities and retention… And so, it's interesting that the department that shares the same building and everything is completely the opposite… I do have to say if it wasn't for applied physics, we would not be having this discussion right now 'cause I would not be here.

Brandon's narrative demonstrates that part of feeling welcomed as a minority STEM student, was to see that faculty also cared about diversity. It was therefore disappointing when faculty seemed not to support efforts to recruit more diverse students into the program:

> For the past couple of years I was in a program that worked on the retention of minorities at [this University]… And one of the problems that we were having with the organization is just that we never can get support from faculty to be a part of it or to be involved, and it's something that I felt always was like – you know, the selling point of coming here. To attract you [as a racial minority student] is to say, "Being a minority is something that we find to be important." But then when we get here, it's kinda not as important as they said it was to begin with. – Ella, North Eastern PWI, Biochemistry/biophysics, PhD, Black

Differential treatment in the program. URM students attending one of the PWIs in our sample spoke about difficulties within their programs that they attributed to their numeric racial underrepresentation. Hailey, a doctoral student in ecology and evolutionary biology at West Coast PWI, was constantly trying to figure out if what she perceived as poor treatment from others within her program was a result of academic hazing in which faculty were "just jerks to everyone" or whether she was "under a special kind of magnifying glass" as a Black student. She goes on to say:

> Coming to a predominantly White [institution], you're constantly trying to prove yourself and represent your race, which is retarded, but it's just the nature of the beast and so all that stuff culminates together to make life suck sometimes.

As one of a few URM students in their STEM programs, multiple students at PWIs spoke of having people question their academic ability until they proved to be competent, peers who didn't want to collaborate on homework or who assumed that they would steal their work, and an overall impression that

people in their classes looked down on them. Interestingly, the peers in students' programs were often primarily international students:

> So when I joined the [lab] group I was the only like American citizen in the group and that was maybe like six or seven people. And there was like a Korean clique and an Irish clique. My advisor came from Ireland, so he kind of brought them over from where he used to teach there. And when he first assigned me to a project he said, "Okay, why don't you help so and so out with this project?" You know I tried. I emailed them a few times. Tried to set up a meeting. But just I felt kind of excluded from that. Like he didn't really want me to help on it. I didn't really directly feel like, oh, it's a race thing or this or that. But you do notice that there's like a, you know a clique of Koreans. 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 like the one line answer. So sometimes you see a little bit of separation within the group like that. At least I've noticed it. And that's still kind of true today. – Chase, Midwestern PWI, Electrical Engineering, PhD, Latino

The fact that collaborating with peers with respect to studying, homework, and research was not a readily feasible option for many URM STEM students pursuing their graduate work at PWIs is problematic precisely because students reported that to survive the high workload of introductory graduate classes graduate classes, it was essential to study with peers and collaborate on homework. Further study groups also served a social function and warded off feelings of isolation. Maria, a Black doctoral student pursing biomedical engineering at Midwestern PWI talks about how important it was to have other Black students in her program to avoid stereotype threat and help her cope with the negative images her colleagues had of people of color:

> As far as being in class…sometimes I feel that as African-American that 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, like the ones that you're seeing. So I feel a little bit of pressure that way…Actually from my cohort, [Laughter] I guess I was very lucky in my cohort, because – or maybe it was just one year where there wasn't a huge number but there was a good amount of African-American women to make me feel that I belong.

Although experiences with outright racism were less frequent, URM students at PWIs had numerous stories of smaller seemingly subtle racial incidents that made them feel less than welcomed in their STEM programs. Kaitlyn, a first year chemistry doctoral student at West Coast PWI recounted an incident with a non-Black peer:

> The first quarter was very difficult, academically and emotionally… I'm coming from a very proud Black place and then coming here, I'm just taking some low blows…These

> people are very intelligent but also ignorant. There are only two Black people in the grad program in chemistry, total. So I'm super visible. [Laughter] I don't wanna be overly visible, but I'm very visible and then at the same time I wanna be myself... I'd never get to blend in, so people notice literally everything that I do, and they just wanna poke and prod. And I've just heard very not cool things… where they say it to my face. [For example] I'm exchanging phone numbers with this guy to see about getting together to study, and he asked me what my last name is and I told him. I said it's James. And he's like, "Oh, so that's your slave name." And I'm like, "Oh, wow."

As a whole, the quotes suggest that issues of race arise within STEM graduate programs despite prevailing arguments that the discipline is purely objective and a place where race has no consequence. Students' narratives reveal how racial issues create another layer of concern and stress that URM STEM graduate students face when transitioning to graduate life as highly underrepresented persons in their respective fields and programs. With respect to gender, many of the URM STEM females were also severely underrepresented in their field if they were not in a discipline related to the biological sciences. Survey data demonstrates that more satisfaction with the representation of women in one's graduate program was associated with greater adjustment to graduate school until other measures were controlled (e.g. faculty guidance) in the larger scale quantitative analyses. This suggests that specific graduate experiences mediate the climate and successful transition to graduate school, which is an area for future study.

