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"IT WAS A WHOLE NEW ENVIRONMENT": TRANSFORMATIVE ORGANIZATIONAL CULTURE AND THE DEVELOPMENT OF SCIENCE IDENTITY FOR UNDERREPRESENTED STUDENTS IN SCIENCE, TECHNOLOGY, ENGINEERING AND MATH (STEM)

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DISSERTATION

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ABSTRACT

Traditional models of student success in higher education focus on access and retention of students, and fall short in their ability to explain the nuanced dynamics of identity formation that occurs for underrepresented STEM students. Drawing on Multicontextual Theory, I examine how academic environments offer non-traditional ways of developing an integrated "science identity" in underrepresented STEM students and offer benefits to these students in terms of attraction to STEM, socialization and persistence. The intersectional, mixed-method data for this dissertation include in-depth interviews, focus groups, and student survey responses from various STEM contexts across multiple institutions in the Southwest. I discuss how traditional academic cultural environments are experienced differently than alternative cultural (program) environments and the implications for integrated identity development. I argue that sociological theories of education such as Tinto and Weidman's of access and retention need to be revised to include the role of cultural

context. Specifically, Multicontext Theory, which encompasses the role of cultural context, pedagogy and student identity, elucidates the importance of providing Multicontextual environments for advancing inclusive excellence in higher education.

Key Words: Identity Development; STEM Education; Science Identity; Race, Class, Gender; Intersectionality; Diversity; Affirmative Action

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CHAPTER 1: INTRODUCTION: MAPPING INEQUITY IN STEM EDUCATION

Points of Origin

The foundation for this project began as I started my first year of college at the University of Nebraska-Lincoln. My first week of college, I moved into student housing where my building, one of many on campus, had a larger population than the farming village in which I was raised. As a low-income, first-generation white, female student, to say that this transition was "culture shock" feels like an understatement. Feeling isolated and alone, I buried myself in academics. I did not know that there were more educational options beyond the bachelor degree (a college degree as a first-generation college student itself was a big achievement.) At that time, I did not realize that my experience was not unique, and that there were many students, like me, that felt alone, out of place, and like they "did not belong" in higher education. It was not until I joined the Ronald E. McNair Post-Baccalaureate Achievement program that I finally found a community of individuals who were like me and I finally felt like there was a place where I belonged.

Since then, understanding and addressing issues of equity in higher education has always been something close to my heart. I vowed to use my degree in sociology to better understand why the institution of higher education leads so many to feel isolated to the point of departure. While I was able to find a supportive community in McNair, not all students have that opportunity. I wondered, "Why is there a need for these programs in the first place?" At this time, Nebraska had just voted as a state to make all Affirmative Action initiatives illegal. I had learned that my participation in McNair was the result of "Affirmative Action" initiatives and became concerned about their ability to thrive in "post-Affirmative Action" environments. I wondered, "where would I be had it not been for

McNair? It became my deep desire to understand higher education to the extent that I knew why programs designed to increase the representation of minority students are needed, what purposes they serve that are missing from the traditional academic environment, and to critically think about how to engrain these practices into a traditional academic environment should a "post-Affirmative Action" political environment become the norm.

In this work, I argue for a more nuanced understanding of success for underrepresented students in science, technology, engineering and math (STEM), which includes racial and ethnic minority students and women. I present evidence that traditional models of student recruitment, socialization and persistence are outdated and in need of serious revision. Research shows that underrepresented students in STEM fields are completing undergraduate degrees, graduate degrees, entering academia and the workforce at much lower rates than their white male counterparts despite equal education aspirations upon entering college and the higher rate of female enrollees (Science and Engineering Indicators 2010).

A variety of nationally funded programs from the National Institutes of Health (NIH), the National Science Foundation (NSF) and the Department of Education (DOE) exist to increase the representation of underrepresented students in STEM fields, with great success. However, even the most successful of these programs lack deep understanding of what it is that they are doing that works. This is because typical program evaluations only include process and summative components used to secure subsequent funding from their national funding agencies such as the NSF, NIH, or the DOE. Thus, they offer relatively superficial ideas about how programs work and why some are successful while others are not (see Clewell, Cohen, Tsui and Deterding 2006; Moorehead and Barrios, Nd.).

The lack of focus on how these programs work in modern higher education may be due to the overemphasis of access and retention models used in the sociology of education, the relatively limited field of the sociology of higher education, and in typical program evaluations in higher education. Often, programs are examined using Vincent Tinto's model of student departure (Tinto 1993) or Weidman's model of socialization (Weidman 1989) as theoretical frameworks. Tinto's model is based on the assimilationist idea that students will stay in post-secondary schools and succeed if they are integrated into the social and intellectual fabric of the institution. Weidman's model of socialization is useful in that it takes into account students experiences in higher education and includes the importance of academic disciplines and departments while calling attention to issues of engagement and investment by students. However, it still emphasizes promoting integration by changing the student to fit the social and intellectual fabric of the institution.

Thus, in both models, if a student learns how to "fit in" in the academic environment, they will succeed. While the burden of this task is put on both students and the institution, these models ultimately focus on identifying how students need to change in order to be successful in higher education, removing critical analysis of the institutions in which students engage. Both models were developed in the early 1990s when access and retention were the major components of diversity models in higher education. Also called "Pipeline Models," access and retention models are ultimately assimilationist models of student retention that seek to identify specific barriers that underrepresented STEM students face and subsequently help students assimilate into a dominant academic cultural context in order to promote persistence and achievement.

Research Questions

Current models of student retention and socialization in higher education offer superficial analyses of culture and do not account for those who succeed without assimilating to a dominant cultural context (Carter, 2006; Ibarra, 2001; Rhoten and Pfirman 2007). Furthermore, the focus on student impact in these models fails to address the impact on other key players, such as faculty mentors and the environments in which faculty student interaction takes place. Thus, these current models ultimately fall short of a meaningful analysis of the impact that programs have on students, faculty and broader institutional culture. In a recent meeting with two directors of such programs,[1] they noted that not only do they see transformation with their students, but the faculty mentors seem to be impacting their departmental cultures from within. It is not clear if this type of institutional change is part of their specific program goals.

Regardless, they want to understand how and why this is occurring, yet their access and retention models do not provide the tools to understand the qualitative mechanisms. This dissertation examines these three key players – student participants, faculty mentors and institutional environments. My primary focus is on identity formation of underrepresented students in STEM. I focus on how students develop an academic and science identity in various cultural spaces in higher education, paying close attention to the cultural environment in which this identity is created and negotiated. I also focus on how student faculty interactions impact not only student participants, but the faculty members who play a key role in this process. In looking at student identity development and the important role that

[1] PMPS Program P.I.s, Personal Conversation, January 25th, 2013, Southwest University, Location Redacted

faculty interaction plays in this development, I also engage with the cultural environment in which this interaction takes place. I address the following questions:

> Primary Research Question:
> How do underrepresented undergraduate students in STEM pipeline programs describe their experiences? How do students compare their experiences in pipeline programs with those in traditional science programs?
>
> Subsequent questions for analysis:
> a. How do underrepresented STEM students describe their experiences with their faculty mentors?
> b. How do faculty mentors describe their experiences working with underrepresented STEM students in alternative cultural environments?
> c. What are the mechanisms that contribute to the development of "science identity" for underrepresented STEM students?
> d. How do underrepresented STEM students describe their experiences with professionalization, socialization and professionalization?
> e. What considerations must be made in order to integrate sustainable cultural change into a broader institutional environment of STEM higher education?

Importance of Questions

Access and retention models have received ample attention in education literature (Bergin, Cooks, and Bergin 2007; Chen 2012; Herzog 2005). However, they represent only one piece of a larger picture of diverse and inclusive campus environments that contribute to success for underrepresented STEM students. While understanding access and retention has helped get these students through the doors of higher education, not enough emphasis has been placed on what happens once the students are on campus, especially as it relates to various disciplinary environments. Milem (2003) points out that there are three mutually enhancive components of diversity that should be considered for a fully working diversity model on campus. These include structural diversity (numerical representation), multicultural diversity (cultural awareness) and interactive diversity (exchange of diverse ideas). Ibarra (2005) adds "context diversity" to this framework, which focuses on reframing

the cultural context of higher education policies, procedures and processes (essentially, cultural changes) to be more inclusive of diverse students.

Access and retention models only fully address the structural component of this 4-part model, and in a limited way, the multicultural component, and thus fall short of a fully operational model of diversity and inclusive campus environments that contribute to success. For example, celebrations of ethnic holidays and culture take place on campuses, but are usually performed in such a way that makes them "exotic" and separated from the day to day culture of the university, leading to a commodification of diversity and difference (Carter 2006; hooks 1999) rather than an integration of difference into a broader academic cultural context. This commodification of difference can contribute to underrepresented STEM students feeling like outsiders, like they do not really belong on campus and in disciplinary environments, leading to complicated academic identity development within the institution and early departure. Rather than focusing on how students can be changed to fit a broader institutional or disciplinary culture, it is necessary to understand how institutional or disciplinary contexts can be reframed in order to promote inclusion of all students, regardless of background.

Despite the numerous documented benefits of diversity (see Antonio et al. 2004; Chang et al. 2003; Hurtado et al. 1999) the focus on access and retention in higher education has consistently been challenged in academic, political and public spaces. It is time to refocus attention in higher education on processes beyond student access and retention models. By doing so, we can refine the definition of diversity in higher education and better understand how to properly evolve Affirmative Action and diversity initiatives beyond programs for underrepresented STEM students that are disjointed from broader institutional

contexts and structural remedies. This involves understanding what happens in disciplinary and institutional contexts that either promotes or inhibits feelings of belonging and inclusion.

This is especially pertinent as the impact of Affirmative Action and "race" based admissions to programs – products of structural diversity models - will likely become diminished in the coming political climates. With the Supreme Court's recent ambiguity about the legality of Affirmative Action in college admissions (see Fisher vs. University of Texas, 631 F.3d 213 (5th Cir.2011), its recent decision to rehear these arguments, and its continued emphasis on the need for colleges and universities to examine "race" neutral alternatives, it is time for understanding new and sustainable diversity models and Affirmative Action initiatives has come. Understanding how programs aimed at increasing persistence of underrepresented students in STEM impact students, faculty and academic departments is a logical first step.

CHAPTER 2: LITERATURE REVIEW: IDENTITY, SOCIALIZATION AND CULTURE IN POST-MODERN HIGHER EDUCATION

Self Identity and Modernity: Constructing Identity within Higher Education

It is important to understand the cultural environment of higher education institutions with which students interact. This necessitates understanding major cultural assumptions of higher education and how they have impacted the university over the past century. The institution of higher education has long been regarded as a highly modern institution. Higher education encompasses traditional, modern ideals such as the reliance on science and the scientific process for acquiring knowledge, the belief that knowledge and discourse from the scientific process is inherently different than knowledge and discourse that originates outside the academy, and the belief that middle class values and "high culture" rather than popular culture are good for individuals and society. Furthermore, higher education as a modern institution values democracy, freedom, and the idea that with the pursuit of education an individual can succeed and either reach or maintain a middle class status. Certain behaviors are assumed to come from modern institutions. These include the assumption that because higher education is an institution that values democracy and equality that relies on an objective, scientific method, that it acts as a purely meritocratic system.

The expansion of higher education in post-war period brought changes to the demographics of the university. The G.I. bill granted entre to a more diverse population of men with lower-income backgrounds and who were considered non-white and non-traditional who previously did not have the opportunity to enter such elite institutions. The 1965 Civil Rights Movement further shifted the demographics of the university with an

increase of the inclusion of women, non-G.I. racial and ethnic minority students, low-income individuals and those with disabilities.

This rapid growth in the diversity of background of those in the academy contributed to post-modern challenges of often taken-for-granted modern assumptions of higher education. The belief that higher education worked as a pure meritocracy and grants all individuals the opportunity to succeed has been challenged, especially as it relates to individuals from non-traditional backgrounds. Furthermore, the assumption that embracing the traditional middle class values of the university is good for all contributes to a uniquely challenging environment for those coming from backgrounds that are not already considered middle-class. From this post-modernist perspective, the institution can be seen as an oppressive structure that values and privileges those who "fit in" the cultural fabrics of the existing institution while disadvantaging and marginalizing those from non-traditional backgrounds in a false-meritocratic system.

As a result of the post-modern challenges to the institution, many programs and policies were created in order to remedy the issue of unequal access to higher education and discrepancies between traditional and non-traditional students in degree completion. Affirmative Action initiatives, instituted by Lyndon B. Johnson first in 1965, made their way into higher education and have been rearticulated, challenged, and evolved over the following decades. The rearticulation of such programs in the early 1990s focused on creating programs that emphasized increasing the access non-traditional students had to higher education institutions post-high school and retention of these students once on college campuses. Academic research supported these efforts and the federal government instated TRIO programs at public colleges and universities to support such efforts. TRIO programs

were created as a part of the student affairs and more administrative side of the institution and therefore were never incorporated into the traditional academic and disciplinary environments. They therefore served as spaces of more "alternative" cultural environments rather than the traditional. While 25 years have passed since this re-articulation of Affirmative Action initiatives in higher education, the focus remains on access and retention models from the 1990s, with increased scrutiny from the public and federal government.

The most recent example of this can be seen in the latest attempts to dismantle Affirmative Action initiatives at the University of Texas with the recent Fisher vs. UT and the Supreme Courts unprecedented announcement in Summer 2015 that it would re-hear arguments against Affirmative Action in higher education less than two years after its 2013 decision to uphold Affirmative Action policies. This back-and-forth may be a result of the unresolved tensions between modernist and post-modernist beliefs about how the institution of higher education works. On one hand, if higher education works as a true meritocracy, there is no need for admissions offices to consider personal background characteristics such as the lived experiences of race, ethnicity, class and gender in their decisions. However, there is ample evidence of a false-meritocracy in the educational system that privileges those who have greater resources while disadvantaging those who come from certain, non-traditional social and economic backgrounds. It is within this complicated cultural system that students are reflexively developing and negotiating their academic identities.

Challenging traditional socialization models

Classic student retention and socialization models, including Tinto's (1993) model of student departure and Weidman's (1989) theory of socialization, often employ concepts like social capital, (Coleman 1988, 1990) cultural capital (Bourdieu 1973) and cultural

reproduction (Bourdieu 1973). Here, cultural reproduction is discussed in terms of 'habitus.' Every individual has a 'habitus,' which primarily consists of imprinted cultural values, beliefs, behaviors and knowledge of how the social world is arranged, amongst other things. This habitus is primarily influenced by the family and is imprinted upon an individual at a young age. It is largely developed by primary relationships with family and social institutions close to the individual, operating beneath the level of the conscience.

Institutions like higher education also have a 'habitus.' It often includes what are referred to as the traditionally white, middle class values of modern society that are reflected in the institution itself. Those students' whose habitus matches the habitus of the school system, it is argued, will be more successful within that system than those whose habitus matches that of a marginalized class. So the process of cultural reproduction for Bourdieu legitimates the superior cultural capital of an already privileged class while disadvantaging those who are already disadvantaged.

However, Bourdieu's notion of cultural capital and reproduction has been interpreted as culturally deterministic and can be used as a cultural deficit model. By operating beneath the level of one's conscience, one has no ability to change their existing position. The cultural reproduction process can also influence individuals from underrepresented backgrounds by subtly suggesting that their cultural capital that comes from their cultural setting is not what is valued within highly legitimated social institutions, like higher education, negatively impacting lived experience within the system of education.

However, thinking about social and cultural reproduction in such a deterministic way is problematic and may contribute to the overemphasis on access and retention in higher education. Literature in the study of race and ethnicity provides insight that should be used

by sociologists studying these concepts in education. For example, Carter (2005) notes that as individuals confront a system dominated by white middle class values and beliefs, they may have a more difficult time finding where they fit and how they might succeed. During this process, students can be seen as taking one of three divergent paths. The first two paths are represented in much literature in the sociology of education. First, students may learn to adopt the dominant values of the institution and thus succeed by following the 'rules of the game' (Carter 2005). In this study, this would be to abandon important parts of one's self-identity that are not valued in higher education in order to fit into the current cultural environment. However, this can be a process where students begin rejecting their cultural and racial identity in favor of the dominant cultural context in order to be successful. This reflects traditional cultural reproduction models in the sociology of education and would be the impact of assimilationist nature of access and retention models.

Second, students may completely reject the dominant values in an overt effort to reject the dominant culture. If the behaviors and attitudes that are developed during this process are not valued in the dominant cultural context, the student may not succeed. Furthermore, if in rejecting the dominant cultural environment the student decides to leave, this could contribute to student departure. What is not given enough attention in the sociology of education is the third path where there is the development of "cultural straddlers" (Carter 2005). Here, students have successfully learned to play by "the rules of the game" while still maintaining a strong sense of racial and ethnic identity. However, this is an extremely difficult process to learn without "losing yourself" in the process (Carter 2005; Ibarra 2001).

This can be especially difficult in systems with high levels of legitimacy in society, such as higher education and the sciences. Disciplinary boundaries can be so rigid that any form of change may be seen as threatening the legitimacy of the structure as a whole. There is a need for what are called "multicultural brokers" who are experienced in straddling two cultural worlds and helping students maintain a strong sense of who they are while navigating a system that says parts of that identity are not important (Carter 2005). It is worth examining if this dynamic exists within components of higher education and if it contributes at all to integration of underrepresented STEM students.

Multicontextuality- A transformative multi-level structural framework of attraction and persistence

An alternative framework for examining the success of underrepresented students in STEM fields exists. Multicontextuality is a framework for understanding student success in higher education developed by Roberto Ibarra (2001) in his work with Latinos in graduate education across the United States. It utilizes theories on learning, cognition, cross-cultural communication, and structures higher education to present an alternative to traditional models of student success that focus on the failure of underrepresented students to become socialized into the culture of STEM. A Multicontextual framework focuses on imbalanced educational systems and how to transform institutions systemically, reaching beyond the individual Affirmative Action tenants of access and retention. Student departure becomes a consequence of cultural conflict within an imbalanced system of higher education. By shifting the focus away from individual student failure to structural imbalance, we can begin to understand how organizational dynamics can influence systemic, structural change to improve the experiences and success of underrepresented students into STEM environments.

Thus, traditional models of access and retention are bypassed for a framework that emphasizes attraction of students to Multicontextual environments where they will persist and thrive.

To understand a Multicontextual framework, it is important to understand what Edward T. Hall (1959, 1966, 1977) discusses as the context surrounding interaction, which is of primary importance. Context is the "information that surrounds a [cultural process] and is inextricably bound up with the meaning of that event. Individuals get sorted into populations based on how they perceive and communicate with one another. The relationship is between the information surrounding a particular cultural process. Those from high-context cultures make meaning and learn using "multiple streams of information which surround an event, situation, or interaction." Those from low-context cultures "filter out conditions surrounding an event and focus on words and objective facts" (Hall and Hall 1990:158). Within a Multicontextual framework, context can be described as either "high," "low" or a combination of the two (Multicontextual). (See Appendix A for examples of "low" and "high" context characteristics.) "High-Context Cultures" (HC), identified in this country as predominantly ethnic minorities and females, tend to focus on streams of information that surround an event, situation or interaction in order to determine meaning from the context in which it occurs. "Low-Context Cultures" (LC), predominantly northern European ethnic groups and majority males, tend to filter out conditions surrounding an event or interaction to focus as much as possible on words and objective facts." (Ibarra 1999)

Institutions like higher education and STEM disciplines also operate with a preferred contextual style. Born from the German research model and characterized by linear processes where abstract thinking, competition, impersonal relationships and individual learning are prioritized, higher education, specifically STEM fields, are noted as operating primarily within a low-context framework that validate low-context individuals. Student departure or failure to become socialized is explained as a result of cultural conflict where high-context individuals confront a stubborn, unchanging low-context environment and as a result, leave, feeling like they don't belong (Espinosa 2011). These individuals are more likely to be engaged in fields that espouse more high-context or Multicontextual characteristics, which allow them to connect to each other and also connect what they are doing to the communities they come from or to humans. This can explain why in STEM, data show more women and minorities opt for degrees in biology and medicine, where humans and living organisms are the unit of analysis, as opposed to technology and physics, which are more abstract and disconnected from human life. Ibarra (2005) notes that students with a preference for high-context environments can learn to be successful by developing a sense of "bicognition" (Ramirez 1999) or Multicontextual practices and behaviors.

While neither low-context nor high-context culture is superior or inferior to the other, the cultural imbalance in STEM fields that favor low-context learning modes and styles works to exclude the large number of individuals who prefer different, high-context environments (p 17). In order to serve a more diverse student body, academic departments and institutions must reframe their contexts and cultures

by fostering Multicontextual cultural environments. This will create a more balanced institutional environment where individuals with a diversity of learning styles can all be successful.

Climate, Culture and the "Science Identity"

Learning how to successfully navigate higher education settings is ultimately an exercise in the development and renegotiation of one's identity. Scholars interested in the success, or persistence, of underrepresented students in STEM often note the importance of the development of what is known as the "Science Identity," (Brickhouse 2001; Espinosa 2011; Foor, Walden, and Trytten 2007; Johnson 2007; Malone and Barabino 2009) a piece of the developing "Academic Identity" (Ibarra 2003). The "Academic Identity" refers to the identity students develop in general as they navigate higher education while the "Science Identity" is used to refer to students in STEM fields, specifically. Both the academic identity and the science identity refer to how an individual starts to visualize themselves in the setting they are in. This involves a constant and reflexive creation and negotiation of self-identity.

The development of the academic identity is important for success in higher education. Here, the student begins to "see themselves" as part of the cultural and academic fabric of the setting in which they are navigating (Austin 2002). Failure to develop a fully integrated identity can lead to higher rates of students leaving higher education (Austin 2002). Students go through a 4-stage process of identity negotiation where they figure out if they really belong in their institution and field. First, the student entering the field must ask themselves "Am I academically able to do this work?" We know this is the case for underrepresented students. Underrepresented students take as many classes and perform as

well as men (Clewell and Campbell 2002), even though they are a little more biased in their self-assessments (Correll 2001).

Second, the student asks two questions regarding their future in the field. "Do I want to be a graduate student?" and "Do I want to do this as a career?" (Austin 2002) They assess the amount of time and energy they will have to devote to their studies and the potential pay-off from earning an advanced degree and some decide to persist while others leave. This is the first big hurdle for many students (Clewell and Campbell 2002). For example, research shows that this pay-off sometimes is not seen as worth the amount of investment needed by the student (Jacobs 1996). Some research suggests that in STEM fields and academia, there is something about the profession that underrepresented students find unappealing (Ibarra 2001), with the atmosphere of the environment that makes it seem "chilly" for women (Ibarra 2001) or maybe it is still the issue of unequal returns (Jacobs 1996).

Finally, the student must ask the most important question. "Do I belong here?" This is where the development of a solid academic or science identity is necessary in order to answer that final "yes". If an individual doesn't feel like they are integrated within an academic unit, their likelihood of wanting to stay there will diminish or the student will not develop an integrated identity. This question is constantly asked throughout an individual's journey through higher education, and contributes to the initial development and renegotiation of identity throughout the student's experience. A feeling of belonging has been shown to be more important than the intellectual caliber of students (Lovitts 2001). It is not academic "incompetence" that pushes a majority of graduate students out of the door of academia; it is issues of "chilly" departmental climates and organizational culture (Ibarra 2001; Lovitts 2001). This leads to an exodus of potential sources of "new knowledge" and

creative ways of assessing the academic world around us (Schuerich and Young 1997) and of reaching a growing diverse student body (Hurtado et al. 1999; Milem 2003).

Developing a "science identity" has been shown to be a more complicated process for underrepresented STEM students. Feminist thought challenges a number of processes in the development of the science identity as it relates to women, and also minorities (Brickhouse 2001). For example, learning in STEM needs to be about more than just memorizing rote knowledge and the fundamental elements of whatever field in which the student participates (Brickhouse 2001). It is beyond just learning everything one needs to "know" in order to be "a scientist." Learning in these fields also involves learning about oneself and how they "fit in" to this broader community of scholars and knowledge. It must involve how one "sees themselves" in the field and how they engage with that field, whether it is the pedagogy or the actual practice. So, the development of the science identity is both developing the proper knowledge base to be a "legitimate" scientist, and also developing the mental awareness of how one fits into the cultural fabric of the field and engages in that environment.

This is problematic for a number of students in STEM fields, including women and minorities. For example, the organizational culture of STEM fields has been shown to impact the development of the science identity for underrepresented STEM students (Johnson 2007). First, STEM fields do not understand the issue or importance of racial and gender "diversity" as much as many other spaces on campus. Their "low-context" environment detracts from this community aspect of teaching and learning (Ibarra 2001). This is the result of many things, including the emphasis on the modern assumption of a completely objective and value free system of knowledge creation and dissemination. Feminist and post-modern scholars also note the impossibility of any knowledge claim being

completely value free (Brickhouse 2001; Scheurich and Young 1997). Specific knowledge is created in specific spaces and what is considered "real" and "legitimate" knowledge claims are always determined by actors in that space (Swidler and Arditi 1994). However, this goes against the very values that underlie the foundation of "science" – that it is completely value free and objective.

The process of identity development is a highly reflexive process that involves what the individual is already conscious of about themselves, their biography, and how they are learning to integrate new environments, negotiate and renegotiate their self in this new scientific, academic environment (DuBois 1903; Giddens 1991). This double consciousness, or "the sense of looking at one's self through the eyes of others" (DuBois 1903:351) is especially pertinent for underrepresented students in STEM environments. This identity is routinely created and sustained by the activities of the individual in the new setting and how those activities are either legitimated by powerful gatekeepers, or not.

The narrative that is created over time by the student becomes the academic and science identity that the student will carry with them as they navigate this new world. If the student's developing identity is disjointed from their behaviors (either what is expected of them from external actors or by themselves) this can lead to disjointed academic identities or a "false-self." The development of a disjointed identity, or "false-self," ultimately results in a feeling of "not belonging" that has been shown to lead to increased levels of student departure. In the development of identity, authenticity and "being true to oneself" above all is most important (Giddens 1991). Being able to integrate personal biography with new values from the academic world will be of primary importance to the non-traditional student.

The rigid belief structure in STEM fields has been attributed to the development of "5 Cultural Myths of Science" that disproportionately impact the identity and persistence of underrepresented students in STEM fields (Foor et al. 2007; Johnson 2007). In many STEM disciplines that espouse highly modern ideals, these "myths" are considered truth**.** They infiltrate the organizational culture of these fields and they also affect disciplinary climate and make up the environment where students are negotiating their identities. These cultural myths, which are raced, classed and gendered, contribute to decisions and actions of individuals within the dominant culture and include:

1. Science is above or beyond gender, race, class, and other sociocultural distinction;
2. Science is a meritocracy;
3. No changes in curriculum or pedagogy are necessary to accommodate different ways of learning or knowing;
4. Challenge and competition are essential to science and weed out classes are necessary to winnow the wheat from the chaff; and
5. Failure is the individual's own fault." (Johnson, 2007:112).

These five myths are important to understand how the development of the science identity for women and minorities can sometimes take a disrupted path. Since identity is reflexive, one's science identity cannot exclude other parts of the individual's experience. It makes it more difficult for women and minority students to develop a science identity in a field that requires them to deny important parts of their lives – such as real racial and gendered experiences, especially in higher education (Hurtado et al. 1999; Milem 2003).

Scholars who study how to move beyond just "structural diversity" on campus in order to increase real feelings of inclusion often note that diversity and inclusiveness must be understood from the level of students who are impacted (Hurtado et al. 1999; Milem 2003; Milem, Clayton-Pedersen and Allen 1999). Therefore, STEM *cannot* suggest that racial and gendered experiences are not legitimate and expect that their student body will not be

impacted in very different ways. There are also real instances of racial and gendered discrimination or just differences in how these students interact in their environment based on their racial and gender identity. How does one fully engage in a science community that pretends that these parts of one's life are not important?

Furthermore, research shows that sometimes underrepresented students respond differently to different types of teaching. For example, cooperation is valued over individual learning (Espinosa 2011; Ibarra 2001; Johnson 2007; Malone and Barabino 2009). The myth that there must be competition in science fields may contribute to some students feeling disengaged in the environment all together. Furthermore, the focus on the "individual" learning aspect of STEM fields and the impersonal relationships between students and with faculty contribute to feelings that women and minorities "Don't belong in this whole engineering thing" (Foor et al. 2007).

The disconnect between science identity and the student contributes to the development of 3 different types of scientists – the academic scientist, who aspires to this value free quest for knowledge for the sake of scientific knowledge; the altruistic scientist, who aspires to gain knowledge for the sake of giving back to the community (often seen in medical and biology students); and the disrupted scientists, who cannot merge their own identity within the field and their career is marred by constant struggle to maintain their identity while becoming a 'scientist' (Johnson 2007).

Identity construction in complex, post-modern organizations

Developing an integrated identity within a complex, post/modern organizational context is complicated. It is important that the student learn to integrate important components of their "self," often developed in their homes with their families, with the

values of the organization within which the student will develop their academic identity. This new identity is reflexively constructed and constantly negotiated, where the institution influences the development while at the same time remains open to being transformed by the individual. Developing a close relationship with what has been termed a "multicultural broker" can be the difference between developing an integrated science identity, or not (Carter 2005). The relationship that develops between the multicultural broker and the student learning to "fit" within the institutional context becomes complex and very important for the successful development of the integrated identity.

There are a number of conditions that are important to consider when fostering this relationship in the construction and negotiation of identity in post/modern institutions like higher education. Since identity is fluid and constructed over a life-course under the influence of multiple institutions (family, religion, education, etc.), it is necessary that the student is able to reflect on these past experiences and integrate them into the academic identity under construction. Having a multicultural broker who is familiar with the importance of individual background as well as an understanding of the values of the institution is necessary. A good multicultural broker can be the difference between successfully developing an integrated identity or not.

Giddens (1991) notes the importance of a "pure relationship" between parties for this type of self-identity construction. A "pure relationship" is sought not only for what the union can bring to the student developing their identity, but also to the broker who is helping the student learn how this modern institution works. There are a number of factors that are important for a relationship to be considered "pure," taking the place of primary relationships in a pre-modern world. The relationship must be organized in a reciprocal way that trust,

commitment, openness and continuity are promoted. This will allow the student developing their identity to connect to their reflexive self while minimizing risk.

There also must be a high level of commitment between both parties. While the student will have much to gain from working with their broker, there must be a genuine commitment on the part of the broker to help the student learn to thrive in this modern institution. Likewise, the broker must feel that the student is committed to developing the integrated identity and that the work is not all on the broker. This commitment on behalf of both parties is necessary for the reciprocity, noted above, to exist.

Beyond reciprocity and commitment on behalf of both parties, there must also be a degree of intimacy and trust within the relationship. This intimacy provides close links between the reflexive project of the self and the pure relationship while mutual trust promotes authenticity in the relationship and open, honest communication. With this intimacy and trust between the student and the broker, an integrated self-identity can be negotiated through the creation of "shared history" and the student undergoes a more complex socialization into a complicated institution that is unaccounted for by Bourdieu's, Tinto's and Weidman's theories of student development of cultural capital and socialization.

Identity, diversity, and institutional transformation

The future of Affirmative Action policies and the expansion of more authentic diversity initiatives are intertwined with the ability to understand how to develop integrated identities for all students in higher education. Integrated identities not only benefit students, who will be more academically successful, but also for the institution in terms of student success and happiness and degree completion. This can propel the development of diverse

student bodies at all levels in the academic pipeline even in post-Affirmative Action political environments.

For example, not only are students encouraged to develop integrated identities, but many of the legal barriers for Affirmative Action can be addressed. As set forth by the Supreme Court, diversity initiatives must prove to be for the benefit of all students. Therefore, while they can be "race-conscious" they must not be "race-based." Supporting efforts to understand and promote the development of an integrated science and academic identity, while conscious of the importance of background, is not a "race based" practice and can be understood " …by contextualizing race conscious admissions policies as part of a larger constitutional framework to alleviate racial isolation and foster diversity to the benefit of all Americans." (Epperson 2011:361). Emphasizing the importance of inclusiveness in supporting a strong democracy upholds constitutional principles (Epperson 2011).

Furthermore, diversity within higher education is a benefit in itself. For example, having a diverse student body has been shown to contribute to cross racial understanding, the disintegration of racial stereotypes, and a better understanding of persons of different races. All of these work together to help our generation better navigate a growing racially diverse nation and world. Furthermore, a diverse environment can foster the intellectual creativity that science needs for innovative discovery (Kozol 2005). By encouraging the development of integrated identities for underrepresented STEM students, we can support the growth of a "critical mass" of students, where all students are meaningfully represented and encouraged to participate in the classroom and not feel isolated (Epperson 2011; Valenzuela 1999). Focusing on policies that foster inclusion and diversity may be seen more favorably than current policies of access and retention that focus on distributing resources based on

individualized racial classifications (Epperson 2011). Documenting the benefits of alternative, diverse spaces on campus for developing an integrated identity for underrepresented students, and speculating about the effects of the removal of these programs, can play an important role in the future of diversity initiatives in higher education. The following section will outline broad theoretical and conceptual framing that underlies this work.

Theoretical and Conceptual Framing: Adding Cultural Context and Intersectionality to Traditional Models of Student Success in Higher Education

Cultural context: Higher education models of student persistence

This research utilizes a college impact framework, taking into account characteristics of individuals (race, class and gender), institutions (size, selectivity and mission) and environment (academic and cultural environment, especially as it varies within the institution) (Pascarella and Terenzini 2005). My primary interest is in how college impact acts as a means of socialization (Weidman 1989), where socialization refers to "the process by which persons acquire the knowledge, skills, and dispositions that make them more or less effective members of their society" (Brim 1966:3). I focus on two different theories on student persistence and academic socialization. First, I examine the traditional models of access and retention discussed earlier (Tinto 1993; Weidman 1989) as well as a model of Multicontextuality (Ibarra 2001) testing both for presence, utility and efficacy.

Understanding the institutional cultural environment, disciplinary cultural environment and program environments will be important. Research in higher education has emphasized institutional environment as well as disciplinary environments (Smart, Feldman, and Ethington 2000) and their impact on student success (Berger and Milem 2000;

Hermanowicz 2005; Tinto 1993; Weidman 1989; Weidman, Twale and Stein 2001; Zhao, Kuh, and Carini 2005) and while some scholars recognize the impact of outside organizations (Weidman et al. 2001), the impact of special programs is in need of a more nuanced analysis.

While Tinto's model of departure stresses the importance of socialization, Ibarra's model of Multicontextuality stresses the problem of institutional cultural imbalance and the need for rebalancing. Multicontextual environments would allow for the development of "cultural straddlers" (Carter 2005). I explore the alternative cultural environments produced by programs aimed at increasing the representation of underrepresented STEM students and examine how they are operating as socialization agents in the assimilationist sense (Tinto 1993; Weidman 1989) or if they are cultural environments that are separate, safe spaces (Carter 2009) alternative to traditional institutional and disciplinary structures. This involves studying not only the physical spaces and experiences of students and faculty within these programs, but also an examination of the physical spaces and experiences of students in their disciplinary contexts as well as comparing these experiences to the experiences that students have outside of the programs. Examination of how students see themselves developing what is known as a "science identity" and what that means will be an important piece of this process (see Figure 1).

Looking at Figure 1, multiple spaces for comparisons on these key concepts can be seen. The most obvious is the separation between academic disciplines and special programs within higher education. Academic disciplines are places that may be seen as spaces of "traditional academic culture" (Ibarra 2001; Tierney and Bensimon 1996) whereas special programs may be seen as spaces of "alternative culture". Here, alternative just means "different" from the traditional. The assumption is that the information about what it means

to be a member of these two separate spaces in higher education differs as well as the specific program components that transfer this information to their members.

Furthermore, these two spaces influence the members (including faculty and students) and the development of their identity as full members in each separate space (Kaufman and Feldman 2004). However, while the primary objective of academic disciplines is to socialize individuals into becoming full members of the discipline, the primary objective of the special programs is to facilitate this development where the academic discipline falls short. The assumption is that the underrepresentation of women and racial and ethnic minority students in STEM may be the result of these individuals not being fully integrated within the academic discipline (Espinosa 2011; Johnson 2007; Lee 1996; Lovitts 2001). Therefore, spaces of alternative cultural environments (special programs) may exist to assist in the development of the individual as a scholar in their discipline.

Intersectionality: Race, Class and Gender as Categories of Analysis

The second conceptual tool I utilize is an Intersectional framework to addressing diversity and development of science identities for underrepresented STEM students in higher education. Academic research on the intersection of race and gender in STEM exists, it is still a developing field with only 116 studies being conducted between 1970 and 2009 (Clewell and Campbell 2002; Ong et al. 2011). While the body of work claiming intersectional approaches has grown in recent years (Collins 2015; Collins and Chepp 2013), it has been critiqued for producing a large amount of "superficial intersectionality."

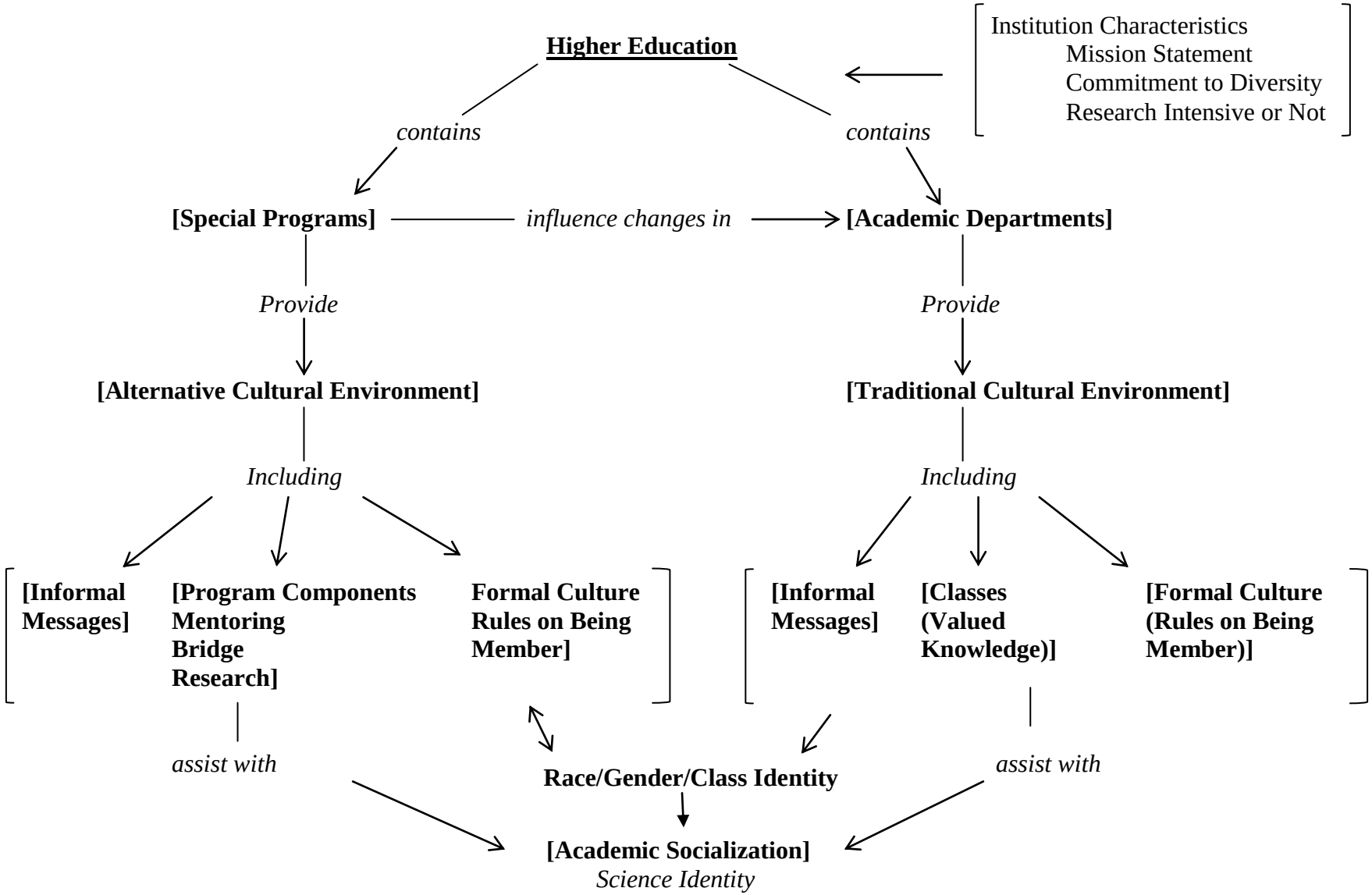


Figure 1: Relevant Concepts and Processes

Cho, Crenshaw and McCall (2013:795) argue that "what makes an analysis intersectional is not its use of the term 'intersectionality,' nor its being situated in a familiar genealogy, nor its drawing on lists of standard citations. Rather, what makes an analysis intersectional...is its adoption of an intersectional way of thinking about the problem of sameness and difference and its relation to power".

An intersectional framework suggests that there are multiple, overlapping systems of oppression that shape lived experience in complex ways (Collins 2000, Crenshaw 1991). A primary concept within this framework is the Matrix of Domination (Collins 2000). Intersectional frameworks require that you recognize race, class and gender as interlocking aspects of one's identity that are multiplicative and simultaneous. This means that you can never separate these things from an individual's experience. Race, gender and class co-constitute and reinforce each other in an individual's experience and they are felt simultaneously. Scholars dealing with diversity don't often recognize the problematic nature of essentialist understandings of "race" or "ethnicity" or "class," let alone the complexity introduced when you realize that there is no one "black" experience" or "low-class" understanding of the world or magic bullet program to increase inclusiveness of underrepresented minorities. This leaves current diversity models with limited abilities in understanding what a diverse institution must consider when theorizing about inclusive environments. For example, trying to understand diversity and inclusion on campus, one must go beyond just looking at "black students," and "Hispanic students" and consider how experiences also differ by gender and class. How a black female student from a middle class background interacts on a college campus will likely be different than how a black female student from a working class background experiences campus. Furthermore, experiences of

Hispanic middle class males will be different than Hispanic middle class females. By pivoting our center and learning to recognize the ways that an environment is experienced differently by multiple groups of people in a more nuanced way, by focusing on how race is lived through gender and how gender is lived through race, we will have a more complete understanding of how to influence inclusive climates and promote a more complete understanding of where our institutions still fall short in their efforts to develop integrated science identities for underrepresented students.

Within the matrix of domination, one must recognize that an individual exists within a much broader system of oppression than the individual level. You must also account for meso (interactional) levels and macro (institutional) levels for a complete understanding. By incorporating the micro, the meso, and the macro in sociological studies, you allow for an understanding of oppression in relation to its partner, privilege. The result is a complex understanding of how power and privilege work alongside oppression to structure individual level experiences. Using intersectional frameworks requires that educational researchers see beyond "barriers to persistence" and instead focus on how institutions are structured in such a way that they impact students from different positions in the matrix differently. This exposes the faulty logic that once a student "gets through the doors" of higher education they will experience the institution in similar ways, leading to similar opportunities to advance.

As I examine racial and gendered experiences in science fields, it is important to remember how science, rationality and objectivity have been masculinized in the institution. One cannot fully understand how to promote more inclusive environments without understanding the dynamics of exclusiveness. It has led me to question what is the process of identity development of successful underrepresented STEM students in fields that mark

them as “less qualified” to achieve. To answer this question, I need to understand the macro-process of how science devalorizes “feminine”, how this infiltrates educational institutions and programs, as well as how that impacts individuals within the institution, and how they use their own agency to challenge the institution (Peterson 2009). An intersectional framework provides the tools for this.

Furthermore, recognizing how controlling images about how intersectional experiences lived through racial and gendered identities help me understand divergent paths and experience in higher education. For example, neoliberal ideology suggests that underrepresented students on campus are there because of Affirmative Action based initiatives. Because of the backlash of the Civil Rights Movement and charges of reverse racism, there is a too common belief that these individuals somehow unfairly received their place on campus solely as a result of affirmative action and that they have some sort of educational deficiency. By recognizing these controlling images, where they are coming from, and how they influence the students who they target, their peers, and the faculty and administrators they come into contact with, we can better understand those places where ideological walls are being built and start the process of deconstruction.

Schuerich and Young (1997) note that marginalized individuals are key to understanding these “anomalous” situations in an institution. Therefore, I focus on centering experiences of women of color and men of color and the knowledge that comes from their marginalized experiences in higher education. Doing so allows me to understand those places where the traditional academic environment falls short. It also involves making sure that underrepresented STEM students are persisting in the institution without “forgetting who they are” so that meaningful change can occur. It also involves examining the relational

aspect of power and oppression. It is important to start to understand who is really being privileged and who is losing in the power relations in institutions of higher education. Furthermore, it is important to recognize the change makers and learn from them how to successfully challenge the institution in meaningful ways.

Within the matrix of domination, it is important to not just reduce an individual's experience to one piece of their identity (race OR gender). Instead, it is necessary to focus on unique social locations to understand where individuals fall within a broader identity matrix of domination (race AND gender) (Hill-Collins 1999). For example, an intersectional paradigm suggests that there are multiple, overlapping systems of oppression that shape lived experience in complex ways (Collins 2000, Crenshaw 1991). Here, it will be important to understand how racial identity and gender identity interact and result in different experiences within and outside of these programs.

Furthermore, identity here cannot be seen as just operating at an individual level. It is also necessary to locate the individual within a broader institutional framework, including a meso (interactional) and macro (institutional) level. One's racial and gender identity will influence how they experience traditional spaces in higher education, how they experience non-traditional spaces in higher education and their academic socialization, which is a product of both spaces. Therefore, it is important to keep race and gender as key variables in this examination. I will primarily address the intersection of race/ethnicity and gender, paying some attention to class. These are the primary social categories that have been previously found to be important when understanding underrepresentation in STEM fields. They are also relevant because the programs that are being evaluated as a part of this study focus on increasing the representation of racial/ethnic minorities and women in STEM fields.

I also utilize a multidimensional, multi-level understanding of racial groups, class and gender (Goméz and López 2013). This approach crosses some boundaries between what is called "intercategorical" and "intracategorical" approaches to intersectional studies (McCall 2005). For example, I primarily engage with an intercategorical approach to intersectionality by utilizing pre-constructed analytical categories of "race," gender, and class to "document changing relationships of inequality among social groups and changing configurations of inequality along multiple and conflicting dimensions" (McCall 2005:1773). However, by engaging multi-level measures of "race," gender and class, I remain critical of the boundaries of the pre-constructed analytical categories which allows me to examine the experiences of individuals who are overlooked by these boundaries within a larger social context, which suggests an intracategorical approach to the study (McCall 2005).