Conclusion

This study builds on previous research by focusing on the experiences that hinder or support transition to the academic graduate environment in the first few years of students' graduate careers. There are six unique contributions of this paper. First, it is clear that many graduate programs are not sufficiently structured, perhaps stemming from the expectation that as doctoral students, students come in already being self-directed learners and researchers. Student accounts show that, in general, this is not the case. Indeed students begin graduate school with the expectation that they will be properly trained, not that they will train themselves. Further many novice URM STEM graduate students were not aware of the questions they should be asking or to whom, which made them feel that they were in a constant state of "being lost." More structure in a

program, that clearly outlines class sequences and expectations for research productivity, at least in the first two years of graduate school could help reduce the uncertainty and doubt incoming graduate students experience and make them feel more in control of their ability to succeed. Relatedly, a second point is that there seemed to be many instances by where students lack a sufficient amount of guidance from faculty advisors which only exacerbated feelings of being lost. Without sufficient guidance, previous research shows that students are forced to have an extremely high-level of self-direction just to keep up (Gardner & Holley, 2011; Holley & Gardner, 2012). Students who do not have this level of savvy or who do initiate mentoring relationships with faculty are in the most vulnerable positions.

A third point is that early faculty support and mentoring is key for all students groups - whether the students are racial minorities or not and irrespective of discipline. Students who do not receive the level of support they need tend to seek it from outside sources, even from faculty outside of their discipline or institution. It appears that students who know they can rely on multiple people in their programs or within their fieldare in the best position for adapting to the graduate environment. It is problematic however that the act of seeking outside help can be a political minefield students are forced to navigate; in effect student mays find themselves between the proverbial ‘rock and a hard place’ as they desire guidance over and above the amount their advisor gives them but may face negative consequences from their advisor for doing so. This tightrope between appeasing one’s faculty member and getting the direction one needs to progress successfully through the program should not be an additional stressor students face.

A fourth point is that teaching quality in graduate school is related to ability to transition and does not simply deal with whether the instructor knows the material (all instructors seem to be highly knowledgeable). Indeed teaching has more to do with the delivery of course content, the pedagogical approaches the instructor takes, the enthusiasm he or she has for teaching students, whether they care that students are mastering the content, and the level of relevancy the course content has to the future career plans of students. Good instructors know how to keep students engaged, demonstrate a high level of care in making sure that everyone understands what is going on, and can connect why the content imparted in

the classroom has relevancy for real world problems and how students might use this information once they enter the workplace. Previous research has already established a link between the curriculum graduate students encounter in their graduate programs and satisfaction (Golde, 1996; Herzig, 2002).

A fifth point is that peers are invaluable to students' ability to transition as they share information and resources. Previous research has highlighted the important contribution peers make to the academic development and skill acquisition of STEM graduate students via collaborative work on assignments, study groups for classes and qualifying exams, and the sharing of academic resources (Mwenda, 2010). What previous research does not demonstrate however is that peer group dynamics is often times (negatively) shaped by international students, because they comprise a great proportion of the incoming cohort of STEM graduate students. These international students often times inadvertently exclude domestic students both socially and academically. In order to ensure that student diversity is an asset, programs must be more attentive to how these intergroup dynamics play out and identify ways of better connecting international and domestic students so that all students can capitalize on the opportunity to learn from peers.

A six point of this study is that racial issues are common topics of concern for URM students in STEM graduate program despite prevailing conceptions that race is not a significant factor in the experiences of students in disciplines like STEM which are thought to be neutral and objective spaces. From students' reflections, we find that students expend precious mental energy on determining whether they were being treated differently in their program by peers or faculty and if race was a contributing factor to that differential treatment. Other research supports our findings and show that URMs often experience confrontations with racism and discrimination during graduate school (Lee et al., 2003) and perceive the graduate environment as being more racially discriminatory that their White peers (Nettles, 1990). Further these experiences are especially apparent in STEM graduate disciplines (Smith, Yosso, & Solórzano, 2007; Oden, 2003). Our study however shows that issues of race are not only about the behaviors URM students experience from other people but also the attitudes of the people around them as well. For URM STEM students to feel welcomed by their pragmatic community was to know that faculty

cared about the diversity present within the program and made an effort to improve it, and cared about linking the implications of course concepts and research to racial/ethnic minority communities. These actions signaled to URM STEM students that they mattered to their programs.

In short a better attention to graduate education is needed to improve student progress as well as degree attainments among URMs in STEM disciplines. Although special programs and initiatives affect skill development for a small set of participants (i.e. workshops offered through student services, writing /graduate centers, programs targeting URMs) and make the graduate environment a more positive place to learn and grow, Departments and Deans must also shoulder more of the responsibility of improving teaching, training, and degree progress at the graduate level so as to reach a larger audience of students. Another major concern to which programs must be attentive is that the graduate transition process is not only difficult intellectually for students but may also take a toll on students emotionally. Indeed we find from student accounts that experiences with different levels of depression is not the exception to the rule. Graduate programs must therefore create additional services to ensure that students can healthfully deal with mental health issues while also continuing to make progress on their degree. Future research should examine the effect mentoring has on students' self-confidence and stress levels, the indirect effects of climate issues, and how different types of diversity (i.e. gender, racial, nationality) within graduate programs affect students transitional experiences.