I want to be clear that my focus on "race" does not indicate some biological or essentialist notion of some "real", innate physical racial category. Instead, "race" is a social construction. "Race" as a social construct signifies that "race" really is not real in any biological way. It is something that is constructed in the minds of individuals and made real in its consequences. In the United States, we have constructed meaning systems around what we call racial groups and society is historically structured along racial lines in such a way that whatever "race" you are identified as by others and by yourself in our racial system has real consequences in terms of educational opportunities. So although many social scientists denounce any real biological differences between races, a socially constructed system of racial hierarchy has real consequences for those living within such a system. Some believe that since we know that "race" is a social construct, that it is just a myth that disappears as soon as we stop talking about it (Bonilla-Silva 2003). This ignores the historical embedding

of race at both macro and micro levels in society. I refer to "race" as racial identity or racial category to emphasize the socially constructed nature of "race." This concept is socially constructed at individual, interactional and structural levels of society and within higher education. Conceptually, "race" here refers to how one self-identifies their own racial classification as well as how they experience "race" in their everyday lives in STEM environments.

Measuring race includes my perception of the racial makeup of the respondent, the respondent's self-identified racial group, as well as their lived experience within the context of higher education. For perceived racial and self-identified racial grouping, I use the census classifications with the assumption that race is a social category as opposed to a biological or genetic category (Morning 2007). The census uses a minimum of five racial categories, including White, Black or African American, American Indian or Alaska Native, Asian, and Native Hawaiian or Other Pacific Islander as well as an option to choose more than one race. Hispanic is listed as an ethnic identification.

Individual, popular understanding of "race" and ethnicity varies. While it is common in academia to separate Hispanic as an ethnic category, many individuals identify it as their racial classification. So as to not force individuals into "boxes" that they would not choose for themselves, I treat Hispanic as a racial classification, allowing respondents to identify themselves as "Hispanic" for their "race." Gender is measured as biologically male, biologically female or other, as specified by the respondent. This takes into account the researcher's perception of the respondent's gender, the respondent's self-identified gender, and the lived experience of the respondent.

Socioeconomic status is important for a number of reasons. First, these programs also target first generation students, including white students, as well as racial/ethnic minorities and women. Often, first generation college students come from working class families with lower socioeconomic resources. There may also be class variation between different institution types. I interview students from both community colleges and 4-year research intensive universities. Students who are first generation and from lower-socioeconomic families are often overrepresented in community colleges where more financially well-off students are more likely to attend 4-year institutions. Socio-economic status will be measured using parental level of education and whether or not the student is Pell-grant eligible.

CHAPTER 3: METHODOLOGY: AN INTERSECTION PROJECT WITH A MIXED METHODS APPROACH

Multi-method studies have a lot of potential to address intersectionality in higher education, especially when tackling issues of inclusive climates and diversity (Hancock 2007). Griffin and Museus (2011) argue that the unique complexity of understanding intersectional identities within broader institutional contexts requires being able to understand multiple forms of data. Qualitative methods can help illuminate how "culture or common understandings within a community…can shape relationships between variables and outcomes" (Johnson and Onwuegbuzie 2004) while quantitative data can support generalizable findings that support the theory building that occurs in qualitative analyses (Griffin and Museus 2011). In this study, qualitative analyses are used to address issues of academic cultural context and illuminate the identity construction that occurs as underrepresented STEM students navigate STEM fields in higher education. Quantitative findings are discussed to address theory building and generalizability.

Cases for Analysis

In this study, I examined two programs aimed at increasing the representation of underrepresented STEM students in STEM fields. The programs are discussed individually below, and include "Promoting Minority Participation in the Sciences" (PMPS) and "Minority Student Development in STEM" (MSDS). The exact names and locations of these programs and the identity of their directors and participants have been removed to protect confidentiality.

Promoting Minority Participation in the Sciences (PMPS)

PMPS is located at a large research intensive university in the Southwest – henceforth known as "Southwest University," and has continually proven its success in graduating underrepresented students in STEM fields since 1991 when it was founded. The program is funded by the National Science Foundation. As part of receiving federal funding, they participate in a 5-year evaluation cycle in order to maintain their funding status. The results of all of their past evaluations indicate that their program consistently produces the outputs that it desires, as can be seen from their most recent project impact statement (citation removed to protect confidentiality). These objectives include increasing the graduation rates of underrepresented students and their access to graduate programs as well as facilitating cultural change within university departments and broader institutional contexts. While the quantitative program evaluations have shown that they are successfully graduating their underrepresented students and moving them into graduate school, they do not understand the qualitative mechanisms why. In discussions with their program directors, they specifically mentioned wanting to understand what it is specifically about their program that proves so successful. Furthermore, they want to examine if qualitative, transformative cultural change has happened as a result of faculty working with the program.

PMPS currently operates across 5 states in the Southwest. It has branch programs at 30 institutions, including nationally renowned research intensive universities with flourishing graduate programs, 4-year primarily undergraduate public and private religious universities and community colleges across these 5 states. PMPS works by funding small, individual research proposals written by faculty with the intention of funding undergraduate students to work on their research projects. Therefore, there are no program P.I.s (Principle

Investigators) or "headquarters" at each campus. Funding is given on an individual basis using a faculty driven and evaluated proposal process. If a faculty's proposal is awarded funding, the faculty can then support an undergraduate student to work with them on their research. The faculty mentor then takes on all personal, professional and academic mentoring of the student. All faculty and undergraduates are required to submit end of semester project reports to the headquarters at Southwest University as a condition of being funded by the home campus. PMPS is run by a team of men – White, Hispanic and Black – from various backgrounds.

PMPS also works with graduate and undergraduate students at all levels as well as faculty in a faculty mentoring institute. Program directors clearly state that their program primarily focuses on underrepresented racial and ethnic minority students and not women. However, when pressed on this issue, they noted that their program may impact women, but that NSF has separate gender-specific STEM programs and that they do not make that their primary concern. Also important to note is that their admission criteria is quite flexible and often not as exclusive as other undergraduate research programs. For example, there are no GPA requirements for the students to be admitted, they do not have to be an advanced undergraduate, and students do not have to be a resident or citizen of the United States.

Admission criteria: Undergraduate student in an eligible STEM field (biological/life sciences, chemistry, computer and information science, engineering, geosciences, mathematics, physics and astronomy, agricultural science, technology and other eligible NSF fields); Underrepresented minority as established by NSF.

Minority Student Development in STEM (MSDS)

MSDS is located at a large research intensive university in the Southwest, henceforth known as "Midtown University." The overall goal of MSDS is to enhance the educational experience of minority undergraduate majors in the natural sciences in order to increase their odds of entering and succeeding in Ph.D. programs in biology, biomedical or medical fields. MSDS is concerned with increasing 'diversity' in STEM fields, especially biomedical research, beyond the undergraduate level. The program is funded by a National Institute of General Medical Science (NIGMS) grant from the National Institutes of Health (NIH). MSDS exists on many campuses across the nation but is independently run by P.I.s at each campus, making it a smaller program compared to PMPS. It also works with a smaller number of students in a more limited range of STEM fields (natural sciences – specifically biology).

This program works mostly with undergraduate students, but has done some work with graduate students in the past. On top of faculty mentoring for undergraduate research in STEM fields, MSDS requires that students engage in a number of professional activities, such as presenting at local and national research conferences and attending weekly small group seminar meetings with all PMPS students where the P.I engages in conversations aimed at developing the student personally, professionally and academically. The P.I. also engages in discussions of race, gender, and diversity in higher education. MSDS also emphasizes the necessity of its students to pursue advanced STEM degrees, spending time helping students prepare for the GRE, identify appropriate graduate programs, and apply to those graduate programs. Students are also encouraged to embrace the goal of increasing the future diversity of STEM fields. The admission criteria are more stringent that PMPS, with a

necessary GPA of 3.0 and a requirement of having at least two years of undergraduate study remaining. However, in discussions with the program director, it was clear that there was some flexibility in these requirements on a case by case basis. MSDS is run by a nationally recognized Hispanic, Native American female biologist at the institution.

Admission criteria: Be a full time student at the Midtown University's main campus; Target GPA of 3.0 and above, others considered on a case-by-case basis; Be two years away from graduation; Commitment to pursuing a Ph.D. in a biomedical research field; U.S. citizen or permanent resident; Have completed at least the first 2 years (60 credit hours) of the curriculum leading to a B.S. degree in the "hard sciences" (e.g. Biology, Biochemistry, Chemistry, Mathematics, Statistics, Computer Science, Chemical Engineering, etc.); Have a commitment to increasing the diversity within the scientific workforce.

There are a number of comparisons to be made within and between these two programs. First, while both programs have similar target populations, goals and objectives, they differ in terms of their leadership structures, program design and activities and their funding agencies. While PMPS has two P.I.s, and a third equally important leadership member, it is fair to say that it is led by a team of men. On the contrary, MSDS is led by one female biologist. The gender differences in leadership structure may impact male and female student participants. Furthermore, PMPS has mentioned that it is concerned with influencing cultural change beyond the individual level, which is not an explicit goal of MSDS. The directors believe they have seen changes in the faculty and academic programs of their students. However, while they have implemented specific programmatic features aimed at fostering broader cultural change, there has never been any empirical evidence to support this claim in prior evaluations (again, due to the lack of nuanced analyses in typical program

evaluations discussed above). Program support staff for MSDS have noted that this type of change is not something that it is concerned with and, if this change is occurring at their institution, they aren't yet seeing it. However, it is important to note that MSDS includes that participants embrace the goal of increasing diversity in STEM workforce.

The size of the programs also differs significantly, with PMPS being a large program located in multiple states and operating in a variety of institution types in locations that are considerably demographically diverse from each other. MSDS is a smaller program at one university. The cultural make up of these institutions vary significantly, as do their individual mission statements and approach to diversity in higher education. Finally, there are a number of comparisons to make within PMPS. While the program is headquartered at one large research intensive institution, Southwest University, there are 30 partner institutions that participate in the program across 5 states. These have been identified by PMPS staff as having high, average or low institutional participation. These include community colleges, primarily undergraduate serving public and private religious institutions as well as 4 year and research intensive universities with thriving graduate programs. This will allow for a comparison of how participation level and institution type impact student and faculty participants.

Sampling

Sampling is three-fold, happening at the institutional, individual, and event level. The three sampling phases are discussed below.

Part 1: Institutions

A total of five institutions are involved in the analysis for this project (see Table 1). For MSDS this includes one large research intensive university in the Southwest, Midtown

University. For PMPS, four of the thirty institutions were selected using purposive sampling techniques. With the assistance of PMPS program directors, I identified institutions that have both high and low levels of student and faculty participation. Initially, community colleges were included in the research design. However, due to bureaucratic and time constraints, I was not able to fully engage with the community colleges in time to include them in the dissertation. I am engaging with the community colleges over the next three years.

Descriptive information from each of these institutions is listed below in Table 1. It is within this sample of institutions that the second and third phases of sampling took place. Table 1 breaks down the individual institutions involved in the study and the number of student and faculty participants within each institution.

Table 1: *Institutions in the Analysis*

Institution	Carnegie Type	Students	Faculty	Administrators	Total
Southwest U	Public Research I	19	13		32
Midtown U	Public Research I	9	4		13
Down South U	Public Research I	10	6	2	18
Private U	Private Religious; Primarily Undergraduate, Limited Master's College	9	1	1	11
Selective U	Private Religious Research I	1	5	1	7
Total	5	48	29	4	81

Part 2: Individuals

Program directors, faculty mentors, student participants and relevant individuals from offices concerned with diversity and research on campus from each institution were interviewed in-depth about their participation in the programs, either individually or as part of small focus groups, and about their ideas on how the campus facilitates diversity initiatives. I used non-probability purposive sampling techniques to select these individuals.

I worked with the program staff from each program in order to obtain enrollment information from each institution included in my sample. This information included student enrollment and contact information as well as faculty mentor contact information. I made first contact by telephone or e-mail with the designated program director or contact person for each institution letting them know who I was and about the purpose of my research. I then told them when I would be visiting their campus and asked for their help in recruiting students. This included having the faculty mentor or contact send an e-mail to the students encouraging them to participate in an in-depth interview. I made individual contact with all students from the enrollment information via e-mail as well as in person at undergraduate research conferences inviting them to complete an in-depth interview. I sent two follow-up e-mails reminding students that I would be visiting their campus and encouraging them to set up an individual interview. Once on campus, I recruited additional participants by introducing myself after their oral presentations or at their poster presentations and scheduling interviews with them in person.

I completed in-depth interviews with a sample of 29 faculty mentors, 48 student participants, and 4 directors of diversity initiatives for a total number of 81 participants. Of the total participants, 71 participated in individual in-depth interviews, 10 participated in

small 2-3 person focus groups, and 7 participated in one larger focus group (4 of these individuals also completed in-depth interviews and have not been double counted in the total number of respondents). Of the individual interviews, 78 were conducted in person and 3 were completed over the phone. All but three of the interviews and focus groups were recorded and transcribed for analysis. Of the three that were not recorded and transcribed, in depth notes were taken during the interview and typed immediately following the interview for analysis.

The results of the qualitative data analysis were used to construct an online survey (Appendix B). The online survey was distributed on April 20, 2015 to all student participants from PMPS as part of an external evaluation of the program. Multiple follow-up e-mails were sent to student participants encouraging them to participate in the survey. A total of 212 students completed the survey.

Part 3: Events

For participant observation, I used opportunistic sampling techniques to select relevant programmatic events. I observed events including initial orientation seminars, two governing board meetings, and three end-of-summer research symposiums. I attended events based on my ability to attend the event and the relevance of the event to the overall project as it developed. My attendance at all events was approved by the program director and relevant directors from the institutions at which the events took place. Consent forms were signed by all individuals at these events. I also sent individual e-mails to students participating in the events letting them know who I was and that I would be attending the event with hopes of scheduling in-depth interviews with them on campus around the time of the event.

Individual Recruitment of Participants

Students and faculty were recruited to participate in this study in a variety of ways depending on the institution and relevant program activities. For PMPS, I obtained a data base of participating, funded faculty and students from the institution group that included contact information and sent them individual, personalized e-mails introducing myself and the purpose of my research to the students and faculty, inviting them to either e-mail or call me to set up time to speak with me about their participation in the program. I also identified relevant program activities taking place at the campus – such as summer research conferences – and planned my interview data collection trips around them. If there was not a large, end of summer event, I worked with faculty mentors at the institutions to identify a good time in the semester to visit that did not interfere with semester holidays, breaks, and faculty retreats. As an incentive, I offered to buy faculty and students a soda or a cup of coffee. While no faculty took me up on the offer (many provided me lunch and coffee, instead), a number of students did. I sent a follow up e-mail repeating the request for an interview a week later.

While faculty agreed to participate at a high rate, individual e-mails to students garnered a smaller return rate. Therefore, it was necessary to make personal contact with many of the students at summer research conferences and other program activities. Here, the initial two e-mails were sent and then I identified and located the students' posters at the research conference and introduced myself and asked if the student remembered seeing my e-mail. In all cases, the student mentioned that they did see my e-mail inviting them to participate and mentioned they "meant to respond" and were interested in doing an interview. I briefly re-introduced myself and the purpose of the study and asked if the student would be

available to complete an in-person interview while I was on campus. A majority of students agreed and I scheduled the interview on the spot. I still sent a follow-up e-mail one day before the scheduled interview to remind them of our appointment and that I would like to buy them a cup of coffee.

For students who could not commit to an in-person interview (reasons being, schedule conflicts, international students were leaving the country the next day, they got called in to work, etc.) I asked if they would be willing to complete a telephone interview at a later date. Every individual invited for a telephone interview agreed to this. In these cases, I confirmed their e-mail addresses and obtained their telephone number in order to set up a good time to complete the telephone interview later in the Fall 2014 semester. All in-depth interviews were conducted between July 2014 and March 2015. All telephone interviews were conducted in November and December 2014. For one institution, Southwest University, all of the interviews were set up and confirmed by PMPS staff members following the recruitment guidelines discussed above. This greatly increased my response rate.

In a small number of cases (e.g. the schools with lower than average numbers of participation), the faculty mentors' help in recruiting their students to participate in the study was necessary in order to get the students to participate. This was especially true in institutions where summer research conferences were not taking place. I enlisted the help of faculty mentors to encourage their students to participate in the interview at both Private U and Selective U, institutions receiving funding from PMPS.

For MSDS, I first attended a program orientation at the beginning of the summer for newly admitted students and introduced myself and the purpose of my study and let them

know that I would be contacting them and inviting them to participate in an individual, in-depth interview. At the end of the summer, I attended their summer research symposium where they presented the work they had been doing over the course of the summer undergraduate research program. I approached each of the students at their poster presentations or their individual presentations and re-introduced myself, reminding them that I would be contacting them for an interview. Two weeks later, I e-mailed them individually and invited them to complete an in-depth interview. All but one of the students agreed.

In depth interviews took place in a variety of locations which were dependent on the resources of the campus. Setting up interview locations at these universities was difficult at first because I was unfamiliar with the campuses. I scheduled initial interviews by looking at the services and businesses in the various student union buildings and inviting the students – many of them who I had not met in advance – to meet me at a coffee shop on campus. Once I got to each university, I reserved time to look around in order to get a feel for the campus and to scope out possible interview locations. I looked for quiet spaces where we would not be interrupted and that offered comfortable seating. Once a location was selected, I waited at the agreed upon coffee shop and then led the student to the area where I felt an authentic and relaxed conversation could be held. For Down South U and Private U, interviews took place in public, but quiet, university spaces such as student union buildings and libraries. For MSDS, all student interviews took place at the Midtown U campus in a small, private room in the basement of one of the libraries or an academic office.

All faculty interviews at all institutions took place in the faculty's office. There was only one exception to this, which took place at Southwest U. At Southwest U, all interviews took place in a large board room. A small, intimate space was developed around a round

table within this board room to foster authentic and relaxed conversation. Coffee, water and pastries were offered to these participants and provided by PMPS program staff.

Data Sources

I collected data through in-depth interviews (either in person or over the telephone) and through small-group focus groups and participant observations in order to examine the respondent's lived experiences within their respective programs. I also developed an electronic survey questionnaire using the qualitative data to reach a larger sample. Event participation started in March 2013. In-depth interviews were conducted from July 2014 through December 2014. Analysis took place from July 2014 with note taking and jottings about preliminary findings and initial coding scheme development and was completed by July 2015. In depth analysis procedures are discussed below in the section titled "Analysis".

Interviews

The interviews were semi-structured in-depth interviews. At the onset of interviews, I introduced myself, disclosed my role as an external program evaluator and also as a Ph.D. student working on my dissertation. I let participants know that my interest in their experiences in program activities was a result of my own participation in similar programs when I was an undergraduate. Two processes of informed consent then took place, one for the evaluation and a separate for the dissertation project. Then, for students, I assessed student's aspirations, expectations of the program, and suggestions for structuring the program to enrich their experience and enhance their learning. I also asked them about aspects of their lives that might intervene to affect their ability to meet project objectives, such as their family circumstances and demands; their economic situation (which could create pressures to direct time and attention away from their research project), and any other

issues that might affect their performance in the programs. I also asked them a specific set of questions about their experiences in the special program as compared to their academic departments, especially as it related to their identity as 'scientists'. I also asked a set of questions pertaining to the students' lived race and gender identities.

Separate interviews were conducted with the non-student participants. Non-students were asked about how they heard about the program, why they became involved, their specific mentoring activities, how their mentoring activities with the students compared to their activities in a "traditional academic environment (e.g. teaching classes and labs), what they looked for in a potential student and how they believed participation influenced the professional development of students. A copy of the interview protocols for both student and non-student participants can be found in Appendix C.

Interview length varied between a minimum of 31 minutes and a maximum of 1 hour and 40 minutes. At the onset of each interview, the participant was informed about the nature and purpose of the interview, and was assured that she or he can decline from answering any questions in the protocol that might create discomfort, and that the results of the interviews would be shared with program directors only in a general way, with no specifics that might lead them to be able to determine the identity of the person providing any particular piece of information. Only one student declined to answer a question which was about relieving stress. Participants were asked whether they would mind if the interview was taped for later transcription. Only 3 requested the interview not be recorded – one faculty and two administrators. All student participants agreed to be recorded. For recorded interviews, the assistance of a paid transcriber was used to create verbatim transcripts. The paid transcriber

completed 33 of the interviews and I transcribed the remaining 48 interviews. I utilized *Dragon Naturally Speaking* software in order to facilitate efficient transcription.

For the interviews that were not recorded, I took written notes of the interview and immediately typed a document that described the information collected during the interview. Interview transcripts were uploaded into *Atlas.ti*, a qualitative data analysis tool. I used this software to code for indicators of success (or not) of the program and issues related to identity. These initial results provided useful information for enabling me to construct a questionnaire for distribution to a larger sample of students during the second phase of the study.

Focus group interviews

Since I was only be able to make a set number of visits to each of the selected institutions, focus groups of student participants and in one case of faculty participants, were used to increase the number of participants. Focus groups took place at two institutions, one with a higher participation level where there were more students and faculty to interview within a limited timeframe, and the other where student schedules necessitated the use of a focus group. These focus groups were given the same set of questions as were given during individual student interviews. The only difference was that students answered in the presence of other students and the interactions became more of a facilitated conversation where students were encouraged to speak to whether their experiences were similar or different from others who were sharing. Recording, transcription and data analysis procedures for focus groups were the same for the in-depth interviewing.

At the beginning of each focus group, participants were reminded of all of the safeguards to their privacy and confidentiality that I have put in place. I also reminded them

of unique risks to privacy that occurs in group settings. This includes not having control over what other group members may discuss outside of the focus group setting. However, I stressed the importance of keeping all of the information shared in the group within the confines of the group. I reminded participants that all members have a freedom to share the information as well as the freedom to refrain from participating or sharing information. I also stressed the importance than nobody's unique experience was "right" or "wrong" or "good" or "bad" and that experiences could instead be looked at as "similar" or "different." I also made myself available to any student who may have not felt comfortable sharing information in a group setting. Four focus group participants also completed individual in-depth interviews. Since part of this project is a program evaluation, I was forthright about my role as an evaluator with the students and my ethical training regarding their privacy and confidentiality. All students were reminded that information would only be presented in a generic form to program directors.

Participant observation

Participant observation in this study differs from purely qualitative research studies. Many researchers in this area would have spent time engaging in STEM environments and labs across institutions to unearth aspects of pedagogy or interactions that occur in these spaces. However, due to limitations of my work (discussed below) I was not able to gain entry into these spaces due to time, monetary and methodological constraints. Therefore, my participant observations are used to illuminate a broader story line of the alternative cultural environments produced by special programs in higher education aimed at underrepresented students in STEM. Student and faculty interview data are used to illuminate the broader story line of the traditional academic cultural environments in which I was not able to access.

Examining the cultural spaces of traditional academic environments is a worthy endeavor for future work. However, the lived experiences of individuals within these two spaces in higher education can work as a temporary, initial "first step" look into these spaces.

Participant observations were done as unobtrusively as possible. I attended events in which I had been given prior approval to attend by the program director. A list of possible events and program activities can be found in Appendix D, but primarily included orientation meetings, undergraduate summer research conferences, graduate preparation institute workshops, faculty directed undergraduate research labs, and governing board meetings. I obtained informed consent at all events, with the exception of large research conferences, where only general information on the context of the event was recorded. Brief jottings were written by hand during the events and intensive summaries were written directly following the events utilizing both jottings and my memory of the events. These notes addressed activities and interactions that took place during the events and how these might be related to academic success and identity for the participants. If there were written materials like program pamphlets or other related material, I collected them for analysis on how they might be related to the program success or the production of an alternative cultural environment for participating students.

Limitations of the study: Challenges of using new theoretical frameworks and merging academic work with evaluation research designs

The theoretical foundation of my empirical work engages with two models of student success in higher education. As discussed earlier in this work, traditional models of student success have decades of research behind them and are the dominant paradigms when examining student success in higher education (see Tinto 1993 and Weidman 1989). The

alternative model of student success, Multicontext Theory, is new, having only emerged in the last 14 years (Ibarra 2001). While some research exists examining the merits of this new framework (see Chavez and Longerbeam 2016; Giddens 2008; Li, Cohen and Ibarra 2005) the empirical base of evidence is vastly smaller than that surrounding Tinto's (1993) and Weidman's (1989) foundational work.

However, while there are no 'best practices' empirically emerging from Multicontext theory, and while the tools to utilize when using Multicontext theory are not well understood, the empirical work that has recently been published utilizing Multicontext theory indicates that this new framework for understanding student success and institutional transformation is worth examining (see Chavez and Longerbeam 2016; Giddens 2008; Li, Cohen and Ibarra 2005). Researchers who are interested in understanding and accelerating the use of new theoretical models in higher education must be willing to engage with these limitations in order to facilitate the development of new, innovative data that has the potential to transform how we understand traditional issues in higher education. This is not too different than the type of innovation and transformation that occurs in the physical sciences as new technology is created in response to new, emergent theories on how to best understand and serve our changing society.

There are also challenges in utilizing evaluation research designs to do academic research. This project was possible to complete only due to my role as part of an external evaluation team to one of the programs in this study. The needs of the stakeholders to understand qualitative mechanisms of their program allowed me to facilitate the design of this study to adequately present it as academic, empirical research. However, the funding of the project only covered certain arenas and did not allow me access to other parts of the

environment being examined that would be involved in other studies, such as the traditional academic cultural environment across all of the institutions in the analysis. While this type of data is important when answering the questions I have posed, the limitations introduced due to the nature of my role as a program evaluator resulted in my inability to fully engage with these areas in a way that only future fieldwork can address.

Researchers who need to utilize evaluation research designs in order to fund academic work must be able to recognize how these limitations influence their empirical work and build a research design that can be adequate even when not conforming to purely academic standards. With increasing competition for limited funding of social science research, the field of Sociology must also adapt in order to recognize the merit of the knowledge produced from such studies and embrace a little recognized source of research funding in the social sciences.

Data Tables

Contextual information: Demographic data

This section details relevant demographic information for the institutions involved in this analysis. I follow this with demographic information of actual participants within the institutions. It is necessary to understand the demographics of institutions and the STEM disciplines, especially as it relates to racial and ethnic minority and gender representation. All data presented in this section was obtained from the Integrated Post-Secondary Education Data System (IPEDS) data base from the Department of Education, National Center of Education Statistics (NCES) and Institute of Education Sciences (IES) using their most recently available data (2014).

Table 2 presents descriptive information on the enrollment rates of the five institutions involved in the study. This table includes information on the total enrollment, the percent of students enrolled full-time, the percent of enrolled students who are male and female and the percentage of enrolled students from the census racial categories, including non-resident students, students of two or more races and the percentage of students whose race is unknown. The average enrollment for this institution group is 37,164 students with campus sizes ranging from 11,253 students at the smallest campus (Private U) to 72,254 students at the largest campus (Southwest U). The average full time enrollment rate is nearly 81% with the lowest full-time enrollment rate being 74% at Midtown U and the highest full-time enrollment rate as 87% at Private U. Nearly 45% of enrolled students identify as male and around 55% of enrolled students identify as female. Male enrollment rate ranges from a low of 34% at Private U and the highest male enrollment rate being 87% at Selective U. The average female enrollment rate is around 55%, nearly 10 percentage points higher than the male enrollment rate in this institution group. The institution with the lowest female enrollment rate is Selective U with 48% of total enrolled students identifying as female. Private U has the highest female enrollment rate for this institution group with 66% of their total student body identifying as female.

In terms of census race categories, the schools have on average 62% white enrollment and 38% of enrollment being non-white students. The institution with the highest white enrollment rates is Selective U, with 84% of the student body identifying as white. Midtown U has the lowest white enrollment rate, with only 42% of enrolled students identifying as white. On average, the non-white enrollment rate for this institution group is around 38% with Midtown U having the highest non-white enrollment rate of 58% making it the only

majority minority institution in this sample. Selective U has the lowest non-white enrollment rate, with only 16% of the total student body identifying as Non-White.

When breaking down non-white enrollment, the institutions have on average 2% of their student bodies identifying as American Indian and Alaskan Native (AIAN), 3.4% of total student bodies identifying as Black, Non-Hispanic (BNH), 4.2% identifying as Asian or Pacific Islanders (API), and nearly 18% identifying as Hispanic. The schools vary in terms of their representation of the different census racial minority group classifications. Selective U, the institution with the lowest non-white enrollment rate, has no representation of both AIAN and BNH students and only 2% of their student body identifying as API and 5% identifying as Hispanic. Southwest U, Down South U and Midtown U – all Hispanic Serving Institutions (HSIs) - have the highest non-white enrollment rates. When looking at these HSIs individually, Midtown U has nearly 37% of their total student body identifying as Hispanic, 6% identifying as AIAN with 3% enrollment rates for both API and BNH students. Down South U, the next highest enrollment of Non-White students, has a 19% Hispanic enrollment rate, 6% enrollment rate of API, 3% BNH and only 1% of students identifying as AIAN.

In 2010 the U.S. census started allowing individuals to identify as having 2 or more races. However, the IPEDS new classification system only allows non-Hispanics to identify as two or more races, while those who identify as Hispanic can also choose any race (see https://nces.ed.gov/ipeds/news_room/ana_Changes_to_10_25_2007_169.asp). In this institution group, only 2.5% of students identified as having 2 or more races with Down South U reporting 4% of their total enrollment of multi-race students and Private U reporting only 1% of multi-race students. Almost 4.5 percent of students across this institution group

identify as non-residents, with Down South U having the highest Non-Resident student enrollment (4%) and Private U having the lowest Non-Res enrollment rate of 1%. On average, 4% of students have an unknown race, with Private U having the highest percentage of students with an unknown race (11%) and Selective U having the lowest rate of students with an unknown race (1%).

Table 3 presents descriptive information on the graduation rates of the five institutions involved in the study. This table includes information on the total graduation rate, the percentage of men who graduate, the percentage of women who graduate, and the percentage of census racial categories that graduate. The average graduation rate for this institution group is 60.6% with the male graduation rate at around 59% and the female graduation rate slightly higher, at 62.4%. Midtown U has the lowest graduation rate, with only 45% of students graduating compared with Selective U's high graduation rate of 78%. The average graduation rate for males is 59.2%, slightly lower than the 62.4% graduation rate for females. Selective U has the highest male graduation rate (79%) and female graduation rate (77%). All of the institutions in the sample have higher female graduation rates than male graduation rates, with the *almost* exceptions of Selective U and Private U, with nearly equivalent male/female graduation rates.

In terms of census race classifications, the graduation rate for white students in this sample is nearly 62.2%, slightly higher than the average graduation rate. The non-white graduation rate for this group is 38%, significantly lower than the total graduation rate. The school with the highest white graduation rate is Selective U, with 78% of white students graduating. The highest non-white graduation rate is for Asian and Pacific Islanders (API) with nearly 70% of API students graduating, which is significantly higher than both the white

and total graduation rates for this institution group. The average graduation rate for Hispanic students is nearly 57%, with Black, Non-Hispanic (Black, NH) students having the third highest non-white graduation rate at 53%. The lowest graduation rate for non-white students is for American Indian and Alaskan Native (AIAN) students, with only 26% of AIAN students graduating. Only three of the institutions in this group report data using the new multi-race census group. For these three institutions, the average multi-race graduation rate is 72.3%. Non-Resident students have an average graduation rate of 72% and 61% of Race-Unknown students graduate.

Table 2: *Enrollment Rates 2011 IPEDS*

	Institution Name					
	Southwest U	**Selective U**	**Private U**	**Down South U**	**Midtown U**	**Average**
Total	72,254	34,101	11,253	39,236	28,977	37,164
Percent Full-time	84	87	82	77	74	80.8
Percent Male	49	52	34	48	44	45.4
Percent Female	51	48	66	52	56	54.6
Percent AIAN	2	0	1	1	6	2
Percent API	6	2	4	6	3	4.2
Percent Black NH	5	0	6	3	3	3.4
Percent Hispanic	17	5	11	19	37	17.8
Percent White NH	61	84	65	57	42	61.8
Percent NW	39	16	35	43	58	38.2
Percent RU	2	1	11	3	3	4
Percent NR	6	4	1	7	4	4.4
Percent 2 Races	2	3	1	4	2	2.4

Table 3: *IPEDS 2011 Graduation Rates*

	Institution Name					
	Southwest U	**Selective U**	**Private U**	**Down South U**	**Midtown U**	**Average**
Total Percent	57	78	62	61	45	60.6
Percent Men	55	79	62	58	42	59.2
Percent Women	60	77	63	65	47	62.4
Percent AIAN	25	33	25	26	22	26.2
Percent API	66	73	88	66	53	69.2
Percent Black NH	39	75	63	50	37	52.8
Percent Hispanic	50	75	58	58	42	56.6
Percent White NH	60	78	61	63	49	62.2
Percent 2 Races	-	70	-	80	67	72.3*
Percent RU	54	80	64	60	49	61.1
Percent NR	72	77	78	67	68	72.4

It is important to look at these institutions in terms of STEM completion rates across gender and census racial groups. Table 4 presents descriptive data on the percentage of bachelor's degrees awarded to men and women for this institution group. It also presents the percentages of STEM bachelor's degrees awarded to men and women. For this institution group, two major conclusions can be made. First, on average, the amount of bachelor's degrees that are awarded to men is 42%, compared to nearly 58% of bachelor's degrees going to women. This pattern is true across all institutions in this group, with women completing bachelor's degrees at higher rates than men. Private U has the highest percentage of bachelor's degrees awarded to women with nearly 67% of all those degrees earned by women. Selective U, the school with the lowest percentage of bachelor's degrees awarded to women, still has over half of all degrees going to women.

The second conclusion to be made is that although women receive the majority of bachelor's degrees within this institution group, they are receiving STEM bachelor's degrees at much lower rates. On average for institutions in this group, women receive only about 33% of total STEM bachelor's degrees. At all of the schools, women are receiving STEM bachelor's degrees at significantly lower rates than men and their own overall degree completion. To illustrate this point, remember that Private U had the highest percentage of bachelor's degrees awarded to women, with nearly 67% of all bachelor's degrees going toward women. However, when looking at the female STEM bachelor degree completion rate, only 28% of all STEM bachelor degrees are awarded to women. This pattern is true for all schools in this institution group. It is important to remember that these numbers tell a more complicated story about representation of women in STEM fields when breaking the STEM bachelor's degrees down by discipline.

Table 4: *Percent Bachelor's Degrees by Gender and STEM*

	Institution Name					
	Southwest U	**Selective U**	**Private U**	**Down South U**	**Midtown U**	**AVERAGE**
Percent Men Bach	45.2	49.1	33.1	45.2	39.2	42.4
Percent Women Bach	54.8	50.9	66.9	54.8	60.8	57.6
Percent Men STEM	66	76.3	71.8	60.1	59.2	66.7
Percent Women STEM	34	23.7	28.2	39.9	40.8	32.7

Table 5: *Percent Male Bachelor's Degrees by STEM Discipline*

	Institution Name					
	Southwest U	**Selective U**	**Private U**	**Down South U**	**Midtown U**	**AVERAGE**
Percent Men Bach	45.2	49.1	33.1	45.2	39.2	42.4
Percent Men STEM	66	76.3	71.8	60.1	59.2	66.7
Percent Men CompSci	93.4	94.4	81.4	88.5	93.9	90.3
Percent Men Eng	84.5	90.3	-*	81.8	79.4	84
Percent Men Bio	45	65.4	39.3	40.6	39.5	46
Percent Men Math	59.3	60.3	66.7	54	65.7	61.2
Percent Men PhySci	47.4	70.3	66.7	66.3	55.8	61.3

Table 5 represents the percentage of men earning bachelor's degrees for this institution group as well as the percentage of STEM degrees by discipline awarded to men. Looking at Table 4, on average while men receive only 42% of total bachelor degrees, they receive about 67% of all STEM degrees. This pattern is represented in all the STEM disciplines, besides Biological Sciences. For example, they receive 90% of all computer science bachelor's degrees and over 60% of bachelor's degrees in Math and the Physical Sciences. In Biological Sciences, men receive just under half of the total bachelor's degrees.

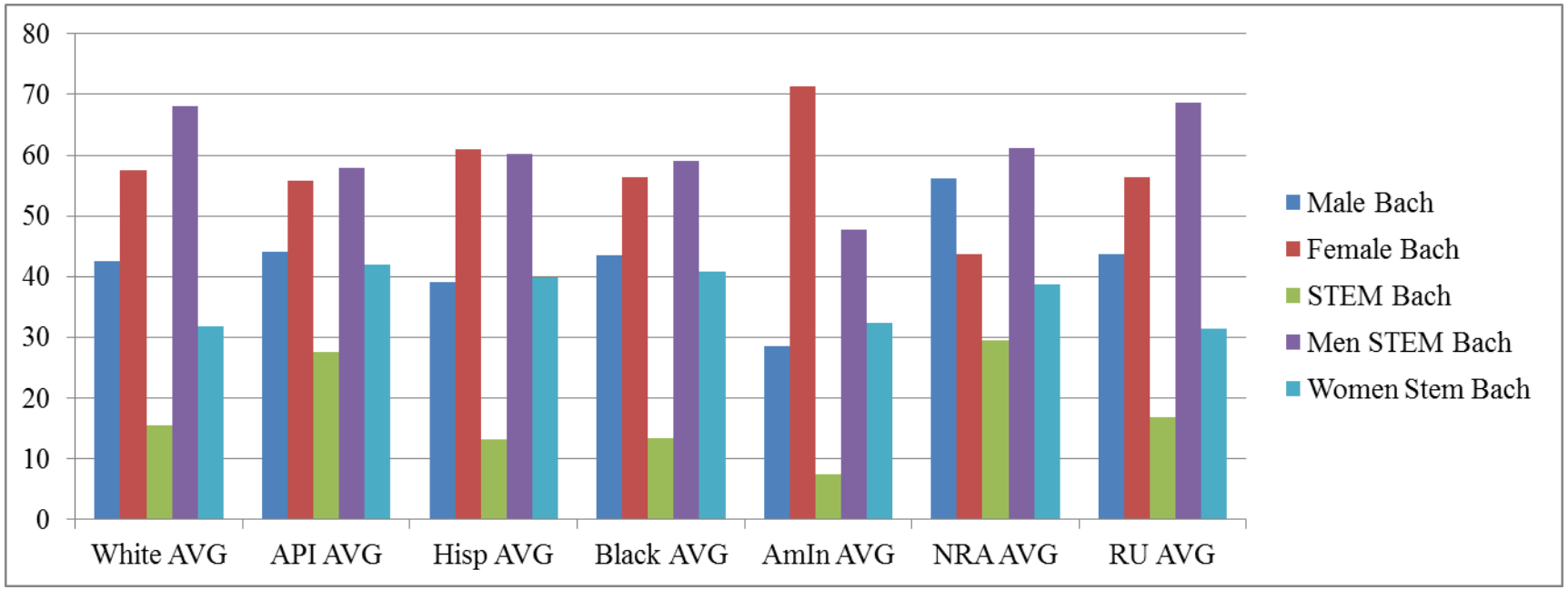
Table 6 represents the percentage of women earning bachelor's degrees for this institution group as well as the percentage of STEM degrees by discipline awarded to women. On average, while women receive nearly 58% of all bachelor's degrees across these institutions, they only receive about 33% of total STEM degrees. However, when breaking down STEM by discipline, the story becomes more complicated. Women earn a bit more than half of all bachelor's degrees in the Biological Sciences. They earn roughly 39% of bachelor's degrees in both Math and the Physical Sciences. The greatest disparities in degree earning for women are within the fields of Engineering and Computer Sciences, with women earning only 16% and about 10% of total degrees in these fields, respectively. This is much lower than their overall degree completion rate of 58%.

Table 7 presents descriptive information on the percentage of degrees going to race by gender cohorts for this sample of institutions. For whites, the table shows that 42.5% of all bachelor's degrees to white students go to white men. 57% of white bachelor's degrees are awarded to women. Of all White bachelor's degrees, 15% are in STEM fields. That is, 15% of all white bachelor's degrees are STEM degrees. This is a higher percentage than for Hispanic, Black and American Indian students.

Table 6: *Percent Female Bachelor's Degrees by STEM Discipline*

	Institution Name					
	Southwest U	**Selective U**	**Private U**	**Down South U**	**Midtown U**	**AVERAGE**
Percent Women Bach	54.8	50.9	66.9	54.8	60.8	57.6
Percent Women STEM	34	23.7	28.2	39.9	40.8	33.3
Percent Women CompSci	6.6	5.6	18.6	11.5	6.1	9.7
Percent Women Eng	15.5	9.7	-	18.2	20.6	16
Percent Women Bio	55	34.6	60.7	59.4	60.5	54
Percent Women Math	40.7	39.7	33.3	46	34.3	38.8
Percent Women PhySci	52.6	29.7	33.3	33.7	44.2	38.7

Table 7: *Percent Bachelor's degrees for Institution Group by Race and Gender*

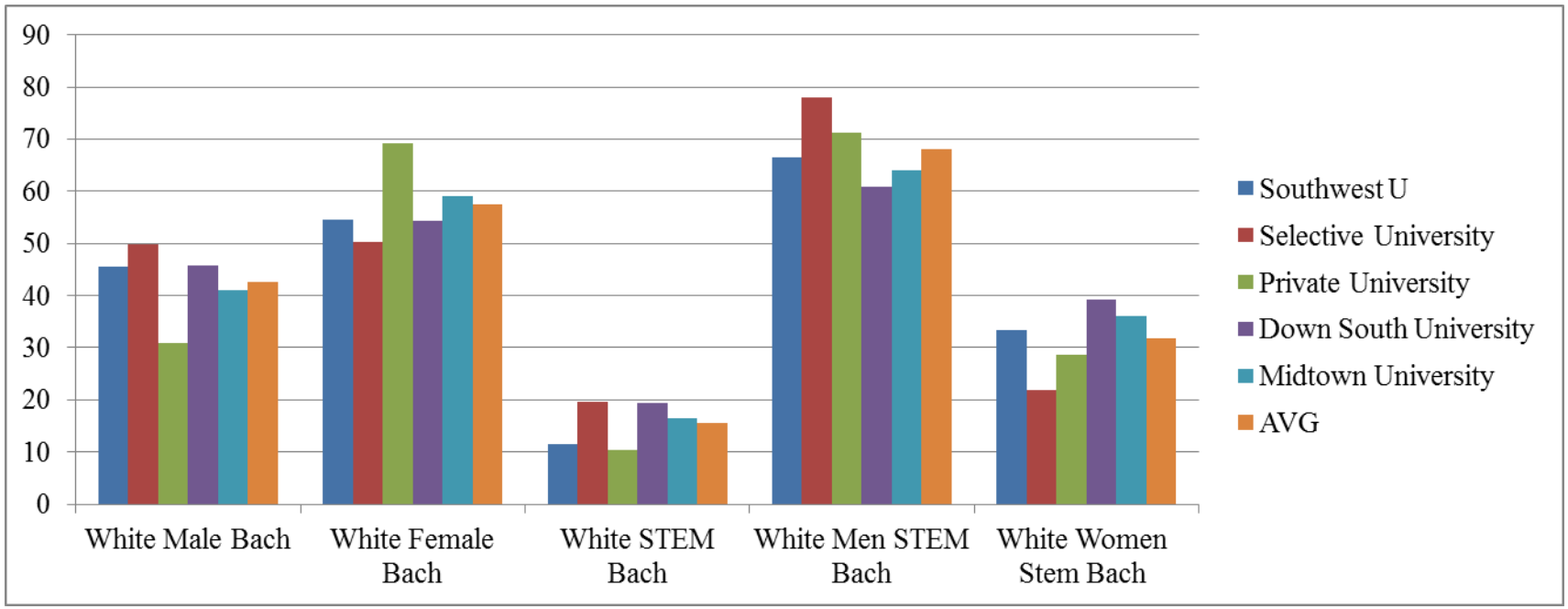


However, Asian/Pacific Islanders have 27% of all their degrees in STEM. The last two bars for each group, the purple and light blue, represent the gender breakdown of the STEM degrees earned within these race/ethnic groups. For example, 68% of all white STEM degrees were awarded to men while only 32% of all white STEM degrees were awarded to women. Men are overrepresented across all race/ethnic categories in STEM fields and underrepresented in total bachelor's degrees earned, with the exception of Non-Resident "Aliens[2]." Again, these numbers should be read with caution as the total number of degrees for some of the race/ethnic sub-groups is quite small. For example, American Indians only received 58 STEM degrees within this entire sample of thousands of students.

Table 8 presents descriptive information for white students at the individual institutions in my sample. The first group of bars represents the percentage of all white bachelor's degrees going to white males at each of the institutions, as well as the average for the institution group. The second group of "bars" is the percentage of white bachelor's degrees going to white females. The third group is the percentage of all white bachelor's degrees that are STEM degrees. The fourth group is the percentage of all white STEM degrees that are awarded to white men. The last group of bars is the percentage of all white STEM degrees going to white women.

[2] I would like to express my extreme discomfort in the use of the term "alien" to describe any human being, whether they are a documented resident of the U.S. or not. The term "alien" is used here only to be consistent with current policy and practice within the U.S. Census and higher education institutions.

Table 8: *Percent of White STEM Bachelor's Degrees by Institution*



Participant demographic information[3]

Promoting Minority Participation in the Sciences

Who are the PMPS student participants? There was much variation in terms of the demographic profile of the student participants. All demographic information, including gender, race, year in school, department, and future plans are presented in the following tables. To summarize, I enrolled 17 male and 16 female student participants. Of the 33 student participants, many identified as affiliated with two or more racial groups. However, their primary self-identification included 27 Hispanic, 3 Native American, 2 Black/African American, and 1 Middle Eastern student.

Table 9: *PMPS Student Gender*

PMPS Student Gender	
Male	17
Female	16
Total	33

Table 10: *PMPS Student Race/Ethnicity*

PMPS Student Race/Ethnicity	
Hispanic	27
Native American	3
African American	2
Middle Eastern	1
Total	33

[3] All numbers in parentheses refer to the frequency of respondents who reported a particular phenomenon. For example, 15 student participants reported being in their senior year. This pattern is true for the remainder of the document.

A majority (15) of participants were at some point in their senior year while 8 had recently graduated with their bachelors of science. Seven of the students were juniors in their third year of their degree program and the remaining 3 were either freshman (1st year) or sophomores (2nd year). In terms of STEM disciplines, a majority of the students either came from an Engineering field (14) a Life Sciences field (including Biology and Veterinary Science) (11), or from a Chemistry field (8). However, there was one student each from computer sciences, mathematics and technology related fields.