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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		
Description of Variables and Scales		
Variable		Scale
Dependent Variables		
	Success at managing the academic environment	A composite measure of nine variables that assess students' success at understanding what professors expect of you academically, managing your time effectively, developing research skills, mastering course content, collaborating with peers, pursuing personal intellectual interests related to your discipline, writing academic papers, developing contacts in your field of study, and presenting academic material.
Characteristics of Undergraduate Institution		
	Percent admitted - total	continuous
	Control: Private	1=public; 2=private
	Full-time equivalent enrollment: Fall 2006	continuous
	Instruction/research and public service FTE staff	continuous
	Doctoral/research university (ref. masters colleges)	0=no; 1=yes
	Baccalaureate colleges (ref. masters colleges)	0=no; 1=yes
	Percent of total enrollment that are URM	continuous
	Research expenses per FTE	continuous
Student Background Characteristics		
	Gender: female	1=male; 2=female
	URM Students in STEM	0=no; 1=yes
	URM Students not in STEM	0=no; 1=yes
	White & Asian & "Other" Students in STEM	0=no; 1=yes
Undergraduate Experiences		
	Work with a faculty member on his or her research	1=no; 2=yes
	Receive mentoring from a faculty member	1=no; 2=yes

	Participate in a structured undergraduate research program (e.g., MARC, MBRS)	1=no; 2=yes
	Participate in an academic club or professional association	1=no; 2=yes
	How well did your undergraduate experience prepare you to: Write effectively	5=Very well; 4=More than adequately; 3=Adequately; 2=Less than Adequately; 1=Very poorly
Admission Attributes and Criteria, Environmental Pull Factors, Identity/Self-Concept		
	Degree Pursuing: PhD	1=masters; 2=Ph.D.
	Felt that your job interfered with your studies	5=Very often; 4=Often; 3=Occasionally; 2=Rarely; 1=Never
	Felt that your family responsibilities interfered with you studies	5=Very often; 4=Often; 3=Occasionally; 2=Rarely; 1=Never
	Academic Self-concept	A composite measure of four variables that assess students' self-rated critical thinking skills, problem-solving skills, academic ability; self-confidence (intellectual), mathematical ability, drive to achieve, and writing ability. The seven variables are measure separately on a five-point scale: 1= lowest 10% to 5= highest 10%
	Altruistic/Social Justice Oriented STEM Identity	A composite measure of seven variables that assess students' the level of importance students attach to the following statements: Improving the health of minority communities, Helping to promote racial understanding, Helping others who are in difficulty, Conducting research that will impact under-served communities, Becoming a community leader, Influencing social values, Working to find a cure to a health problem
Climate of Graduate Institution		
	Perception of racial climate: Hostile	A composite measure of four variables that assess students' agreement with the statements: I have been singled out because of my race/ethnicity, I have heard faculty express stereotypes about racial/ethnic groups, there is a lot of racial tension on this campus. The three variables are measured separately on a four point scale: 1= strongly disagree; 4= strongly agree
	I have been singled out because of my gender	1=strongly disagree; 4= strongly agree
	How many current school associates share your race/ethnicity	6=All; 5=Most; 4=About half; 3=Some; 2=None; 1=NA

	International and domestic students work well together here	1=strongly disagree; 4= strongly agree
	Satisfaction: representation of women	5=Very satisfied; 4=Satisfied; 3=Neutral; 2=Dissatisfied; 1=Very Dissatisfied
	Felt intimidated by your professors	5=Very often; 4=Often; 3=Occasionally; 2=Rarely; 1=Never
	I see myself as part of the campus community	5=Very satisfied; 4=Satisfied; 3=Neutral; 2=Dissatisfied; 1=Very Dissatisfied
Graduate School Experiences		
	What year did you start your current or most recent program? 2007-2011	5=2011; 4 =2010; 3=2009; 2=2008; 1=2007
	Frequency: Discussed course content with students outside of class	5=Very often; 4=Often; 3=Occasionally; 2=Rarely; 1=Never
	Faculty Provision of Guidance	A composite measure of seven variables that assess the frequency faculty provide students with the following: Advice about your educational program, Feedback on your academic work (outside of grades), Intellectual challenge and stimulation, An opportunity to discuss coursework outside of grades, Help in accessing professional networks, Letters of recommendation, An opportunity to collaborate on research
	Frequency: Written for publication	5=Very often; 4=Often; 3=Occasionally; 2=Rarely; 1=Never
	Frequency: Conducted experiments or collected data	5=Very often; 4=Often; 3=Occasionally; 2=Rarely; 1=Never
	Satisfaction: Relevance of coursework to career plans	5=Very satisfied; 4=Satisfied; 3=Neutral; 2=Dissatisfied; 1=Very Dissatisfied

Appendix C			
Construction of factors for analyses			
	Component		Factor loadings
Success at managing the academic environment (α = 0.906)			
Since entering this college, how successful have you felt at:			
	Mastering course content,		0.76
	Presenting academic material.		0.74
	Pursuing personal intellectual interests related to your discipline,		0.74
	Collaborating with peers		0.73
	Understanding what professors expect of you academically		0.72
	Developing research skills,		0.72
	Writing academic papers		0.71
	Managing your time effectively		0.69
	Developing contacts in your field of study		0.68
Academic self-concept (α = 0.803)			
	Critical thinking skills		0.83
	Problem-solving skills		0.82
	Academic ability		0.68
	Self-confidence (intellectual),		0.61
	Mathematical ability,		0.52
	Drive to achieve		0.48
	Writing ability		0.42
Altruistic/Social Justice oriented STEM identity (α = 0.855)			
Level of importance students attach to the following:			
	Improving the health of minority communities		0.84
	Helping to promote racial understanding		0.76
	Influencing social values		0.69
	Conducting research that will impact under-served communities		0.67
	Helping others who are in difficulty		0.66
	Becoming a community leader		0.64

	Working to find a cure to a health problem		0.50
Perception of racial climate: Hostile (α = 0.788)			
Level of agreement with the following:			
	I have heard faculty express stereotypes about racial/ethnic groups		0.81
	There is a lot of racial tension on this campus		0.74
	I have been singled out because of my race/ethnicity		0.71
Faculty Provision of Guidance (α = 0.910)			
Frequency faculty provide students with the following:			
	Advice about your educational program		0.85
	Feedback on your academic work (outside of grades)		0.84
	Intellectual challenge and stimulation		0.82
	An opportunity to discuss coursework outside of grades		0.81
	Help in accessing professional networks		0.79
	Letters of recommendation		0.73
	An opportunity to collaborate on research		0.60