Table 11: *PMPS Year in School*

PMPS Year in School	
Post-Senior	8
Senior	15
Junior	7
Sophomore	1
Freshman	2
Total	33

Table 12: *PMPS Major*

PMPS Major	
Engineering	14
Life Sciences	11
Chemistry/Biochemistry	8
Computer Science	1
Mathematics	1
Technology	1
Total	36

Of the 33 students, 19 were either already enrolled or planning on enrolling in a graduate program after completion of their bachelor degree while 8 were interested in pursuing a job in industry and 3 were considering a more professional degree, such as an M.D. The remaining students were unsure of what they wanted to do after completing their bachelor of science.

Who are the PMPS non-student participants? There was also much variation in terms of the demographic profile of the faculty or non-student participants. All demographic information, including gender, race, title, department, and why they became involved are presented in the following tables. To summarize, we enrolled 15 male and 10 female faculty participants. Of the 25 faculty participants, their primary self-identification included 11 White, 9 Hispanic (4 from Central and South America), 2 Middle Eastern, and 1 each identifying as Black, Native American, and Asian American.

Table 13: *PMPS Faculty Gender*

PMPS Faculty Gender	
Male	15
Female	10
Total	25

Many (16) were tenured faculty either as a full professor (9) or an associate professor (7).

Table 14: *PMPS Faculty Race/Ethnicity*

PMPS Faculty Race/Ethnicity	
White	11
Hispanic	9
Middle Eastern	2
Black	1
Asian American	1
Native American	1
Total	25

Assistant professors accounted for 4 of the participants and the remaining 5 were working at the administrative level, either in charge of diversity and multicultural programs at their campuses or in other administrative offices. In terms of STEM disciplines, there were 5 faculty mentors each from Engineering fields, the Life Sciences, and Chemistry. Faculty from Physics and Astronomy accounted for 4 participants, with less representation from

Psychology (2), Medicine (1) and Mathematics (1). The remaining 4 faculty participants were in administrative offices.

Table 15: *PMPS Title*

PMPS Title	
Professor	9
Associate Professor	7
Assistant Professor	4
Director, Diversity	4
Administration	1
Total	25

The amount of time that faculty have been involved with the program varies significantly. One faculty had just completed his first semester with a PMPS student while 6 others had been associated with the program nearly since its beginning in the early 1990s. Many faculty mentors had been involved between 3 and 10 years (10). Faculty noted a number of reasons why they became involved with the program, with the most common responses including needing a program to help them support students in their lab (16) especially in terms of impacting the diversity of their labs (7), an interest in working with young minority scientists (8), because of a lack of diversity they see in their own field (6) or because they themselves faced challenges as minority scientists (6), and a need for financial support (in terms of a paid research assistant or supplies) for their own research (7). Most of the faculty first heard about PMPS support from other faculty in their social networks that had been working with the program (17).

Table 16: *PMPS Department*

PMPS Department	
Engineering	5
Life Sciences	5
Chemistry	5
Graduate College/Diversity	4
Physics and Astronomy	4
Psychology	2
Medicine	1
Math	1
Total	28

Minority Student Development in STEM

Who are the MSDS student participants? There was much variation in terms of the demographic profile of the MSDS student participants. All demographic information, including gender, race, year in school, department, and future plans are presented in the following tables. To summarize, I enrolled 2 male and 7 female student participants. Of the 9 student participants, none identified as affiliated with two or more racial groups. Their primary self-identification included 5 Hispanic, 3 Native American, and 1 Black/African American.

Table 17: *MSDS Student Gender*

MSDS Student Gender	
Male	7
Female	2
Total	9

Table 18: *MSDS Student Race/Ethnicity*

MSDS Student Race/Ethnicity	
Hispanic	5
Native American	3
African American	1
Middle Eastern	0
Total	9

Half (4) of participants were at some point in their senior year while 1 had recently graduated with their bachelors of science. Juniors represented the other half (4) of the sample. In terms of STEM disciplines, a majority (7) of the students came from a Life Sciences field (including Biology and Psychology) (11), or from a Chemistry/BioChemistry field (2).

Table 19: *MSDS Student Year in School*

MSDS Student Year in School	
Post-Senior	1
Senior	4
Junior	4
Sophomore	0
Freshman	0
Total	9

Of the 9 students, all were either already enrolled or planning on enrolling in a graduate program after completion of their bachelor degree. Two of these individuals were also interested in a professional degree in terms of a combined M.D. /Ph.D. program.

Table 20: *MSDS Major*

MSDS Major	
Engineering	0
Life Sciences	7
Chemistry/Biochemistry	2
Computer Science	0
Mathematics	0
Technology	0
Total	9

Who are the MSDS non-student participants? While there are a small number of faculty participants from MSDS, there was some variation in terms of the demographic

profile of the faculty or non-student participants. All demographic information, including gender, race, title, department, and why they became involved are presented in the following tables. To summarize, I enrolled two male and two female faculty participants. Of the four faculty participants, their primary self-identification included one White, two Hispanic and one Middle Eastern participant. One participant also identified as Native American/Hispanic.

Table 21: *MSDS Faculty Gender*

MSDS Faculty Gender	
Male	2
Female	2
Total	4

Three of the four faculty members were tenured, full professors in their respective fields. One faculty member was formerly an associate professor and had moved to an administrative role, where he was working specifically with professional development of minority students in his department. In terms of STEM disciplines, two faculty members were in Engineering, one was in Life Sciences and one was from Chemistry.

Table 22: *MSDS Faculty Race/Ethnicity*

MSDS Faculty Race/Ethnicity	
White	1
Hispanic	1
Middle Eastern	1
Black	0
Asian American	0
Native American	2
Total	4[4]

Table 23: *MSDS Faculty Title*

MSDS Faculty Title	
Professor	3
Associate Professor	1
Assistant Professor	0
Director, Diversity	1[5]
Administration	1[6]
Total	4

[4] One faculty participant identified as both Hispanic and American Indian Alaskan Native. Therefore, while five racial classifications are listed, there were only four faculty participants.
[5] One faculty participant identified as both a full professor and the director of a diversity program.
[6] One faculty participant identified as both an associate professor and as an administrative staff member.

Table 24: *MSDS Faculty Department*

MSDS Faculty Department	
Engineering	2
Life Sciences	1
Chemistry	1
Graduate College/Diversity	0
Physics and Astronomy	0
Psychology	0
Medicine	0
Math	0
Total	4

The amount of time that faculty have been involved with the program was relatively constant. All of the faculty were long-time members of program, with the most senior faculty having been involved for 10 years. Faculty noted that the reasons they became involved in the program stemmed from experiencing struggles as minority scientist (2), needing a program to help them support students in their lab (2), an interest in working with young minority scientists (3), because of a lack of diversity they see in their own field (2). One faculty discussed her reasons for being involved in the program were not at all motivated by minority issues and that she saw involvement as an opportunity to receive funding for her lab. Most of the faculty first heard about PMPS support from other faculty in their social networks that had been working with the program (3).

Analysis of Qualitative Data

I used neither a strictly inductive or deductive model for the analysis of data. Instead, inductive and deductive processes were utilized in a more cyclical fashion. For example, deductive processes were used in the development of interview questionnaires where I made sure important concepts in the study were addressed. This meant making sure I probed respondents to discuss issues of cultural context (how their experiences in special programs were either similar or different from their experiences in traditional classroom environment, their race and gender identities, and their program activities). This reflects a more deductive process to the development of an interview guide and development of a coding scheme. However, I wanted the specifics and details of what the participant deemed most important within these broad categories to emerge organically so that the details were grounded in participant experience. Therefore, when I constructed the questionnaires, there are clearly broad categories that I wanted to talk about but questions that I asked allowed the respondent to answer these questions in a way that allowed for the important details to emerge from their own lived experience in narrative format.

Analysis of the interview data was a constant, ongoing process. I was constantly making jottings and memos from participant observations that were turned into extensive field notes following all data collection trips and participant observations. During events and recorded interviews, I took notes on what I felt were major findings emerging from the interview or event. In some cases, these notes on emerging concepts influenced interviews that followed. For example, as I was talking with a number of students, the importance of interdisciplinary studies and research were brought up consistently without probing. This was not a general concept that I set out to explore, but it was obvious that it was important

for many of my participants across institutions. Therefore, as my interviewing progressed, I made sure to pay attention to whether or not the student expressed interest or placed value on interdisciplinarity and I began to probe more about its importance to the participant. This reflects a more inductive approach to the construction of an interview protocol and initial coding guide.

I utilized my interview protocol and field notes in order to develop an initial coding guide. The coding guide addressed broad categories that I either entered the project with (e.g. attraction factors, demographics, family and living situation, mentoring…) or that emerged as important concepts during the interview process (e.g. interdisciplinarity, diversity…). For the interviews that were not recorded, I took written notes of the interview and immediately typed a document that described the information collected during the interview. I coded these documents in a similar manner as the verbatim transcripts. Interview transcripts went through two rounds of coding. The first round consisted of coding chunks of verbatim conversation and classifying them into broad categories. The broad categories are represented as underlined, bold print in Appendix E: Coding Guide. A short description of the broad concept is included in italics. Once the interviews were coded this way, each one was re-analyzed where more specific codes within the broad concept were developed. These are reflected in normal type-print on the coding guide in Appendix E. None of these more specific codes were developed prior to analyzing interview transcripts. Instead, I used words and ideas expressed by interview participants in order to construct these codes.

In order to promote efficient coding and data management, interview transcripts were uploaded into *Atlas.ti*, a qualitative data analysis tool. While some code development

happened via pen and paper during field note writing, both rounds of coding were ultimately completed using this software. Once all of the transcripts were coded and saved in *Atlas.ti*, I was able to break down respondents and codes by relevant groups, including by institution, race, gender and status (student/faculty). I was also able to extract all coded text pertaining to any concept that I was analyzing. For example, I was able to analyze all interview text that was coded as "Mentoring" and break apart this text into how faculty discussed mentoring as opposed to students, or how females discussed mentors as opposed to males. Once interviews were coded and I felt confident in my finished coding guide, I used the results to construct an online survey questionnaire for distribution to a larger sample of students during the second phase of the study.

Findings and a discussion of the findings are addressed in the next chapter.

As a qualitative researcher, my professional goal is to most accurately tell the story of my participants rather than construct my own version of events. In order to do this and have the important voice of the participants heard, I rely heavily on quotes from participants and dialogue between participants and me. Therefore, in the following chapter you will be presented with extensive dialogue. It is my professional belief that I could not tell the participants' stories better than in their own words. I introduce my own analysis and understanding of the dialogue between quotes.

CHAPTER 4: MULTICONTEXTUAL ENVIRONMENTS: THE IMPORTANCE OF FACULTY/STUDENT INTERACTION IN NURTURING SCIENCE IDENTITY FOR UNDERREPRESENTED STUDENTS IN STEM

It is important to note that the framework of this section differs from traditional studies of student success in higher education. For example, researchers in higher education often only focus on the impact that various practices, such as mentoring, study groups, and learning communities have on the students involved and not critically engaging with the faculty members involved in these interactions. When faculty members are involved, the focus is processes that are disjointed from the context in which this interaction occurs. Therefore, studies will either examine students as active recipients of faculty mentoring, or – if at all – faculty as a separate section of analysis. Instead of separating out these two groups of participants, I focus on the interaction that occurs between faculty mentors and their student mentees and the impact that this interaction has on both faculty and students. Therefore, much of the qualitative data that is presented in this section will focus on the interaction of students and faculty and not just on students *or* faculty.

In this section, I first take a step back and use the interview data to tell a story about these concepts and processes by drawing on quotations that illuminate the general story line of the traditional academic cultural environment and the alternative cultural environment, as described by all key players in the environments – faculty and students. Following this section, I address the impact that the program has on faculty, especially through the process of mentoring. Finally, I discuss the major concepts of Multicontext theory and Context Diversity that emerged during my fieldwork and how they fit within a more nuanced theoretical framework than is presented by Tinto (1993) and Weidman (1989), relying on

both frequency of respondents who discuss the concepts from interview and survey data that support the generalizability of those findings.

The Traditional Cultural Environment "I felt like I was definitely looked down upon"

Understanding the findings of the described research is best facilitated by revisiting Figure 1: *Relevant Concepts and Processes*. Focusing only on the right trajectory of Figure 1: *Relevant Concepts and Processes,* the logic is that within higher education, there exist academic departments that consist of a traditional academic cultural environment. Within this environment a student is exposed to informal messages through daily participation and interaction, valued knowledge through coursework and formal culture regarding rules on being a member of this environment. Filling in Figure 1 with data collected during the research presents how respondents described their lived experiences within this space of higher education.

Figure 2a: *The Traditional Academic Environment* reintroduces this model with data. Based on the lived experiences provided by interview participants, the logic is as follows. Within in higher education, there exist academic departments. While the environment of these departments varies by institution, they are often described as spaces characterized by formulaic learning of rote knowledge through activities such as test taking and paper writing. Papers typically consist of writing up lab results from lab experiments where one is handed a sheet of instructions and guided by the lab instructor on how to go about conducting the experiment.

There is always one outcome to the experiment, and if the experiment fails, it is because the student did not complete the instructions correctly and therefore the student fails the experiment. This environment is often described as boring, full of information,

unrealistic, pre-packaged "cookie cutter" situations. Here, Dan, a professor of medicine from Down South University discusses this environment:

> I think that the traditional academic environment doesn't include working in a lab. It just includes going to classes, going to labs that are pre-set and there are, in the labs there are pre-made results. And if you follow every step, everything works every time and that's not real life. *–White, Male, Professor of Medicine*

Miguel, an associate professor of Chemistry and Biochemistry from Southwest University noted how he saw the traditional academic environment as "fundamentally different" from what is offered in alternative program environments:

> No they are, this (program supported research) is fundamentally different. Because like these experiments, in a classroom setting, the outcome is clear so they go in there, they have like a cooking instruction on a sheet, they do their thing and then at the end of one or two or three sessions, this is done. In most cases the outcome is clear. These are things that work and it familiarizes them with the kind of work. And so that's fundamentally different from the (faculty/program) lab where we give them projects that are open-ended and I don't know the answer to that [research question]. *–Hispanic, Male, Associate Professor of Chemistry and Biochemistry*

It is within the traditional academic environment that students discuss having the most difficult experiences in higher education. Students discuss feelings of isolation, unfriendly instructors, feeling intimidated, and ultimately excluded which is often attributed to the environment being isolating due to a lack of diversity or feeling like the individual is not important to the instructor. It is important to point out that most of these difficult experiences from the traditional academic cultural environment were based on the respondents' lived experiences as underrepresented students and the intersection of race and ethnicity and identifying as female. After making a note of how I identified the respondent based on phenotype, I asked all study participants to self –identify their racial and/or ethnic identification as well as how they identify their gender. I identified all respondents as they identified themselves, except for the case of two light skinned Hispanic male students who I

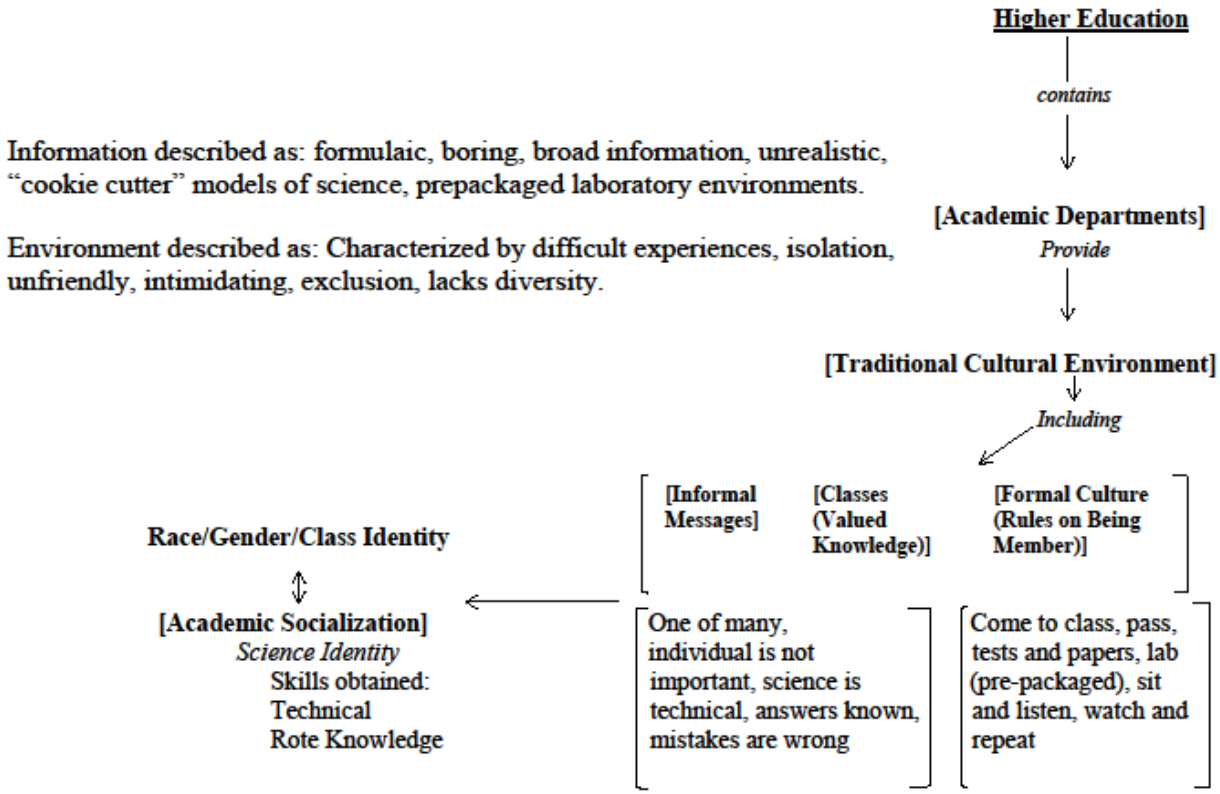


Figure 2a: The Traditional Academic Environment

incorrectly identified as “white/non-Hispanic” in my notes. None of the students who self-identified as Hispanic, regardless of complexion, also identified as being White. This has implications for current classificatory systems that separate “race” from “ethnicity” and encourage students to identify as “white-Hispanic” or “white-non-Hispanic.” For these students, their primary racial self-identification is “Hispanic,” regardless of how the institution chooses to capture this information (see Saenz and Morales 2015).

All respondents, regardless of their racial, ethnic and gender identification were then asked the same questions regarding if there were ever times they felt like they either benefited or were challenged because of this identification. Many of the students of color in this study noted that their racial and/or ethnic identification was an important part of their overall identity. Students were involved in student organizations for minority student STEM organizations, such as the Mexican American Engineering Society (MAES) and the Society for Native American Chemists (SNAC), often serving leadership roles. Students of color were quick to note that they have benefitted from identifying as a minority because of their ability to participate in their current PMPS and MSDS programs. Minority male respondents also recognized that they had benefited from being male. In one case, during a small focus group with one Hispanic male and one Hispanic female at Southwest University, the male student was surprised to learn of their differential experiences as it related to gender. Here, these two students, both Chemical Engineering majors from Southwest University, discuss how they have experienced the same environment differently based on the intersection of ethnicity and gender. The Ana, the female respondent begins by discussing the imbalance she sees in the racial/ethnic make-up of the chemical engineering student body at Southwest

University. She finishes this discussion by stating that she feels that while the racial/ethnic imbalance is noticeable, the gender imbalance is more salient to her:

> ANA: I think I can identify, I mean it's really hard, but I can identify like five maybe Hispanic students and maybe two that are like African American and then the rest some a lot of them are from the middle East and then the rest is white in our class. So those are the two main groups in chemical engineering. But definitely in professors, I've only had professor [name] is the only black professor that I've seen in chemical engineering and I think [name] is Hispanic but the rest and then [name] is from India.
>
> REBECCA: Does that at all have any impact on your experiences here or in your classes or anything?
>
> ANA: I actually feel like our, like, I feel like there's more Hispanics growing like in engineering because actually like I meet some and like most of my friends are without even meaning to me, well actually I just started talking to this girl, she just came she's a transfer from Mexico in chemical engineering so I feel like they're starting to come more from like Mexico but mostly like definitely our number one is Arab, like Middle East is like number one for chemical engineering, that's like most of my classes. And then second probably like the white and then I feel like, and then no it's probably white and then Asian and then it's like I'm trying to I'm being politically correct I'm not saying like I'm just doing for research, I'm not singling them out or anything. I have friends of all of them um and then I probably like Hispanic, there's Hispanics but let me tell you I feel like it's more segregated for woman than men.
>
> REBECCA: Tell me about that.
>
> ANA: Well like there's hardly, like especially like in the intro to engineering course I felt like I was definitely looked down upon. So when I started I actually I, like ironically, like we were all put together like the Hispanics. I don't know if that was on purpose, but it was like, so I was really intimidated going because like they're all going and they kinda looked down on me but once I stood firm and I started, kinda established myself as like the leader and I was like we're going to get this done and when they didn't get this done I still got it done. I was like, "Oh, okay." And they were like, "Oh, you *can* do this." So you have to like -- I feel like it's kind of hard to say, "Oh, okay, I'm not here just because I want to be here." Some of the girls like are just here because they want to find a husband; I'm not saying that because it's actually true. They're just looking for engineering husbands or stuff but most of them though are here to like learn and I feel like that's starting to like change a lot and they're trying to take us a little more seriously. Like, okay, we're here and actually to finish it. After 211 [a large introductory course] especially, once they like weed out a lot of people, like here I go. You are actually serious about doing this degree.
>
> REBECCA: Did you feel like you maybe had to work a little harder?

ANA: Yeah and that's what [program] has helped me a lot with too. Like, I felt more sure about being in the workplace, especially as a Chicana.

After this, I asked the Felipe, the male respondent to discuss if his experiences were either similar or different to the female student's experiences. He begins his narrative, truly shocked, by apologizing to Ana for her experiences. He follows this by briefly agreeing with the Ana about the racial/ethnic imbalance in chemical engineering and sometimes feeling like he needs to assert himself as a leader more to be taken seriously. But, he returns to the gender issue by discussing a female Hispanic student that both Ana and Felipe know and her abilities in chemical engineering, distancing himself from the belief that women have to work harder while acknowledging the female respondent's experiences:

REBECCA: [To the Hispanic Male Respondent] Do you have similar, do you have or feel similar or any differences?

FELIPE: I mean the thing is you know, in order to say you know somebody's point of view you have to walk in, the quote says, walk in their shoes. I mean for a hundred miles. I would I don't know, and I'm sorry to hear that. Wow. I am just like shocked because there is a girl [name] who I've been working with and uh I'm not sure how [name] but [name] let us choose our teams…

FELIPE: Yeah I transferred 'cause I was stuck with a bunch of freshmen, I called them freshmen. They were all freshmen straight from high school. But I know what you mean, a lot of them were, for me a lot of them were white. The ones that told me that, "Hey, I'm already," a lot of them were already chemical engineers, they were studying chemical engineering.

ANA: A lot drop though.

FELIPE: A lot do. And I told them, "Hey I'm already going through this, the chemical engineering process." 'Cause, I tell you at the same time I felt like some of them were trying to, I guess when you have a group someone tries to be the leader, and I'm like I tried telling them, I'm like, "I know this," and I think I was along with them. I'm like, "Most of you guys probably aren't going to be." But you know, we all ended up working together but um it worked out great. I mean I, I didn't know that. With [name] she's been, she's smart, she's great and um we've been working in multiple group projects, and when I tell her, "Can you do this?" she gets it done. And

> um right away and um and the thing is she's also doing research with another professor…But, uh, you know we speak Spanish and when we're just working um. I'm sorry. I'm sorry you feel like that. It's just wow - I've never seen that [gendered experience].

I noticed that as Ana was talking, she attributed her work with the program as having given her more confidence as a Chicana in chemical engineering environments. I wanted her to discuss this more, so I asked her about it again. She talks about how her experience in the alternative academic environment with her program exposes her to other Chicana chemical engineers so that she has a confidante in what she describes as an environment with gender imbalance:

> REBECCA: [To Hispanic Female Respondent] You mentioned that [program] can kind of help you, helps you because it gives you this experience because you know you can do this. Does your mentor ever help you balance those personal dynamics that can happen?
>
> ANA: Like I said, like he's super, super helpful. Really, really um understanding um and so like [name] is in our labs like we both enter lab at the same time. She just finished [program], her last semester was last semester, so she already did three semesters of [program] and she like she and I would like sometimes talk about that and it feels like. We feel like super, super. I say super too much.
>
> REBECCA: No you don't. You're fine. [Chuckles]
>
> ANA: I feel like really comfortable in our lab setting. Our mentor makes us feel that way too. Like the woman setting, well it's easy there too. Like in engineering it's kind of different.
>
> REBECCA: How so? Is it the imbalance?
>
> ANA: Yeah, there is a really big imbalance. Like in my nanoparticle meeting I am the only girl that goes out of like eleven, or twelve or thirteen of us.

Many other students of color, especially women, noted having difficult experiences within the traditional academic cultural environment based on their racial, ethnic, gender or in some cases, the intersection of their race/ethnic and gender identification. In this

exchange, Wesley, a Biology student who identifies as African American from Midtown University discusses how feeling like the only black student influences him on campus:

> WESLEY: To be honest, I have not seen any other Black STEM anything. I have not seen any other Black student that's doing biology, sciences, technology, engineering or math. I haven't…There are times that it happens because there is a low rate of African-Americans here. I'll be in a 300 – a class size of 300 in my macroeconomics class, and be the only African American.
>
> REBECCA: And have you ever had an African American STEM instructor?
>
> WESLEY: I have not.
>
> REBECCA: Never?
>
> WESLEY: Never.
>
> REBECCA: So what does that-- does that affect you at all?
>
> WESLEY: It does. You know what? It really does, because I really-- if someone would understand from my position what happens - the names you could be called, the different things that could be held from you - then I would really love-- I would love an African-American STEM instructor. I really, really would.
> *-Black, Male, Senior Biology Student*

In this next interchange, Sofia, a Puerto Rican student at Down South University discusses how being labeled as a non-citizen by school administrators, even though as a Puerto Rican she is a U.S. citizen, led to her feeling different than the students around her contributing to feelings of isolation and insecurities:

> SOFIA: I was being honest with you, I don't know nothing about - I go to my advisor - nothing about biology. I don't really think that chemistry we should go off everything at the beginning, and she say of course! And we went through when we discussing I get in trouble and stuff like that because I was human I was looking and they were not acclimated to that type of person who was new here who was oh my god, and how is your U.S. citizen but you don't speak English? That was a question. Um, "How did you pronounce your name?" Um so many things.
>
> REBECCA: Yeah. How did that make you feel in that environment, did you feel like you were a part of the team?

> SOFIA: No, never. Never, never. And it feel criticize me by myself ya know -- I bad, I never sleep with the guys because I am Latina, I am woman. Um in the classes, if I sit here, the people next to me just move away so it was kind of – isolating. Yes. Oh my god yes. – *Female, Hispanic, Junior, Biology Major*

Carlos, another student who recently graduated with his B.S. in Chemistry from Private University discusses how he sees his Hispanic last name influencing his interactions with peers on campus:

> CARLOS: Sometimes it can be negative, because they definitely approach you or see you as one way. Just because my last name's Montoya, they immediately have certain stipulations. But at the same time it can also have benefits, because they [university] want to diversify themselves, or they want to come off that way. So it's tough. It's kind of playing both sides and trying to make yourself seem as professional and beneficial as possible.
>
> REBECCA: So, there's times where it can be a challenge and times where it can be beneficial?
>
> CARLOS: There's been a couple instances…I just know that I did meet up with somebody once and they were like, "I totally had a different outlook of what you'd be because your last name is Montoya," and all this stuff. And I was just like, "Well, sorry to disappoint, I guess [chuckles]." It's difficult, but you just kind of have to turn it around and impress them for who you are. I understand that sometimes you do have an image already implanted in your mind of somebody's name or something like that.
>
> REBECCA: Have you ever felt like you had to work harder to prove yourself than you feel like you should have?
>
> CARLOS: I think so, but that might be because of different reasons. Everybody has to work hard to prove themselves. I don't know if that was necessarily that or not. I'd probably say that, "you're not really meant for it, you're not cut out for it." I think that's kind of dumb, but I do think that it's kind of a stipulation or a stereotype, that Hispanics aren't really noticed in the scientific or the STEM sciences. If you are, then you're kind of an outlier. You're not really meant to be there sort of thing. – *Male, Hispanic, Post-Senior, Chemistry*

Maria, a senior Chemistry student from Private University also discusses the difficult environment she encountered being a Latina in the sciences. Notice that she feels students attribute social class to her being Hispanic and the heartbreak that follows her feelings of not

belonging even though she feels just as competitive as her peers. Insecurities regarding her future employability develop from feeling like "the only minority" or as a female in a world characterized by male scientists:

> MARIA: And I had days where people would comment about me saying that I came-- like I'm poor because I'm Hispanic. And it just hurt my heart, just because that shouldn't happen. But then I had my final straw, and it totally affected where I wanted to go to school, because I didn't want to go to school at certain places just because of the people I might encounter. But one day-- but [chuckles] … I had a student *[RB: Upon later probing, I found that the student was black.]* who locked me out of the classroom one day, and he--
>
> REBECCA: Locked you out?
>
> MARIA: Yes. The teacher was not around. He locked me out of the classroom and had a sign that said, "No Mexicans allowed here." Yeah [laughter]... But that really impacted me just because-- I might be Hispanic, but I have the [inaudible] [chuckles].
>
> REBECCA: I'm sorry, but you have the what?
>
> MARIA: Same potential…But I know that in science and other things that I've only heard about majority male scientists, so I think that's where I get scared, I get nervous, that I feel like someone's going to consider a male more if it's a job than I do. It's always an insecurity I have, but I feel like if I prove that I can work hard, that will change. – *Female, Hispanic, Senior, Chemistry Major*

Upon probing, Maria disclosed that the student who locked her out of the classroom was a black student, highlighting that these dynamics of inclusion and exclusion can go beyond majority students targeting minority individuals. Paula, another Latina student, a recent B.S. in Chemistry at Private University, discusses her difficulties navigating peer relationships as she pursues her path to medical school. In the following exchange, she discusses how one student in particular views her successes being primarily based on her playing the "minority card." When she tries to put forth her accomplishments as the reason she is successful, she is dismissed:

> PAULA: There was this one student who told me that my only way of ever getting to medical school is if I pulled the minority card, and that I wasn't smart enough to do it on my own. I think that's what took me aback, and I was just like, "How could you sit there and tell me that I'm not good enough because I'm not White like you are?" I took that to heart and I think that's when I talked to my dad, he was like, "Why does that matter to you? You know your own self. Look at what you're doing. Look at the research that you do. Look at the school work that you do. Look at your grades. That should be enough to tell you that he has no idea what he's talking about."… I think I was more embarrassed because he was talking to a bunch of other friends about medical school and where they were going to. I wasn't even talking to them. I just walked in then sat down because we were going to have a meeting for the pre-med honor society thing. He just looked at me and laughed and said, "The only way you're ever going to get into medical school is if you flip the minority card." I just sat there and I was like, "Did he really just say that?" I left before the meeting got started. I just picked my stuff up and I left the room and called my dad. He was like, "How? Why is this happening?" I guess coming from Hawaii where the minorities are the majority, I never had to experience that. I think it's a whole different-- it's more of like, "You're not smart enough."

She continues by discussing how professors in her program encouraged her to address the situation and her challenges in doing so. Following this, she notes that being discriminated against on campus by her peers was something that she did not anticipate before starting college and how disheartening the discriminatory treatment is. She finishes her thoughts by recognizing how the diverse environment created by her program involvement gives her strength to combat these microagressions (see Sue 2010) and recognize that there are many talented minorities and that she at least can find a community in them:

> PAULA: One of the students - and I had to talk to him about it, because my professor is like, "Paula, you need to address the issue with him" - he has called me a baby, and told me that I'm just not cut out for the program. Every time I contribute and say something, he tells me that I'm wrong and I don't know my material. It's just like, "No, I do know my material. I'm doing well in the program right now. I can show you my grades." It just makes it seem like my input and my values or whatever I have to say isn't important to him. I think that's like the most disheartening thing that I have to work in groups with him. Because it's just like, "How do I talk, and how do I contribute well, when you're telling me that I'm wrong?" [And] That was his biggest criticism, that I'm such a baby, I don't know what's going on, and that I need to voice my opinion more. "When I try to do that you don't take me seriously and you don't respect what I have to say." So it's like how do I find that happy medium and address

> the problem without taking it so personal?..I know that I have to work with him again today. So they [professors] gave me ways to address that issue without being so confrontational. I'm hoping that by applying these means: telling him, "Let me finish my thought first," and then like, "I want to hear what you have to say. Let me get this out before I forget it," kind of addresses that issue and makes him realize: "I'm serious and I am not going to stand by while you walk all over me again."
>
> REBECCA: So he kind of cuts you off?
>
> PAULA: All the time. He rolls his eyes when I talk. He never asks me questions if he needs clarification. It's just building up--I never thought about it, I never anticipated it. When it happened I was just so thrown back by it, because we've come so far, but how is racism still so prevalent in society? That stuff is just mind-boggling. I don't understand how that's even possible. We've made so many great steps to eliminate it, but there's always those people, whether it be how they were raised or maybe it's what they think or believe, it's still there. Unfortunately, all you can do is advocate and teach them and all that stuff. I don't feel like it's ever really going to be enough. Being with [program] it's nice to know that there are lots of minorities out there, but they are just as smart. They are just as good as everybody else regardless of skin color. They have so much more to contribute. And it's nice to be part of that community. – *Hispanic, Female, Post-Senior, Chemistry*

It was also common for students to note that prior to their program experience, they felt intimidated by faculty in the traditional academic environment. Student experiences with their program faculty mentor helps students to see faculty in a less intimidating, more approachable manner. For example, a Hispanic female Chemistry student from Southwest University interactions with her program faculty mentor challenged her to deconstruct what she described as “the wall” she had put between her and faculty members in the past. By deconstructing this wall, she was finally able to visualize herself as a future faculty member:

> Honestly it felt like there was a wall up between being a student and knowing a faculty member as a person besides just being your teacher-that you don't really see them as a peer. So I think the [program] has really helped that relationship of feeling that I am going to be that and almost like I am-- make it to where your interactions are different with your professor than they would normally be. – *Senior, Female, Hispanic, Life Sciences*

Since the student respondents in this study are participants in programs designed to increase the representation of minority students in STEM, there were very few white participants. However, experiences for the four students who identified as white/non-Hispanic in this study varied significantly. For example, while students of color often noted that their racial or ethnic identity was important, none of the white students did so. Most of them were adamant that their identity as white was not something that they identified as important at all (see Frankenberg 1993). Here, Claire, a white, female first-generation college student from Midtown University discusses her reluctance to apply for the program based on her identity as white:

> CLAIRE: Um well I had always wanted to do it [program], for some, what was the reason that I was postponing? Maybe it was because I knew it was for, um, minorities and it was increasing diversity and I think when the recruiter asked, she goes, "Still apply you may still get it," or something like that. So it dispersed that doubt that I had about um how I could've contributed to being me and white but I am also female and white isn't necessarily a part of my identity.
>
> REBECCA: So you don't identify strongly as white?
>
> CLAIRE: It doesn't, no, it doesn't make a difference, I don't really have a white culture at home, we don't do white—I don't know what's white, I mean, white's nothing. It's not. Sure I identify, like if I was taking one of those fill out things for the government and they asked what my race was I'd check white. - *Senior, Female, White, Biochemistry Major*

When asked the same questions regarding experiences where they felt they either benefited for faced challenges based on their racial or ethnic identification, none identified as having benefitted in any way. Two of the four noted that they felt that they had faced more difficulties because they were white, especially in terms of being passed up for scholarships and program opportunities. Claire discusses that while she has felt overt discrimination for

being white, that "everyone has probably experienced" some sort of discrimination based on some social characteristic:

> CLAIRE: Um there's kind of overt racism, I had that. I was maybe at a table with a group of Hispanic people and they would say, I mean I don't even remember now what they'd say, but like white trash. It was fine, you can get picked on for anything, if someone finds out you're a Christian and forget about it. They're going to say horrid things sometimes. Perverse, disgusting things. Um so it's just I don't, yeah. I mean everyone has probably experienced that at some point. – *Senior, Female, White Biochemistry Major*

While both students of color and white students discuss experiences based on race, ethnicity and/or gender, the experiences were discussed more emotionally by women of color, especially and men of color to a lesser degree. The white students minimized the salience of "race" in their own lives (see Bonilla-Silva 2006; Frankenberg 1993). While the racial and ethnic identities of the students of color were recognized as important to their overall identities, white was not a salient part of the white student's identity.

The Alternative Cultural Environment: "It was a whole new environment"

You may notice that it is common for students to discuss the traditional academic environment in relation to the alternative cultural spaces that they experience as part of their program participation. To examine this alternative cultural environment experienced by program participants, it is helpful to reexamine the left trajectory in Figure 1. The logic is as follows. Within higher education, there exist special programs, including PMPS and MSDS, which operate to increase the diversity and success of underrepresented students in STEM fields. A cultural environment alternative to the traditional cultural environment exists here in order to reach these objectives. Within these alternative cultural spaces, students are exposed to informal messages and program components that differ from traditional class work and formal rules on what it means to be a member of this group.

Figure 2b: *The Alternative Academic Environment* reintroduces this figure by adding data gathered during research which represent the lived experiences of the participants. While this environment inevitably varies by program, they are typically described as small, intimate (often discussed using familial terminology) and friendly spaces with supportive mentors/staff that facilitate learning challenging lessons in an informal, hands-on work on high level research and non-standardized manner.

All of the students involved in faculty-led research experiences discussed the hands-on experience with high level, advanced research as the most significant experience they had with their programs. Students were able to work with faculty on advanced research projects that are often funded by larger organizations such as National Aeronautics and Space Administration (NASA, the National Institutes of Health (NIH), and the National Science Foundation (NSF). Other students were able to travel to the deserts of Arizona to camp through the whole summer and study the habits of prairie dogs and even to Central America to study jaguars. Some students were able to help develop the technology that went on a vehicle to Mars. Still others worked on technology to understand how to decontaminate local water sources and to develop computer technology to code anti-bullying role playing games into a Spanish language version.

It was often the case that the supportive and friendly mentors played a significant role in creating these friendly, intimate spaces. Here, a Latina, junior majoring in Physics at Southwest University discusses this idea:

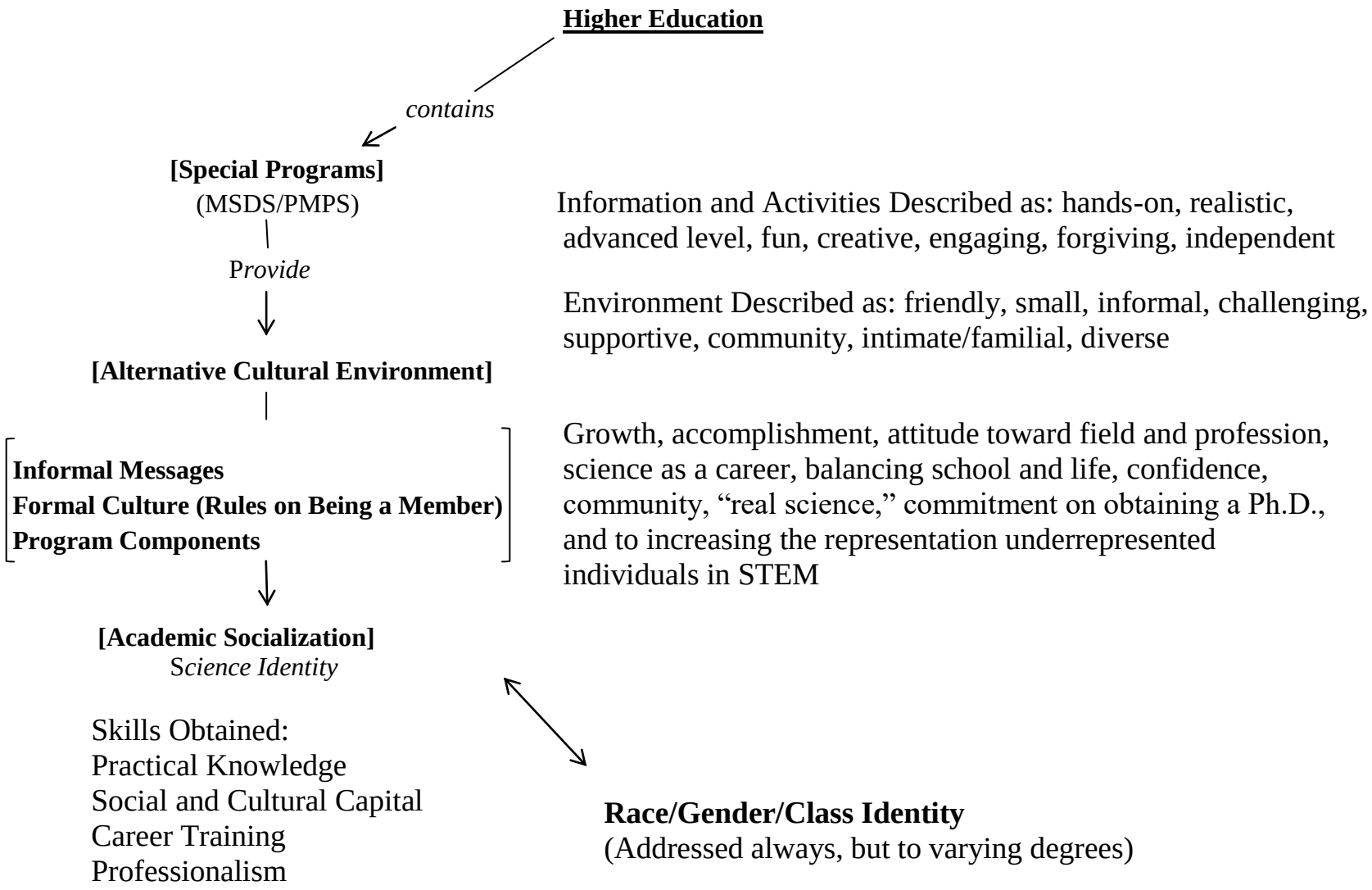


Figure 2b: The Alternative Academic Environment

> …. something really valuable [that] I found with them is a support kind of community maybe. Because they [faculty mentor and graduate student mentor] were really friendly people, both of them.… I always thought professors were kind of scary or prejudiced or really busy. But these people gave me their time to teach me something. That's really valuable and you really appreciate that when someone does that. Maybe at the moment I was so scared I didn't notice it maybe. But definitely afterwards, when you start building some of that confidence, I realized that they took that time out of their busy lives to help an undergrad. – *Junior, Female, Hispanic, Physics*

These spaces are often described as communities consisting of diverse student and faculty bodies. The lessons taught here allow for independent study using hands-on techniques that are fun, realistic and advanced (real academic research) that allow for engagement, creativity and the ability to make mistakes. Here, a senior from Southwest University discusses the differences in these environments:

> Being in the lab in a class is so much easier. They're holding your hand, they're telling you, "This is what needs to happen," but conducting research, it's not all black and white. There are so many grey areas and I think working with Dr. [redacted] he really taught me that and he pushed me to understand that it's not going to be easy. It's not going to be an 8:00 to 5:00 kind of thing. It's sometimes 8:00 to 11:00 at night and it's something that you have to work on and be patient with…I think that's helped me with my other research projects outside of lab. – *Post-Senior, Female, Hispanic, Life Sciences*

In this environment, if an experiment fails, it is not the result of an individual failing to be a good scientist and follow the lab instructions. Rather, it is discussed as the result of the scientific process and embraced as a learning experience where the student must think about why the experiment failed and try a new method. Faculty and student mentors reinforce the idea that a failed experiment is integral to the scientific process and a normal part of everyday operations of a lab. Here, two students in the Life Sciences from different universities discuss troubleshooting as a lesson learned from research in alternative academic environments:

> [In a classroom] You don't get to learn the in-betweens and you don't really get to learn independence. It's very, "[f]ollow this, do this," while in actual research, you won't have a protocol that someone just hands you. You make your protocol. You look at the fine details that other people that have done the experiment and you see what they've done. What can you improve? Then troubleshooting is probably one of the bigger things. A lot of research is troubleshooting, because not everything is going to turn out the way that you want it to. – *Senior, Male, Native American, Life Sciences and Technology*
>
> And…
>
> There's a few classes here where it's like, "Oh, this could explain this. This could explain this," but you don't really get a chance to troubleshoot or anything like that and that's what you really learn. I think that's one of the more important aspects of research. If something doesn't turn out, where do you go from there? – *Senior, Male, Hispanic, Life Sciences*

Developing the ability to learn from mistakes and resilience that is part of this learning is discussed by Dan, a Professor of Medicine from Down South University:

> And the advantage of putting these kids in a lab, a real functioning lab, is [that] the people in there have encountered these problems before. They know that not everything goes right the first time. They know that certain things blow up if you do something wrong. So I think that's a big advantage. I think the other advantage, the other thing they learn that many students don't know including the [program] students is that things rarely go right the first time. And you shouldn't beat yourself up over it, you just need to figure out why and then start again and do it the way that will work. – *White, Male, Professor of Medicine*

A senior in the Life Sciences from Southwest University discusses how the development of the ability to troubleshoot and the resiliency helps her see mistakes as an exciting experience that allows for creativity rather than as a failure:

> You're not really worried about messing up because as long as you know what you did wrong, then it's not really a mess up. It's just-- you figure out what you did wrong. So it's even a little more exciting when you do mess up because it kind of allows that deductive reasoning to happen and that's important, I think, as a scientist. To know that things aren't always going to happen-- like, what's anticipated to happen is not always going to happen. – *Senior, Female, Hispanic, Life Sciences*

Once an experiment is complete, the ultimate project is either an academic, publishable paper or a conference presentation. Students are encouraged (and required) to network and present at local and national academic conferences as undergraduates. The student is mentored one-on-one through this whole process by a faculty member (and in the case of MSDS the program P.I.) and many of these individuals adopt a co-mentoring type environment where advanced undergraduates mentor younger, less experienced undergraduates. Eventually, these younger undergraduates become the advanced undergraduate and take on the task of mentoring new students to the lab. Mentoring is discussed in depth in a separate section of this chapter. But to illustrate the value of peer mentoring in this context, a Native American, male, Junior Chemistry major from Southwest University discusses how undergraduates in the program lab settings work together to embrace failed experiments as a normal part of the scientific process:

> But then there was times when we both were stumped, and we were just like, "What do we do now?" and we would just look at each other. And he's like, "Don't worry. I'm a senior, and I still don't understand this. So you're a freshman–it's okay. We're in the same boat." That just helped me, because even if you do have the experience, there's times when you're still not going to know what you're doing, and that's okay [laughter]. So it was great. – *Junior, Native American, Male, Chemistry Major*

The program components are described by participants as early exposure, often the only exposure, students have to what a career in science is really like. Here, a faculty member in Physics and Astronomy from Selective University discusses this:

> You're not going to duplicate the experience in an actual research lab in a lab class. So many things go into that. You're exposed to a much more focused area of science. So the students have to learn in detail about some area, whereas the lab classes are generally trying to cover a broad area of science, given skills that are broadly applicable and knowledge. And then the research that they do with the professor is much more focused, and then it goes and gets them. So there's knowledge that's associated with that and skills, but then just the understanding of okay, this is what science is. This is what scientific research is like. Again, they're not going to get that

> experience just from classes. – *White, Male, Associate Professor of Physics and Astronomy*

The general, broad environment of low-context, traditional cultural environments like classrooms has the potential to turn prospective, high-context students away from pursuing a career in science. This physics and astronomy professor highlights how Multicontextual research labs, which allow students to apply general knowledge and skills in a hands-on, creative way allow for an opportunity to engage that "goes and gets them" and can facilitate retention in a STEM field in a way that a low-context environment cannot.