Appendix D					
Descriptive Statistics n=2846 students; n= 387 institutions					
Variable		Mean	S.D.	Min.	Max
Characteristics of Undergraduate Institution					
	Percent admitted - total (Rescaled by 10)	1.30	9.90	6.31	1.92
	Control: Private	1.00	3.00	1.68	0.47
	Full-time equivalent enrollment: Fall 2006 (Rescaled by 1,000)	0.40	47.75	7.13	7.91
	Instruction/research and public service FTE staff (Rescaled by 100)	0.32	52.84	5.87	8.15
	Doctoral/research university (ref. masters colleges)	0.00	1.00	0.28	0.45
	Baccalaureate colleges (ref. masters colleges)	0.00	1.00	0.33	0.47
	Percent of total enrollment that are URM	2.00	99.00	18.76	21.29
	Research expenses per FTE (Rescaled by 10,000)	0.00	9.87	0.29	0.89
Dependent Variables					
	Success at managing the academic environment	-0.03	0.94	-4.57	1.04
Student Background Characteristics					
	Gender: female	1.59	0.49	1.00	2.00
	URM Students in STEM	0.12	0.33	0.00	1.00
	URM Students not in STEM	0.48	0.50	0.00	1.00
	White & Asian & "Other" Students in STEM	0.40	0.49	0.00	1.00
Undergraduate Experiences					
	Work with a faculty member on his or her research	1.42	0.51	0.00	2.00
	Receive mentoring from a faculty member	1.66	0.49	0.00	2.00
	Participate in a structured undergraduate research program (e.g., MARC, MBRS)	1.19	0.42	0.00	2.00
	Participate in an academic club or professional association	1.63	0.50	0.00	2.00
	How well did your undergraduate experience prepare you to: Write effectively	3.81	0.96	0.00	5.00
Admission Attributes and Criteria, Environmental Pull Factors, Identity/Self-Concept					
	Degree Pursuing: PhD	1.17	0.38	1.00	2.00
	Felt that your family responsibilities interfered with you studies	2.24	1.19	0.00	5.00

	Felt that your job interfered with your studies	2.46	1.28	0.00	5.00
	Academic Self-concept	0.00	0.93	-3.45	1.57
	Altruistic/Social Justice Oriented STEM Identity	0.07	0.96	-1.84	1.82
Climate of Graduate Institution					
	Perception of racial climate: Hostile	0.05	0.93	-2.03	11.15
	I have been singled out because of my gender	1.47	0.72	0.00	4.00
	How many current school associates share your race/ethnicity	3.30	1.48	0.00	6.00
	International and domestic students work well together here	2.86	0.85	0.00	4.00
	Satisfaction: representation of women	3.67	1.08	0.00	5.00
	Felt intimidated by your professors	2.27	1.11	0.00	5.00
	I see myself as part of the campus community	2.70	0.90	0.00	4.00
Graduate School Experiences					
	What year did you start your current or most recent program? 2007-2011	3.16	1.17	0.00	5.00
	Frequency: Discussed course content with students outside of class	3.68	1.20	0.00	5.00
	Faculty Provision of Guidance	0.00	0.97	-3.25	1.45
	Frequency: Presented research at conferences	1.70	1.20	0.00	5.00
	Frequency: Written for publication	1.92	1.28	0.00	5.00
	Frequency: Conducted experiments or collected data	3.03	1.53	0.00	5.00
	Satisfaction: Relevance of coursework to career plans	4.02	1.03	0.00	5.00

Table 1

Descriptives and Means Across Key Groups

	DV: Success at managing academic environment		
	N	Mean	SD
Male	1061	-0.05	0.87
Female	1785	-0.01	0.99
White	1131	-0.03	0.79
Black	632	-0.01	1.01
American Indian	153	0.00	0.93
Asian/Pacific Islander	201	-0.29	0.89
Latino	630	0.03	1.03
Other &/or Multi-racial	99	-0.12	1.05
URM STEM Majors	320	-0.09	0.97
White/Asian STEM Majors	1364	-0.07	0.81
URM non-STEM majors	1162	0.02	1.03
Total (i.e. total sample)	2846	-0.03	0.94

Note. Data are weighted for the mean and SD.

Table 2

ANOVAs Across Key Groups on Academic Success

		Sum of Squares	df	Mean Square	*F*	Sig. (p-value)
By racial groups	Between Groups	13.23	5.00	2.65	2.99	0.01
	Within Groups	2412.51	2724.00	0.89		
	Total	2425.74	2729.00			
By three groups	Between Groups	6.27	2.00	3.14	3.53	0.03
	Within Groups	2419.47	2727.00	0.89		
	Total	2425.74	2729.00			

Note. Data are weighted.
By racial groups refers to the five racial groups represented in the data.
By three groups refers to URM STEM, URM Non-STEM, and White/Asian/"Other" STEM majors.

Table 3

Bonferroni Post-Hoc Tests for Success at Managing Academic Environment by Key Groups

1st Group	2nd Group	Mean Dif. (1st-2nd)	p < .05
Asian/Pacific Islander	White	-0.26	0.03
	Latino	-0.32	0.00
	Black	-0.28	0.01
URM STEM majors	URM non-STEM majors	-0.11	n.s.
	White/Asian STEM/"Other" Majors	-0.02	n.s.

Note. Data are weighted. Only significant between-group differences for race are displayed in this table.

Table 4
Independent sample T-test for Success at Managing the Academic Environment by Key Groups

1st Group	2nd Group	Mean Dif. (1st-2nd)	p < .05
URM STEM Majors	URM non-STEM majors and White/Asian/"Other" STEM Majors	0.07	n.s.
URM non-STEM Majors	URM STEM majors and White/Asian/"Other" STEM Majors	-0.10	0.00
White/Asian/"Other" STEM Majors	URM non-STEM majors and URM STEM Majors	.07	0.00

Note. Data are weighted.

Table 5

Results of Regression Predicting Success at Managing Academic Environment for URM STEM majors. n=320

		Model 1		Model 2		Model 3		Model 4		Model 5		Model 6		
Variable	r	B	S.E.	B	S.E.	B	S.E.	B	S.E.	B	S.E.	B	S.E.	t
Intercept		-0.19	0.19	-1.41 **	0.46	-2.64 ***	0.50	-2.65 ***	0.51	-3.58 ***	0.50	-3.48 ***	0.47	-7.38
Student Background Characteristics														
Gender: female	0.02	0.05	0.12	0.00	0.12	-0.01	0.12	0.05	0.12	-0.02	0.11	0.13	0.09	1.54
Characteristics of Undergraduate Institution														
Percent admitted - total (Rescaled by 10)	0.02			0.01	0.03	0.02	0.03	0.00	0.03	0.00	0.03	0.00	0.02	-0.16
Control: Private	0.12 *			0.56 ***	0.16	0.39 *	0.16	0.31 *	0.16	0.22	0.14	0.11	0.11	0.94
Full-time equivalent enrollment: Fall 2006 (Rescaled by 1000)	0.00			0.03 *	0.01	0.03 *	0.01	0.02	0.01	0.02	0.01	0.02 *	0.01	2.38
Instruction/research and public service FTE staff (Rescaled by 100)	-0.04			-0.02	0.01	-0.01	0.01	-0.01	0.01	-0.01	0.01	-0.01	0.01	-1.53
Doctoral/research university (ref. masters colleges)	-0.06			-0.04	0.16	-0.05	0.15	-0.05	0.15	-0.04	0.13	-0.07	0.10	-0.70
Baccalaureate colleges (ref. masters colleges)	0.08			0.17	0.19	0.11	0.19	0.01	0.18	-0.08	0.16	-0.06	0.13	-0.49
Percent of total enrollment that are URM	0.08			0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.67
Research expenses per FTE (Rescaled by 10,000)	-0.07			0.03	0.08	0.03	0.07	0.01	0.07	0.03	0.06	0.08	0.05	1.54
Undergraduate Experiences														
Work with a faculty member on his or her	0.06					-0.14	0.12	-0.17	0.12	-0.10	0.11	-0.11	0.09	-1.19
Receive mentoring from a faculty member	0.22 ***					0.31 **	0.12	0.31 **	0.12	0.20	0.11	0.16 *	0.08	1.97
Participate in a structured undergraduate research program (e.g., MARC, MBRS)	0.06					0.08	0.13	0.08	0.13	0.09	0.11	0.01	0.09	0.14
Participate in an academic club or professional association	0.16 **					0.14	0.11	0.10	0.11	0.07	0.09	0.04	0.07	0.47
How well did your undergraduate experience prepare you to: Write effectively	0.30 ***					0.23 ***	0.06	0.15 *	0.06	0.07	0.05	0.07	0.04	1.77

Table 5

Results of Regression Predicting Success at Managing Academic Environment for URM STEM majors. n=320

			Model 1		Model 2		Model 3		Model 4		Model 5		Model 6		
	Variable	r	B	S.E.	B	S.E.	B	S.E.	B	S.E.	B	S.E.	B	S.E.	t
Admission Attributes, Environmental Pull Factors, Identity/Self-Concept															
	Degree Pursuing: PhD	0.09							0.27	0.14	0.24	0.13	-0.01	0.11	-0.08
	Felt that your family responsibilities interfered with your studies	0.26 ***							0.17 **	0.05	0.14 **	0.05	0.06	0.04	1.62
	Felt that your job interfered with your studies	0.17 ***							-0.01	0.05	-0.04	0.04	-0.04	0.04	-1.04
	Academic Self-Concept	0.23 ***							0.17 **	0.06	0.17 **	0.06	0.10 *	0.04	2.21
	Altruistic/Social Justice Oriented STEM Identity	0.17 **							0.10	0.06	0.09	0.06	0.04	0.04	0.80
Climate of Graduate Institution															
	Perception of racial climate as Hostile	0.06									0.17 **	0.06	0.08	0.05	1.56
	I have been singled out because of my gender	0.01									-0.12	0.08	-0.11	0.06	-1.75
	How many current school associates share your race/ethnicity	0.07									0.04	0.04	0.04	0.03	1.57
	International and domestic students work well together here	0.25 ***									0.13 *	0.06	0.04	0.04	
	Satisfaction: Representation of women	0.43 ***									0.24 ***	0.05	0.05	0.04	1.19
	Felt intimidated by your professors	0.00									-0.08	0.04	-0.07 *	0.03	-2.07
	I see myself as part of the campus community	0.42 ***									0.27 ***	0.06	0.11 *	0.05	2.26

Table 5

Results of Regression Predicting Success at Managing Academic Environment for URM STEM majors. n=320