As a result of their program experience, many students are able to co-author papers with their faculty mentors. Both students and faculty mentors discuss the benefits of this. First, an associate professor of Engineering from Down South University discusses how the opportunity to publish is both an academic reward and goes beyond just getting "a taste" of what graduate school is like:

> It's not even a taste, all those undergrad students including [program] students; they got the publication at the end of the day as a co-author actually…So they can get the academic reward at the end of the day. It's just not really shadowing, it's a lot more than that. – *Male, Hispanic, Associate Professor, Engineering*

And then, a senior engineering student from Southwest University discusses how having the opportunity to co-author a paper was something he never thought he would be a part of. This opportunity that he did not expect made him feel like he was "getting somewhere" academically:

> Pretty amazing! [I] never really thought about that in my future. And once I got asked to be like a part of that I was like 'wow'! I'm getting somewhere and really being able to further [research] like what's been done. I definitely didn't think that would be available as an undergraduate student. – *Senior, Hispanic, Male, Engineering/Technology*

The informal messages within this environment and formal program components impact the student by promoting personal and academic growth and accomplishment, a more positive attitude about their field of science in general and prospects of science as a career, confidence in individual abilities through engagement with "real science" and a mentor that makes them feel like they are important.

As a result of their participation in program supported environments, faculty mentors and students reported academic growth (36) and general feelings of accomplishment (35). Says one white, female, assistant professor of engineering at Southwest University, "[student name] blossomed under that compared to where he was when I first met him in high school. Where he is now because of [program] is a completely different level." It was common to hear stories where general feelings toward STEM fields and STEM professions changed as a result of the participation in program supported environments (29). Participants also discussed how confidence in student abilities increased over the course of the program research experience (42) and a general increase in confidence about their future professional goals and plans (24). Here, a faculty mentor at Southwest University discusses how she saw her program students develop academically over the course of their time with her. She mentions that not only do they improve their coursework, but they also gain expertise as far as lab techniques are concerned:

> And [the program students are] getting "A's" every single semester. I don't know. It's like they are really getting better. I mean, they were good. And now they are better. And with their academics, they become much, much better; really good! And technique wise, they didn't know anything. So they went from 0 to 100 from the experience. It is amazing. – *Female, Hispanic, Research Scientist, Life Sciences*

For some students, the academic growth they saw was in their own confidence to take courses that previously were intimidating. Here, a senior geology student at Down South

University discusses that her exposure to chemistry related material during her program experience made her more confident to take chemistry courses in the upcoming academic year:

> We get the data, we work with the data, we collect the rocks in the field and we do the analysis too [laughs]. But when I was there, I don't know anything about chemistry. It would be interesting but what's awesome is because I learned so much I think I am now going to the chemistry class. I will get better. Then [after] the first chemistry [class] I'm thinking of taking more chemistry courses. – *Female, Hispanic, Senior, Geology*

The academic growth that occurs as part of the involvement in the program funded environments is noticed outside the lab by non-program faculty members. Here, a faculty mentor at Southwest University discusses a conversation she had with a colleague about the growth they saw in one of their mutual students. Notice the impact that the student's excitement about her program research project had on the faculty member's perception of her:

> And other faculty noticed when she was in their class she was a mediocre student. But then they noticed that when she talks about her project, there's a light on and they get much more excited about it when it's something that they own. So she ended up getting much more engaged with the material and more excited about science than just sitting through a class and memorizing the material. – *Female, Hispanic, Assistant Professor, Natural Sciences*

Beyond general academic growth, students mentioned feeling a sense of accomplishment after their program experience. This accomplishment often came as a result of the independent work that students do. Here, a recent graduate from Private University discusses how the independence led to his own professional growth and confidence:

> I think the thing that I found the most valuable was my level of independence. I think that is the greatest thing…And I don't mean independent as in 'you're confident in order to just do one thing,' but also to take a step backward and evaluate everything that you're doing and question how you can do things better, what you can do different, on top of what you could do in order to make things better. That's where I

> got to at the end of my research with Dr. [Name]. Today, I will find random papers on my own and say, “Let's do this instead,” or, “How about this experiment?” And he'll just be like, “Oh, what did they do? Cool,” and then turn around and just be like, “Okay, do it then.” At this point, I'm independent. – *Hispanic, Male, Post-Senior, Chemistry*

These hands-on experiences with high level work and the opportunity to participate at an advanced, professional level contributed to increased confidence in themselves and their own capabilities. Here, a senior engineering student from Southwest University discusses how she now thinks about people doubting her abilities:

> Actually, sometimes I [think], if people don’t believe in us, look who I am, look where I am standing, look where I am going to be, and once I get my Ph. D. no one can ever tell me something that I cannot do. It’s my life. – *Female, Hispanic, Senior, Engineering*

Some students were initially confused at why faculty chose them to work in their lab. Over the course of their program experience, they were able to gain the confidence in themselves that they were capable of doing this type of academic work. A female, Hispanic, junior Chemistry major from Private University discusses this:

> I would say when I first started, I thought the man [faculty mentor] was crazy, because I had no idea what was going on. But now when I think about science and math and everything, I understand it to the point where I'm helping others, I'm teaching others. I didn't think I would ever have that understanding, but people actually come to me, fellow classmates come to me, because they think that I just get it. – *Female, Hispanic, Junior, Chemistry*

Other students mentioned having confidence in their future plans as a result of the skills they have developed during their program funded experience. Here, a white woman, a junior in the life sciences from Down South University, discusses how her confidence in her ability to enter competitive professional programs has been impacted by her experience:

> Getting into vet school is super competitive. That’s what I’ve been hearing. It’s kind of like scary horror stories about how hard it is to get in. So I think that this really helps me stand out a lot from other people who are probably going to apply to vet

> school. I am really grateful for that opportunity because I know that this will look really good. "Oh she did field work and she did, you know, she did a presentation." – *Female, White, Junior, Life Sciences*

Finally, as a result of their experiences with programs, faculty mentors and student participants noticed a change in student attitudes toward their STEM field and their futures. Here a Latina faculty mentor from Southwest University discusses how she saw a passion for research develop in her students. "Now they are loving it. They are passionate about research. It's like, they are more enthusiastic about learning, reading, you know."

As a result of their work with their mentors, students were also able to learn the many different paths they can take with an advanced degree in their field. Here, a Latino student from Down South University discusses how his experience opened his eyes to all of the different opportunities in his field:

> I mean I still have a general idea of what I want to do, but now I have seen the different opportunities within that. So it's not so constricted to just doing this. I can do research and I can go out into the field and it's opened my eyes to the different opportunities. – *Hispanic, Male, Junior, Life Sciences*

As a part of this eye opening experience, students were able to learn themselves if graduate school was the right option for them. Another Latino student from Down South University discusses how his participation in research and ability to attend conferences to present his research opened his eyes to going to graduate school instead of entering industry:

> That was actually the point when I started working on the project that I did with [program]. The project that I did had to do with math modeling, epidemiology, and so when I did that, I found that it was really fun and it was really cool, and I got to go to conferences and stuff. And at the conferences, I found out about graduate schools. I figured I don't want to go to industry so graduate school seems like the perfect opportunity. – *Hispanic, Male, Junior, Physics*

Another student from Down South University discusses how he was afraid of pursuing his Ph.D. because he had no experience with the process of obtaining one. He did

not understand the difference between undergraduate and graduate education and was hesitant to pursue the Ph.D. because of this. However, during his program summer research experience, he felt that he got a better understanding of what graduate work would entail and left the summer excited about the prospect of pursuing his Ph.D.:

> One of the things I was afraid [of] is, I want to [achieve] a PhD, but I don't know what it's like, grad school. What is grad school? It's like everything. It's like grad school is more difficult than undergrad. That's obvious. But the thing is that you're in undergraduate [education], you take all these classes like humanities, social science, science, sports and in grad school it's only what you like. This [research] is what I like. This is what I want to do. So, you have all the focus on one thing…And then I go to here [program summer research] and these ten weeks I love. These ten weeks fly by because I was so excited so happy so in place. It's just like the summer passed by very, very fast. – *Black, Male, Senior, Engineering*

Program components: Becoming a young professional

While many students started their work with the programs to participate in hands-on research, they were exposed to a number of other professional activities that they were not anticipating including the opportunity to present their research at national research conferences, the opportunity to write research papers and even co-author, and the opportunity to network with other scientists across the nation. Over one-fourth of students (20) mentioned that their activities through their programs were the first time they were exposed to these activities.

Both faculty and students mentioned that the most important professional activities that students are exposed to through the programs are conference presentation (36) and the ability to travel to national conferences (32). Furthermore, participants discussed the benefits of writing academic papers and leaving college with a co-authored publication (19). Participants also discussed how networking as a result of conference travel and participation is an important part of professional development. Some students met their future Ph.D.

advisors and even received job offers as a result of the networking that took place during program funded conference travel. A senior Engineering major from Southwest University discusses this:

> And my mentor, he's the chair of the graduate admissions committee, so he was like 'I am going to write you a letter of recommendation and you better be here next year.' It's okay. – *Hispanic, Male, Senior, Engineering*

Finally, students and faculty mentioned the exposure to graduate and professional school as an important part of the student impact of the program (29). Here, a faculty mentor from Southwest University discusses this:

> I learned that a while ago having [a] nice, friendly conversation and feeling part of something helps. More often at the undergrad level, it's just a lack of information…they're not even thinking about grad school. They're talking about the amount of debt or worried about how expensive it would be and they often they don't have the information that in many fields–like in chemistry and physics–you don't put a penny toward the degree,…and when you learn that and you see that is a different type of investment… students don't know that… I think realizing that [in] many fields you can get a job without actually paying tuition, [students] get very surprised. And that's why these people (program staff) are wonderful because they help. – *Hispanic, Male, Associate Professor, Chemistry*

This supportive relationship with the faculty mentor who invests in the student and provides this type of information has a significant impact on the trajectory of the research participant. The following quotes discuss the role of a supportive mentor that makes the individual student feel as though they are important. The first comes from a Junior Physics major at Down South University:

> I would just like to say I'm very grateful for the opportunity. I feel like without this I don't know what I would do. And I feel like it certainly helped to find my path. Some way, I feel like before this I was really, really lost. I didn't know what I wanted to do at all and being in [program] has given me some confidence as to have some vision for my future. – *Male, Hispanic, Junior, Physics*

A Latina, junior Chemistry major from Private University shares this sentiment, and even discusses her relationship with her faculty mentor using familial terminology:

> I always go to Dr. [Name]. I really do. I just feel–it's really funny, I always tell people that Dr. [Name] is my grandpa [laughter]. Just because if I have a question, I will talk to him about it, just because I know he has the most experience in the field. He's been at Private University for 20-something years… So he cares. He really cares, and that just made me want to try harder, just because I know there's someone there who's watching out for me. He wants to make sure that I'm doing the best I can in everything, and he's going to go beyond to help me in succeeding. It just made me work harder. I try my hardest, I really do, and my work ethics changed - my time is more organized, I schedule time for homework, I schedule time for studying. Just because it's Dr. [Name's] motto to get ahead, I try to get ahead in my classes just so I'm prepared. So it just helps so much. – *Hispanic, Female, Junior, Chemistry*

These Multicontextual environments allow for "authentic relationships" to develop, rather than "aesthetic relationships" that exist in traditional academic environments, where students "build walls" between faculty and themselves (see Valenzuela 1999). Remember, these authentic relationships are an important element of the reflexive process of identity development (Giddens 1991) and without such high-context, authentic relationships, one risks developing a disjointed identity.

Academic socialization: Developing integrated science identities

In my discussions with faculty mentors, I pressed them to state what it meant to be a professional or scientist in their field of study. In other words, what are the skills, knowledge or behaviors that are associated with being a "scientist?" Faculty participants noted that it is important to have curiosity and inquisitiveness, a strong work ethic, a passion for the work, talent, persistence and resilience in the face of challenges as well as experience with professional activities, such as lab procedures, academic writing, conference presentations and the ability to network. When re-examining Figures 2a and 2b, it is clear that while basic information and lab procedures are addressed within the traditional academic environment,

the majority of these characteristics are developed within the alternative academic environments. Some faculty even noted that when reviewing applications for graduate study, they will pass up students who have not had experience within a real faculty lab because they know students with this experience are more likely to persist and thrive in graduate education:

> Well it's (program research) essential. Basically with what they learn – and I don't think how anybody who just takes class work has any notion of what research or what graduate studies is about. And I've been for years on the graduate admission committee for chemistry too and that's actually something we're looking at…we want to minimize the risk of the people that we accept in the program… because from class work itself people have no clue what this [research and graduate work] is about… – *Hispanic, Female, Associate Professor of Chemistry and Biochemistry*

One might argue that students have the opportunity to independently engage in academic, faculty research without the help of these programs. However, in my work with students, I found that many of these individuals had tried to join a faculty lab prior to their work with programs and were overlooked and rejected due to high admission standards (often based on one-dimensional criteria like GPA) or a lack of experience approaching faculty in a manner that would allow them to gain entry to the environment. In these cases, experienced program staff members were able to see the potential in these students and work as a gatekeeper to help them pass into these competitive environments. Seven of the interviewed students were rejected from such programs before being accepted into program labs. It is important to note that these previously rejected students are still good students that show a lot of promise. Here, a Latino, senior Engineering student from Down South University discusses the impact of eventually being accepted into a research lab after being rejected in the past:

> Well, if we're not for [program], I would not be here. And this is my first summer experience, and last sadly because I am graduating. Besides my good GPA and everything, my good letters of recommendation, apparently I am not that awesome at writing personal statements and that didn't get me into other REU programs for summer internships and stuff. But this year I got into Down South University's [program]. It's like awesome... thanks for the funding and everything. I'm here and like, whoa! There's so much I didn't know about research, about grad school…This is a whole new experience for me. – *Hispanic, Male, Senior, Engineering*

This demonstrates that programs play an important role in exposing these students to opportunities that they would not have been exposed to in a traditional academic environment as well as serves talented students who are overlooked by other research opportunities on campus that privilege a certain type of student. The following exchange is with Claire, the white, female student in the BioChemistry program at Midtown University. Here, she discusses how program mentors helped her navigate the politics of being accepted into a faculty lab and even stepped in to help ensure she was considered for an interview:

> REBECCA: That makes sense. So you applied and got rejected the first time. Did they help you understand what was going on with that?
>
> CLAIRE: Um it might have been a logistics issue, but um I got a very vague response I don't know if this is necessarily true, but she told me something when I applied, when I applied the second time that the first time I applied I was a sprinter.
>
> REBECCA: A what?
>
> CLAIRE: A really fast-moving person and she was training long distance runners.
>
> REBECCA: Did you understand what she was talking about?
>
> CLAIRE: No and I didn't want to press into it for a couple of reasons. Um not like what the heck are you talking about and I didn't want to make her justify it either…I didn't want to make her justify her comment. That's why I didn't ask.
>
> REBECCA: Yeah but you still came and re-applied…Why?
>
> CLAIRE: It also takes really good advice from your P.I., like being in the lab is a really incredible culture to be a part of because they, those are people that have uh done what you have to do and they've made the mistakes and they're gonna help you

> not. You're just gonna say, "Well you apply again." And I was like wow. And she goes and wait until you apply for grants, [laughs]
>
> REBECCA: [laughs]
>
> CLAIRE: That's gonna be eight, nine times before you get one. I was like okay I will just be bold, jus' if you want something ask. They say no, ask again…[Program P.I.] contacted her for me. I got set up with an interview.

This process led to the student eventually being accepted into the research lab. Undergraduate research opportunities are highly competitive and sought out by a number of students – both underrepresented and from privileged backgrounds. Because of the large pool of students with very high GPAs, many promising, talented students are overlooked by a selection process that is not unlike one at a highly selective school. Because these programs cast a larger net and rely on the faculty recruitment of what they see as promising students, stringent admission criteria do not filter these students out before they have a chance to perform. A discussion of these alternative criteria is discussed below in the section on mentoring.

In summary, I found that the alternative, Multicontextual environments experienced by students within programs impacted student participants in a number of ways, primarily through the support to do hands-on, high level research. As a result of their experiences, student participants are exposed to a diverse community of mentors and peers that they turn to for support within and outside of their research lab. Student participants also show academic growth, a sense of accomplishment, develop confidence in themselves, and change their attitudes about their field and their future. Students also engage in a number of professional activities, such as conference travel, presentation, networking and professional writing that they were not initially expecting from the program. These activities result in

students being exposed to graduate and professional school, sometimes meeting their future faculty mentors and even leave college as a co-author on a published paper. Ultimately, students are able to develop a majority of "soft skills" that faculty associate as being integral to the development of a "science identity" that they would otherwise not be exposed to as part of the traditional academic cultural environment of the university.

Mentoring and community: Creating a safe space

Beyond this exposure to high-level, hands-on research, student and faculty participants also mentioned the exposure to a community of like-minded scientists and the support that comes from that community as a benefit to their participation (48). This community included the research lab environment that consisted of at least one P.I. (the faculty mentor), graduate students (16) who play a role in mentoring the undergraduate students, other undergraduates with various levels of experience that participate in co-mentoring activities (10) and other underrepresented minorities at all levels (undergraduate, graduate, faculty).

In these environments, a team approach to mentoring develops organically. While the faculty mentor plays a leadership role and has frequent contact with her or his program undergraduate, they often employ the help of graduate students to teach the students procedures and get them up-to-date on experiments. Here, Dan, a professor of Medicine from Down South University discusses how he utilizes peer mentoring in his lab:

> So, you can couple students together to get them to share their experiences and have a better opportunity and better chance to do what they want to do. Many of these students have a vision, and some of them feel like they can't achieve what they're trying to get at because they don't have somebody in the family or somebody that is going to give them a path. If you help them get a path, many of them can do it. – *White, Male, Professor, Medicine*

An associate professor of Psychology from Southwest University discusses how this co-mentoring environment also benefits the advanced students that are in the co-mentoring relationship in terms of self-confidence and a sense of belonging to the lab environment:

> …. in their second semester new students come in and now they can show the other students how things are done. They gain a lot of confidence. There's a sense of the things that these more junior students are learning. It's something they know already they can show them how to do. So I think that boosts their confidence and also makes them feel that that they belong to a lab. This is somewhere where they've acquired some mastery, some expertise and they like to be there. – *White, Female, Associate Professor, Psychology*

Furthermore, peer mentoring is often used where younger students are paired with more advanced undergraduate students. This gives the undergraduate an opportunity to learn how to teach and train before they even have their bachelor degree. The community approach to mentoring was appreciated by many students. Here, a Latina, senior biology student at Southwest University discusses this:

> That was my very first research, yeah. I was completely mind-blown. I had no idea what I was doing. I also knew so many other people that were in the program too, and that were getting funded with Dr. [Name], that I seek their help and their guidance as well. That just touches up on back to the whole community thing here at Southwest University. You can talk to Dr. [Name]. He's always there to mentor. You also have your peers that you can talk to, other professors, if you have further questions. We're all helping each other out. That's what I like. – *Hispanic, Female, Senior, Biology*

Students described their relationships with their faculty mentors in very positive terms (21). The most common descriptions of mentors included that mentors were "awesome," very supportive, experienced, and accessible. Here, a Latina junior in the life sciences from Private University discusses how working with someone that she sees as experienced inspires her to "be like him" in the future:

> He is very nice. I think he has a lot of experience with students, working with them. He really cares about student opportunities and helping them grow as scientists and I was very thankful and excited about that because he's so knowledgeable. I've seen all

> the work he's done like just the lists of things he has published and I feel so happy to be able to follow in his footsteps. In a way [to] be like him. – *Female, Hispanic, Junior, Life Sciences*

Another student from Down South University discusses how this supportive and kind relationship that she developed with her faculty mentor made her challenge her view of professors as being "scary," "prejudiced," and busy. Remember the exchange from above:

> …. something really valuable [that] I found with them is a support kind of community maybe. Because they [faculty mentor and graduate student mentor] were really friendly people, both of them.… I always thought professors were kind of scary or prejudiced or really busy. But these people gave me their time to teach me something. That's really valuable and you really appreciate that when someone does that. Maybe at the moment I was so scared I didn't notice it maybe. But definitely afterwards, when you start building some of that confidence, I realized that they took that time out of their busy lives to help an undergrad. – *Female, Hispanic, Junior, Physics*

Finally, the mentoring relationship that develops as part of the program funded experience often expands beyond the lab environment. Students respect the experience of their mentors, learn to trust them and approach them with issues that they face outside of the program experience. Remember the quote from above from Private University student on how her faculty mentor inspires her to be a better student:

> I always go to Dr. [Name]. I really do. I just feel–it's really funny, I always tell people that Dr. [Name] is my grandpa [laughter]. Just because if I have a question, I will talk to him about it, just because I know he has the most experience in the field. He's been at [Name of School] for 20-something years… So he cares. He really cares, and that just made me want to try harder, just because I know there's someone there who's watching out for me. He wants to make sure that I'm doing the best I can in everything, and he's going to go beyond to help me in succeeding. It just made me work harder. I try my hardest, I really do, and my work ethics changed - my time is more organized, I schedule time for homework, I schedule time for studying. Just because it's Dr. [Name's] motto to get ahead, I try to get ahead in my classes just so I'm prepared. So it just helps so much. – *Female, Hispanic, Junior, Chemistry*

The program environment also has an impact on the faculty mentors that are involved. Faculty mentors report having frequent contact with their program students. This contact

ranged between daily (6), weekly (10) and sometimes monthly (1) contact. In their mentoring activities, faculty members often utilize the help of other individuals who are already in their lab. For example, graduate students were used to help mentor undergraduate program students by 13 faculty members. An additional 11 faculty mentors utilized a co-mentoring model where upper-level undergraduate students were paired with younger, less experienced undergraduates. The utilization of graduate student mentors as well as co-mentoring models were seen as positive by the student participants. Here, an assistant professor of Engineering from Down South University discusses how having program students in his lab impacts graduate student development:

> They help mentor these students so I think it gives them an opportunity um to be a leader …You're taught how to do research. You're not being taught the mentoring skills and I think it allows me to basically have them co-mentor somebody and see what it is to manage people…You're not getting a helper. You're not getting a dishwasher. You're getting somebody that actually has their own project and you have to guide them and it's really I think a tremendous opportunity. I know a lot of people, guys and gals, who have gotten their PhD's and have never mentored somebody else. It's tough. It's tough and people, people step up. People do, and I think that takes away a lot of that fear. – *Male, Asian American, Assistant Professor, Engineering*

When I asked faculty about why they became involved with the program, their responses made it clear that the program impacts the mentors as well as the students. Furthermore, faculty participation in the program can influence broader change within the traditional academic departments, as is represented in Figure 1: *Relevant Concepts and Processes*. For example, 19 faculty mentors mentioned that the program helps them in their efforts to include undergraduate students in their lab. Programs facilitate these efforts by providing a financial incentive that faculty can use to recruit the students and keep them in their lab. Furthermore, 10 faculty mentors mentioned that the supplies stipend provided by

the programs, while modest, had a positive impact on their lab research. Of these faculty mentors, 9 specifically mentioned that program support helped them in their efforts to increase the student diversity in their labs, which they see as a step toward diversifying their own departments. Here, an associate professor of Psychology from Southwest University discusses how the program played a role in his efforts to diversify his lab:

> Since I became faculty, one of the things that I wanted to do was try to promote the involvement of underrepresented students in my lab. And one of the things that I noticed from the beginning was that it was really hard. Even though you know I teach also in psychology and I see the make-up of the undergraduate community, and it's pretty diverse. Yet all the students that apply to work with my lab… in terms of ethnicity they're all Caucasian. And even though we make an effort….to recruit undergraduates who have a minority background, we're not able to do it. So…when I heard about [program], I thought this is a fantastic incentive to get students involved and it has worked. Now our group is a little bit more diverse. So typically we have one or two [program] students and that has helped. I think it has created a better environment in terms of this idea of people that otherwise wouldn't have much in common finding common-ground in their research interests. – *Hispanic, Male, Associate Professor, Psychology*

I also noticed an unintended impact of the program on a few faculty mentors. Some faculty started their work with the program to receive financial support for undergraduate student researchers as well as utilize the supplies funding. However, in the process, they realized their attitudes towards working with underrepresented students changed in a positive way. Here, an associate professor of psychology from Southwest University discusses how he sees the underrepresented students differently than many other students who come to work in his lab. He mentions that these students make a special effort and often see the experience as an opportunity rather than one more requirement:

> …whereas many other students they take it as if it was another course or another academic requirement that they have to complete, for a lot of the minority students, they've already overcome this problem, this idea that they're excluded in some way from doing research. And so…they make a very special effort that I see is reflected in their work. That also was somewhat of a surprise when we started seeing it and we

> decided that that was good. That was something that we wanted to keep. A lot of students in the past in particular would take it for granted that uh they were not really as committed as we wanted to the work in the lab. Because they felt this is another course, it's something else. Whereas the minority students in particular, not all of them but most of them for sure, felt a different level of commitment. You can tell this was a struggle. This was not something that was an easy decision that they make. – *Male, Hispanic, Associate Professor, Psychology*

Another faculty from Southwest University recalled seeing faculty members in his department who initially started with the program to help financially support a student. However, over the course of their interaction with the program student, their attitudes toward minority students were challenged and their interest in working with these students grew:

> I actually know a couple of faculty members relying on this [program] grant greatly. I have actually seen that they were initially not interested in minority education and then since this is their only [financial] resource they have, they are forced to work with the minority students. And then they actually found that they may have some prejudice. [For example] 'all the Hispanic students are lazy,' that kind of stereotype that you know [learn] that's not true. – *Male, Hispanic, Associate Professor, Engineering*

Finally, knowing that there is a source of financial support for underrepresented students to engage in STEM environments encourages faculty to look out for and reach out to these students on their campuses. According to a white, male Physics Professor from Selective University, program funding "makes us very aware of our minority students, makes us very anxious to identify them and to talk to them about getting them support."