			Model 1		Model 2		Model 3		Model 4		Model 5		Model 6		
Variable	r		B	S.E.	B	S.E.	B	S.E.	B	S.E.	B	S.E.	B	S.E.	t
Graduate School Experiences															
Year started current or most recent graduate program	-0.22	***											-0.08 *	0.03	-2.21
Frequency: Discussed course content with students outside of class	0.41	***											0.03	0.04	0.84
Provision of Faculty guidance	0.59	***											0.18 ***	0.05	3.41
Frequency: Written for publication	0.36	***											0.12 ***	0.03	3.32
Frequency: Conducted experiments or collected data	0.40	***											0.09 **	0.03	2.94
Satisfaction: Relevance of coursework to career plans	0.63	***											0.38 ***	0.05	8.28
			Adj. R = .000		Adj. R^2 = .024		Adj. R^2 = .113		Adj. R^2 = .180		Adj. R^2 = .362		Adj. R^2 = .615		

Notes. ***p<.001, **p<.01, *p<.05.

Success at managing the academic environment is a composite measure of nine variables that assess students' success at understanding what professors expect of them academically, managing their time effectively, developing research skills, mastering course content, collaborating with peers, pursuing personal intellectual interests related to their discipline, writing academic papers, developing contacts in their field of study, and presenting academic material.

Table 6

Results of Regression Predicting Success at Managing Academic Environment for URM non-STEM Majors. n=1,162

			Model 1		Model 2		Model 3		Model 4		Model 5		Model 6	
	Variable	r	B	S.E.	B	S.E.	B	S.E.	B	S.E.	B	S.E.	B	S.E.	t
	Intercept		0.04	0.12	0.14	0.24	-0.80 **	0.30	-1.03 **	0.33	-2.67 ***	0.30	-2.16 ***	0.31	-7.00
Student Background Characteristics															
	Gender: female	-0.01	-0.02	0.07	-0.02	0.07	-0.02	0.07	0.05	0.07	0.01	0.06	0.06	0.05	1.10
Characteristics of Undergraduate Institution															
	Percent admitted - total (Rescaled by 10)	-0.03			-0.02	0.02	-0.02	0.02	-0.02	0.02	-0.01	0.01	0.00	0.01	-0.25
	Control: Private	-0.08 **			-0.07	0.08	-0.05	0.08	-0.01	0.08	-0.04	0.07	-0.11	0.06	-1.79
	Full-time equivalent enrollment: Fall 2006 (Rescaled by 1000)	0.10 ***			0.01	0.01	0.01 *	0.01	0.01 *	0.01	0.02 **	0.01	0.01	0.01	1.13
	Instruction/research and public service FTE staff (Rescaled by 100)	0.06 *			-0.01	0.01	-0.01	0.01	-0.01	0.01	-0.01	0.01	0.00	0.01	0.06
	Doctoral/research university (ref. masters colleges)	0.07 *			0.08	0.09	0.09	0.09	0.09	0.09	-0.03	0.07	-0.03	0.07	-0.41
	Baccalaureate colleges (ref. masters colleges)	0.00			0.20	0.11	0.18	0.11	0.17	0.10	0.16	0.09	0.11	0.08	1.46
	Percent of total enrollment that are URM	-0.04			0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-1.45
	Research expenses per FTE (Rescaled by 10,000)	0.01			-0.01	0.06	-0.03	0.06	-0.02	0.06	-0.01	0.05	-0.05	0.05	-1.02
Undergraduate Experiences															
	Work with a faculty member on his or her	0.04					0.03	0.07	0.03	0.07	0.06	0.06	0.03	0.05	0.48
	Receive mentoring from a faculty member	0.04					0.03	0.07	-0.01	0.06	0.03	0.06	0.01	0.05	0.14
	Participate in a structured undergraduate research program (e.g., MARC, MBRS)	0.05 *					0.08	0.09	0.07	0.09	0.08	0.07	0.07	0.07	1.00
	Participate in an academic club or professional association	0.02					0.02	0.06	-0.02	0.06	-0.06	0.05	-0.08	0.05	-1.78
	How well did your undergraduate experience prepare you to: Write effectively	0.15 ***					0.17 ***	0.03	0.13 ***	0.03	0.07 *	0.03	0.05	0.03	1.83

Table 6

Results of Regression Predicting Success at Managing Academic Environment for URM non-STEM Majors. n=1,162

			Model 1			Model 2			Model 3			Model 4			Model 5			Model 6			
	Variable	r		B		S.E.	B		S.E.	B		S.E.	B		S.E.	B		S.E.	B		S.E.	t
Admission Attributes, Environmental Pull Factors, Identity/Self-Concept																					
	Degree Pursuing: PhD	-0.01											-0.09		0.12	-0.03		0.11	-0.21	*	0.10	-2.14
	Felt that your family responsibilities interfered with your studies	0.16	***										0.09	***	0.03	0.04		0.03	0.01		0.02	0.42
	Felt that your job interfered with your studies	0.15	***										0.08	**	0.03	0.02		0.02	0.02		0.02	0.82
	Academic Self-Concept	0.18	***										0.16	***	0.04	0.15	***	0.03	0.12	***	0.03	4.18
	Altruistic/Social Justice Oriented STEM Identity	0.07	**										0.01		0.04	-0.01		0.03	-0.07	*	0.03	-2.52
Climate of Graduate Institution																						
	Perception of racial climate as hostile	0.12	***													0.03		0.04	0.02		0.04	0.59
	I have been singled out because of my gender	0.15	***													0.05		0.05	0.02		0.05	0.40
	How many current school associates share your race/ethnicity	0.11	***													0.04	*	0.02	0.02		0.02	1.47
	International and domestic students work well together here	0.38	***													0.20	***	0.03	0.07	*	0.03	2.49
	Satisfaction: Representation of women	0.46	***													0.31	***	0.03	0.12	***	0.03	4.48
	Felt intimidated by your professors	0.08	**													-0.04		0.03	-0.08	***	0.02	-3.21
	I see myself as part of the campus community	0.35	***													0.14	***	0.03	-0.01		0.03	-0.18

Table 6

Results of Regression Predicting Success at Managing Academic Environment for URM non-STEM Majors. n=1,162

			Model 1		Model 2		Model 3		Model 4		Model 5		Model 6		
Variable	r		B	S.E.	B	S.E.	B	S.E.	B	S.E.	B	S.E.	B	S.E.	t
Graduate School Experiences															
Year started current or most recent graduate program	-0.02												0.00	0.02	0.12
Frequency: Discussed course content with students outside of class	0.47	***											0.16 ***	0.02	7.05
Provision of Faculty guidance	0.55	***											0.17 ***	0.03	5.47
Frequency: Written for publication	0.27	***											0.03	0.02	1.34
Frequency: Conducted experiments or collected data	0.39	***											0.09 ***	0.02	4.41
Satisfaction: Relevance of coursework to career plans	0.54	***											0.22 ***	0.03	8.01
			Adj. R =.000		Adj. R^2 = .009		Adj. R^2 = .031		Adj. R^2 = .077		Adj. R^2 = .325		Adj. R^2 = .474		

Notes. ***p<.001, **p<.01, *p<.05.

Success at managing the academic environment is a composite measure of nine variables that assess students' success at understanding what professors expect of them academically, managing their time effectively, developing research skills, mastering course content, collaborating with peers, pursuing personal intellectual interests related to their discipline, writing academic papers, developing contacts in their field of study, and presenting academic material.

Table 7

Results of Regression Predicting Success at Managing Academic Environment for White, Asian, & "Other" students in STEM Majors. n=1,364

			Model 1			Model 2			Model 3			Model 4			Model 5			Model 6			
	Variable	r		B		S.E.	B		S.E.	B		S.E.	B		S.E.	B		S.E.	B		S.E.	t
	Intercept			-0.17	*	0.08	-0.59	**	0.21	-1.61	***	0.26	-1.23	***	0.27	-2.22	***	0.29	-1.96	***	0.28	-6.89
Student Background Characteristics																						
	Gender: female	0.05		0.08		0.05	0.07		0.05	0.04		0.05	0.09		0.05	0.09		0.05	0.18	***	0.05	3.81
Characteristics of Undergraduate Institution																						
	Percent admitted - total (Rescaled by 10)	0.07	*				0.03	*	0.01	0.03	*	0.01	0.03	*	0.01	0.02		0.01	0.01		0.01	1.25
	Control: Private	0.05					0.15	*	0.08	0.13		0.07	0.12		0.07	0.10		0.07	0.09		0.06	1.49
	Full-time equivalent enrollment: Fall 2006 (Rescaled by 1000)	-0.03					0.00		0.01	0.00		0.01	0.00		0.01	0.00		0.01	0.00		0.00	0.02
	Instruction/research and public service FTE staff (Rescaled by 100)	-0.03					0.00		0.01	0.00		0.01	0.00		0.01	0.00		0.01	0.00		0.00	-0.11
	Doctoral/research university (ref. masters colleges)	0.00					0.12		0.08	0.14		0.08	0.13		0.08	0.14		0.08	0.05		0.06	0.72
	Baccalaureate colleges (ref. masters colleges)	0.01					-0.03		0.08	-0.08		0.08	-0.07		0.08	-0.05		0.08	-0.06		0.07	-0.87
	Percent of total enrollment that are URM	-0.01					0.00		0.00	0.00		0.00	0.00		0.00	0.00		0.00	0.00		0.00	0.42
	Research expenses per FTE (Rescaled by 10,000)	-0.05					-0.06		0.04	-0.04		0.04	-0.04		0.04	-0.05		0.03	-0.02		0.03	-0.72
Undergraduate Experiences																						
	Work with a faculty member on his or her research	0.04								0.02		0.06	0.01		0.06	0.01		0.05	-0.07		0.05	-1.60
	Receive mentoring from a faculty member	0.08	**							0.09		0.06	0.08		0.06	0.02		0.06	-0.06		0.05	-1.17
	Participate in a structured undergraduate research program (e.g., MARC, MBRS)	0.05								0.05		0.06	0.04		0.06	0.06		0.06	0.03		0.05	0.63
	Participate in an academic club or professional association	0.07	*							0.06		0.05	0.05		0.05	0.02		0.05	-0.01		0.04	-0.19
	How well did your undergraduate experience prepare you to: Write effectively	0.23	***							0.19	***	0.03	0.13	***	0.03	0.10	***	0.03	0.10	***	0.02	4.28

Table 7

Results of Regression Predicting Success at Managing Academic Environment for White, Asian, & "Other" students in STEM Majors. n=1,364

			Model 1		Model 2		Model 3		Model 4			Model 5			Model 6			
	Variable	r	B	S.E.	B	S.E.	B	S.E.	B		S.E.	B		S.E.	B		S.E.	t
Admission Attributes, Environmental Pull Factors, Identity/Self-Concept																		
	Degree Pursuing: PhD	-0.03							-0.07		0.06	-0.07		0.06	-0.16	***	0.05	-3.22
	Felt that your family responsibilities interfered with your studies	0.00							0.01		0.03	0.00		0.03	0.01		0.02	0.24
	Felt that your job interfered with your studies	-0.03							-0.02		0.02	0.00		0.02	0.02		0.02	0.89
	Academic Self-Concept	0.22	***						0.21	***	0.03	0.18	***	0.03	0.14	***	0.03	5.73
	Altruistic/Social Justice Oriented STEM Identity	0.19	***						0.15	***	0.03	0.08	**	0.03	0.09	***	0.03	3.40
Climate of Graduate Institution																		
	Perception of racial climate as hostile	-0.02										0.05		0.04	0.04		0.04	0.95
	I have been singled out because of my gender	-0.06	*									-0.08		0.05	-0.07		0.04	-1.70
	How many current school associates share your race/ethnicity	0.04										0.01		0.02	0.00		0.01	0.35
	International and domestic students work well together here	0.20	***									0.09	**	0.03	-0.01		0.03	-0.26
	Satisfaction: Representation of women	0.28	***									0.14	***	0.02	0.03		0.02	1.34
	Felt intimidated by your professors	-0.08	**									-0.03		0.02	-0.07	***	0.02	-3.49
	I see myself as part of the campus community	0.31	***									0.22	***	0.03	0.03		0.03	1.17

Table 7

Results of Regression Predicting Success at Managing Academic Environment for White, Asian, & "Other" students in STEM Majors. n=1,364

			Model 1		Model 2		Model 3		Model 4		Model 5		Model 6		
	Variable	r	B	S.E.	B	S.E.	B	S.E.	B	S.E.	B	S.E.	B	S.E.	t
Graduate School Experiences															
	Year started current or most recent graduate program	-0.08 **											-0.01	0.02	-0.49
	Frequency: Discussed course content with students outside of class	0.32 ***											0.11 ***	0.02	5.40
	Provision of Faculty guidance	0.53 ***											0.26 ***	0.03	8.18
	Frequency: Written for publication	0.30 ***											0.11 ***	0.02	5.93
	Frequency: Conducted experiments or collected data	0.28 ***											0.07 ***	0.02	4.17
	Satisfaction: Relevance of coursework to career plans	0.39 ***											0.16 ***	0.02	6.36
			Adj. R = .001		Adj. R^2 = .007		Adj. R^2 = .057		Adj. R^2 = .120		Adj. R^2 = .224		Adj. R^2 = .439		

Notes. ***p<.001, **p<.01, *p<.05.

Success at managing the academic environment is a composite measure of nine variables that assess students' success at understanding what professors expect of them academically, managing their time effectively, developing research skills, mastering course content, collaborating with peers, pursuing personal intellectual interests related to their discipline, writing academic papers, developing contacts in their field of study, and presenting academic material.

Table 8

Comparing significant coefficients from the URM STEM model to the coefficients from the URM non-STEM model and the White/Asian/"Other" STEM Model

	URM STEM n=320			URM NON-STEM n=1,162					White/Asian/"Other" STEM n=1,364				
Variable	**B**		**S.E.**	**B**		**S.E.**	**Z-Score**	**Meaning**	**B**		**S.E.**	**Z-Score**	**Meaning**
Characteristics of Undergraduate Institution													
Full-time equivalent enrollment: Fall 2006 (Rescaled by 1000)	0.02	*	0.01	0.01		0.01	//	Only affects URM STEM	0.00		0.00	//	Only affects URM STEM
Receive mentoring from a faculty member	0.16	*	0.08	0.01		0.05	//	Only affects URM STEM	-0.06		0.05	//	Only affects URM STEM
Admission Attributes, Environmental Pull Factors, Identity/Self-Concept													
Academic Self-Concept	0.10	*	0.04	0.12	***	0.03	n.s.	Similar effect	0.14	***	0.03	n.s.	Similar effect
Climate of Graduate Institution													
Felt intimidated by your professors	-0.07	*	0.03	-0.08	***	0.02	n.s.	Similar effect	-0.07	***	0.02	n.s.	Similar effect
I see myself as part of the campus community	0.11	*	0.05	-0.01		0.03	//	Only affects URM STEM	0.03		0.03	//	Only affects URM STEM
Graduate School Experiences													
Year started current or most recent graduate program	-0.08	*	0.03	0.00		0.02	//	Only affects URM STEM	-0.01		0.02	//	Only affects URM STEM
Provision of Faculty guidance	0.18	***	0.05	0.17	***	0.03	n.s.	Similar effect	0.26	***	0.03	n.s.	Similar effect
Frequency: Written for publication	0.12	***	0.03	0.03		0.02	//	Only affects URM STEM	0.11	***	0.02	n.s.	Similar effect
Frequency: Conducted experiments or collected data	0.09	**	0.03	0.09	***	0.02	n.s.	Similar effect	0.07	***	0.02	n.s.	Similar effect
Satisfaction: Relevance of coursework to career plans	0.38	***	0.05	0.22	***	0.03	-3.06	More pronounced effect for URM STEM	0.16	***	0.02	-4.32	More pronounced effect for URM STEM

Notes. ***p<.001, **p<.01, *p<.05. Z scores that fall outside the range of -1.96 and +1.96, indicate a p-value of less than 0.05, and demonstrate that the beta coefficients between URM STEM students and the respective comparison group are statistically different. See article by Paternoster and colleagues (1998) for equation to test for the equality of regression coefficient. A Z test was only performed if beta coefficients for a given variable were significant for both groups; otherwise you see a "//" symbol.