To summarize, program participation impacts faculty mentors in a number of ways. The funding provided through the programs help faculty get talented students involved in their lab that otherwise may not have the opportunity. The supplies funding also provides an incentive to get faculty mentors involved. Program funding helps faculty mentors as they work toward diversifying their lab environments and in some cases, challenges faculty attitudes towards working with minority students. The impact on faculty mentors has the

potential to change traditional academic environments so that they are more Multicontextual, by creating a welcoming and supportive environment for underrepresented STEM students as well as increase the awareness of these students on campus and even influence faculty who may not have otherwise been interested in recruiting minority students into their faculty labs, thus influencing change in the broader cultural environment.

Attracting and recruiting faculty and students into STEM: Humanizing STEM environments

In this section, I discuss topics related to the recruitment of potential program faculty mentors and students. The PMPS program uses a somewhat non-traditional model of student recruitment, so I wanted to examine this aspect of the program. In this section I discuss how faculty mentors and student participants heard about PMPS, factors that attracted PMPS students to the program, the challenges in recruiting undergraduates and potential faculty mentors to the program, factors that make a good program candidate, and advice for working with underrepresented STEM students. I follow this with a discussion on the overall framework of MSDS, as it is quite different from PMPS, and how this variation impacts students differently.

PMPS recruitment and mentoring: The value of faculty led recruitment

In this section, university identifiers are removed to protect the confidentiality of participants. I asked faculty mentors and student participants how they heard about the PMPS program. Students were primarily recruited through faculty mentors or other university administration (23). For students who were recruited through faculty mentors, they had already had a relationship with the faculty mentor and the mentor helped them find program funding to either support them as they entered or continued in the faculty mentor's lab. Some students approached faculty (9) looking for opportunities to work in their lab that

they had read about online or heard the faculty talk about in class. One decathlon participant heard about PMPS funding through a friend who had just received support to attend the decathlon.

Faculty primarily heard about PMPS through other faculty members that had received funding in the past (15). Some faculty mentors were still involved after being part of the original team that developed the PMPS program (4). Two other faculty mentors had found PMPS during their search for programs aimed at increasing the representation of minority students in STEM fields. They had worked with programs similar to PMPS in the past at other institutions and were looking for opportunities to become involved when they moved to their current institution. One faculty mentor was served by PMPS as a graduate student and decided to continue working with the program as a faculty mentor after she finished her education and took an academic position at her campus. It is important to note that many current PMPS students also embraced this desire to mentor underrepresented students in the future as a result of their program participation. This lends further support to the role the program plays in increasing broader cultural change within traditional academic environments in the years to come as these undergraduate become graduate students and then faculty.

Faculty mentors discussed a number of challenges they face when trying to recruit potential students and faculty mentors to the program. However, most faculty were unsure of how to improve recruitment of participants and wanted more information on how to attract minorities to the STEM fields and help them thrive in STEM research environments. For faculty mentors who did have insight on challenges in recruiting, they mentioned that students are often unaware of the opportunities to participate in a faculty members research

lab and that there are programs to support their participation (4), because of non-traditional academic paths (3) they may not feel comfortable approaching faculty about working with them (4). And finally, underrepresented students can sometimes have a skewed vision of science (4). This vision includes needing to be "super smart" to participate and that research in a lab is not something in which they would want to participate. Here, a faculty mentor from Southwest University discusses the problems of this skewed vision of a researcher:

> …there is a sort of expectation, there is an image about what a researcher looks like and it's not them. And I think that's terrible. But those students don't show up in my lab. The ones that show up in my lab do it after surpassing the problem. So I think that's the main issue. There is this idea that if you're going to go into research you have to be super smart, you have to be you know three standard deviations above the mean and that is a trend for them. – *Female, Hispanic, Associate Faculty, Psychology*

Here, Wesley, a Black student from Midtown University discusses this skewed vision of science that he had prior to entering a program lab. The conversation starts off as the student was discussing how his dream in high school was to enter a field in order to help people. Therefore, he was considering a medical degree even though he was interested in STEM courses and a career in science:

> REBECCA: So you started your path towards really wanting to become a scientist pretty young, junior high school type-- can you remember at that time, what was it that you thought a scientist did? What is a scientist at that time?
>
> WESLEY: Oh, a scientist?
>
> REBECCA: Yeah.
>
> WESLEY: At that time--Even a little bit in high school, I thought scientists were either these people who like work in NASA or astronauts or like who did these huge technical innovative things or they could just be people who are really boring and dig up rocks and stuff. But now, I realize, every one of those things are so important. Every job that we have is so important. Even the geologist is so important.
>
> REBECCA: Was there ever an image that you had in mind about what a scientist-- what does a scientist look like?

WESLEY: Albert Einstein.

REBECCA: Albert Einstein?

WESLEY: That's it. That was it--I know, the crazy hair, old guy, eccentric. Crazy white hair, and he was old. He's a scientist. That's it.

When asked about the challenges of recruiting other potential faculty mentors, current faculty mentioned that the time commitment of training undergraduate researchers (8) as the primary reason faculty may be hesitant to get involved. They also mentioned that the small grants for supplies to the lab and the low pay for the students may deter faculty from making the significant time commitment to train these students (5). Finally, a few faculty mentors mentioned that their colleagues may be unaware of and uninterested in these types of programs for undergraduates (4).

Attracting underrepresented students to STEM environments. To support the efforts of faculty mentors in recruiting underrepresented students to their labs, I asked students to identify what made them interested in STEM research and working with their respective program. I found five primary areas that were discussed as "attraction factors" to these environments. Most students discussed that the opportunity to learn and participate in "hands-on" on real research (30) that was fun (18) was what drew them to these experiences. A Latina, junior Chemistry major discusses how these factors attracted her to the possibility of academic research:

> I think the one thing that caught my interest was that it was just researching. It was a whole new environment. As I was telling you yesterday, I grew up in a low-income family, low socioeconomic society, that in school we didn't have those opportunities. We were given textbooks, and that was our research. So just being able to go into a lab just caught my interest, because I never had that opportunity. So I was like, "yeah, I would love to do this hands-on." – *Female, Hispanic, Junior, Chemistry*

I found that opportunities to engage in altruistic research were just as important to students as the ability to participate hands-on. The research projects that the faculty mentors were working on drew them to the environment because they saw the work as a place where they could help communities around them and make the world a better place (29). Here, a student discusses how her initial reluctance to become involved in serious research was displaced by feeling the need to help a community:

> I was like, 'oh my god, I don't want to do this.' But I feel that I have to. There is a community living there. This research is going to help what is going to happen in the future here–the future generation. And I say, 'okay, I am going to do this'…I link it to that because I want to help people at the same time I am doing science. I don't want to do science…without people who make use for it…So I think that's good. Believing [in] the problem, [is] believing in the solution. Believe that you will get because it's better for our society. That's what I believe. – *Female, Hispanic, Senior, Geology*

Another student discusses how initially she was unsure of the research that her faculty mentor was working on. He encouraged her to learn about the problem by watching a popular movie about how the problem impacts real people. This allowed her to connect personally to the issue:

> And so that's where I was like, 'okay, I guess I'll look into it.' And then it was just the chromium idea. They're pumping chromium throughout water, and these people and these towns were affected, and they were having cancer, getting cancer. I was like, 'oh, this is an actual problem.' So that's where I started my research. It might be so simple to watch a movie, but it actually helped connect what I'm doing. – *Female, Hispanic, Junior, Chemistry*

Another student discusses how her experience with an impersonal medical system while her mother was sick influenced her to be a change agent in what she saw as a flawed system. She became involved in her research to help people. Her program mentor supported her and encouraged her to work toward this goal:

> I think with all of that, I just wanted to be able to help people. I saw how my mom was treated when she had lymphoma cancer. I'm not dogging on any of the doctors.

> People are just different. The way I saw her get treated, I wanted to get into the field, and hopefully implement some change. I feel like working with Dr. [Name], he really inspired me to keep pushing forward. He's one of those guys that just-- you don't want to disappoint him. But at the same time, it's all about constructive criticism and developing your skills and getting better that way. – *Female, Hispanic, Senior, Biology*

Some students even mentioned that they decided to forego their pre-medicine plans to do academic research because they saw research as a place where they could impact more people and make a larger impact on the world around them. Here, an international student discusses this idea:

> Well, I'm from a third world country so uh the reason I wanted to be a doctor is because I wanted to help people. But it's not enough. Doctors help, but if they don't solve healthcare problems, technology by itself won't do it. So we need to provide tools and stuff to the doctor to do their job. So, by middle school I had already decided I wanted to get an engineer [degree]. Which type of engineer [degree] I had really no [idea]. When I started school I was going for electrical engineering. I didn't know about BME [biomedical engineering] until I [came] here. – *Black, Male, Senior, Engineering*

Aside from being involved in "hands-on" and "fun" research that has the potential to positively impact the world around them, students were attracted to being a part of a diverse community on campus, especially one where they were surrounded by other students of similar backgrounds (24):

> I was surprised that the PMPS officers, like [Name], she's Hispanic. And [Name], she's from Peru. Stuff like that. [Name] is Spanish, or part-Spanish. All these people are from different cultures. I feel like, 'cool.' I felt very accepted coming in. I guess that's something that I really appreciate about PMPS, because I've also worked research in the physics department and it's quite different there. You don't see any [Hispanics] (chuckles). I'm probably the only Hispanic female in physics. – *Female, Hispanic, Junior, Physics*

Students talked about diversity of the communities in a variety of ways, including having a female P.I. (when many of their instructors were male), working with other students from underrepresented backgrounds, being in environments where they felt comfortable

speaking Spanish, and being around people from other disciplines. Nearly one-third of the students mentioned that they enjoyed being around students and faculty from other disciplines and learning their perspectives on common research problems:

> Well, here, I feel good. I feel that no matter if I'm woman or not or Latina, my advisor just says 'okay, you're welcome, let's go work in the lab' even if I am a geology major and they are chemistry or environmental science. – *Female, Hispanic, Senior, Geology*

Being exposed to a diverse community of scholars was comforting to the underrepresented students who participated in the programs. It let them know that they were not alone and belonged in the academic environment where everyone was smart and capable, regardless of their skin color:

> Being with PMPS it's nice to know that there are lots of minorities out there, but they are just as smart. They are just as good as everybody else regardless of skin color. They have so much more to contribute. And it's nice to be part of that community. – *Female, Hispanic, Senior, Biology*

Finally, receiving stipends (13) and having supportive mentors (10) were programmatic aspects that attracted these students to the program supported research activities. In summary, students are attracted to the program environments for a number of reasons. Among them is the opportunity to engage in hands-on research that has the potential to positively impact communities around them. Students are also drawn to the diverse communities that the programs create and support. Finally, having funds and supportive mentors draws students toward the program to engage in these activities.

Factors that make a good candidate for research lab. To further promote faculty understanding of how to recruit and support underrepresented students in their research labs, I asked them about their experiences working with program students in the past. I started by asking them what they look for in a potential student that lets them know they will be a good

candidate for their lab. Faculty mentioned that a commitment to the work (12) and a genuine interest in science (11) were the two factors they looked for most. Here, an associate professor of engineering discusses what she sees as very simple screening criteria for a good candidate for her lab – the courage to ask a question:

> For me, if a student comes to ask me a question, they are a potential program student. And of course, if they fit the criteria of PMPS, right? If they ask me a question, regardless of what that question is. So it's one criterion that I have, and it's very simple. If they have enough courage to ask a question, regardless of what that question is, then I see potential in them–very simple. – *Female, Black, Associate Professor, Engineering*

An assistant professor in the natural sciences discusses further how a genuine interest in the research project can lead to student retention in the lab:

> The main thing is a genuine interest in what we're doing. So coming to me saying, 'I'm excited about how plants grow, I'm excited about how fungi interact with plants.' You know students have come to me with like, 'heard this in class and I think it's neat,' or 'my family has started an organic garden. I'm interested in that.' So they have a genuine interest means that they're going to do well in the lab. So you can just talk with them and understand they're interested, they're going to stick with it. – *Female, White, Assistant Professor, Natural Sciences*

For some faculty, seeing a genuine interest in science and the desire to improve one's own economic circumstances are more important than a "super" academic background. Here, a professor of Chemistry discusses this:

> Well I can, first I talk with them and they are interested in science. Even though if their background is not super but they are excited. Okay, [its] something that they find that it is interesting for them. And then one thing that is pretty obvious is…that they want to do good for themselves. They know that by studying and going into science they will probably improve their economic status in society. And I don't know if you know, his name is [name]…He is a PMPS student and this is exactly what he told me. *–Female, Hispanic, Professor, Chemistry and BioChemistry*

Beyond a genuine interest in science and the ability to ask a good question, faculty mentors mentioned that a documented strong work ethic (5) and good academic record (4) were important factors to consider when recruiting potential program students to their labs.

Working with program students. I asked faculty mentors if they had advice for other potential faculty who are beginning their work with underrepresented students in their lab. The most common response was that faculty mentors need to understand the backgrounds of their students and that they may have taken non-traditional paths to get where they are today (23). Here, an associate professor of Psychology discusses the need to understand that the role of a faculty mentor should be to help expose the program student to a world of science they may be unfamiliar with due to different backgrounds:

> Well, I think that something that is particularly important with the PMPS students is that the students are in a very peculiar situation, and [they are] aware of that. That these are folks that have an enormous interest in pursuing a career in science and they are exploring the air, exploring to see if this is really for them and that faculty should be facilitating that. Facilitating the exploration more than steering them in one particular direction or another, just showing them how things really are…they come with a different history. They have overcome different challenges than their peers. And mentors should be aware of that. Often, this was not an easy decision for them to make. I mean sometimes–in our case, more often than not–these are students that are first generation college students. They don't know what it is they're supposed to be doing. – *Female, Hispanic, Associate Professor, Psychology*

This professor then discusses the importance of making sure the underrepresented student feels welcome in the lab and that their capabilities are not questioned:

> … minority students are really excited. They come with excitement but [they are] also very intimidated by the fact that they don't know what they're getting into. So making them feel comfortable in the lab, making them feel welcomed in the lab and that there should be no question of their capabilities to do this. That's the kind of thing I focus most when I am working with them. – *Female, Hispanic, Associate Professor, Psychology*

Understanding that their program experience may be the students first exposure to "real life" science outside of a classroom as well as the potential to go to graduate school (8) was mentioned by over one-fourth of the faculty interviewed:

> These are kids; they very rarely consider graduate school. I don't think it's on their radar. I mean, to have kids that don't even know what it is and what it does for some. These are kids that are usually getting into a B.S. program [that] is already an achievement so high that they never thought about anything else after that. Because they were already doing something that most of the time was a huge achievement. So some are so good and they have [it all.] They're qualified and they're really good material for grad school, so just identifying these kids, giving them information and the environment, to me, that's huge. I had a student last semester, my last PMPS student. He didn't even know what [the concept of] grad school meant. So in a few years, he's getting ready to apply. What's better than that? That's exactly what it is, it's just opening doors. – *Hispanic, Male, Associate Professor, Chemistry*

Faculty mentors recommended that other faculty learn how to listen to their students and find common ground (10) in order to understand their backgrounds and how to best serve their students:

> Just listen. Listen with three ears. Okay, find out their background, their family background, their socioeconomic background, their ethnic background, and be very clear about that. Be very clear about not putting them down. On the contrary, be supportive. Turn anything and everything into support and, 'yes, you did it right, that's all you need, that was the only option you had.' Just turn everything in psychotherapy school utilize - anything they throw at you, you utilize the positive. – *Hispanic, Female, Associate Dean, Graduate College; Professor, Psychology*

Finally, faculty mentors mentioned that their program students are high caliber, very good students (17). Here, a Latina professor of Psychology who works with many underrepresented students on her campus discusses how the quality of the students has slowly impacted the faculty that they work with:

> They are high caliber, okay, but that has taken a long time to imbue the mentors with [the idea], 'you're not getting a runt, you're not getting somebody who's damaged, you are getting a kid who's just as good but maybe better because he's been through so much." They have success when treating them as a young graduate student with

> responsibilities rather than a research assistant who is just cleaning dishes or entering data.

She continues:

> We treat them like grad students, we don't cut them any slack. The hilarious Latin-American students were talking and at the end were saying, 'well we haven't seen you in four weeks!' – 'I was in the lab! I couldn't get out! [laughs]

A director of recruitment and diversity initiatives at one university (I am withholding the name to protect confidentiality) agrees, noting how much she enjoys working with program students due to their motivation and curiosity:

> I love working with the PMPS students because they are so motivated. They are so curious. As an example, in the summer program…it is amazing to me when I see a student from maybe a nutritional sciences background asking faculty in cancer biology questions that are really, really relevant to both parties. They're making connections based on their field of study to a different field of study and that happens all the time and in really deep ways. Faculty [mentors] consistently say to me and in front of the class, "That's a great question, I am so glad you asked that." And I think sometimes they're a little bit surprised by the quality and the depth of the questions that the students ask. I think that I draw a lot of energy from that and it makes me feel like we're building a community with the students and with the faculty so that they all trust each other and learn from each other. – *Female, White, Director, Recruitment and Diversity Initiatives*

Promoting the values of a diverse research lab and reinforcing the idea that minority students and women do not come into the setting as "runts," but rather as high-caliber students with backgrounds that contribute to the vibrancy of the scientific community can help reinforce that racial and ethnic identity is both positive and invigorating, something to be fostered and celebrated within these environments. (See Figures 1, 2a, and 2b for the role of race/gender/class identity within the broader logic.)

To summarize, faculty mentors provide some key insight into working with and supporting underrepresented students in their labs. They encourage faculty to look for students with a genuine interest in science and a commitment to the work. They mention that

sometimes these two qualities over-shadow a less-than-perfect academic background. Once students get to the lab, faculty mentors stress the importance of listening in order to understand the student's background and making them feel welcome and comfortable in the lab. Finally, they remind faculty to not forget that their role is to expose these students to the opportunities of a career in science and the potential to go to graduate school. Faculty mentors discuss that the program students that they mentor are high quality and should be treated as such.

MSDS recruitment and mentoring: Merging personal life with professional activities

This section outlines the MSDS program recruitment and mentoring styles. All university identifiers have been removed and names have been changed to protect the confidentiality of research participants. The MSDS program employs a different model of student recruitment and mentoring than the PMPS program. In my work with students from both programs, it was clear that the differing models have a differential impact on students. Instead of a faculty driven recruitment model, MSDS recruits students primarily through posting a student job advertisement on the university's student employment website, a low-context practice. The job description is for an undergraduate research assistant in the sciences from a minority background. In some cases, MSDS students heard about the opportunity to join MSDS during large seminar classes on campus where current MSDS participants act as recruiters by discussing the program and encouraging interested undergraduates to apply through the university's employment website. Still other students heard about MSDS from a friend who was a current participant and encouraged them to apply. Interested students then apply for the job through the university website and are contacted by the program P.I., Stacy, who identifies as Hispanic and Native American, for an

individual interview. During this interview, Stacy determines if the student would be a good fit with PMPS and either offers admission into the program or not.

I conducted multiple interviews with Stacy about her role as a program P.I. because she takes on a large role as a faculty mentor to the MSDS students. This is very different than the faculty driven recruitment of PMPS students, where faculty mentors in the lab play the largest role as mentor. The MSDS admission criteria are more stringent than for PMPS students and there is a clear GPA cut-off for students. Students all must be advanced students, having completed 60 hours of undergraduate coursework and are encouraged to stay in the program their final two years of undergraduate study. However, Stacy has mentioned that she reviews students on a case by case basis and sometimes GPA requirements can be overlooked for an otherwise promising student. During her interview with students, Stacy probes them about why they are pursuing a career in the sciences, their background, and tries to gauge if the student possesses a commitment to increasing the future diversity of STEM programs.

Once students are admitted into MSDS, there are two separate years of program activities. During the first year, Stacy helps participants find a research lab and helps them navigate the process of gaining entry into that lab. There are times where she steps in to encourage faculty to take on MSDS students. This is different than the faculty driven recruitment of students to labs that occurs within the PMPS program. After students enter into a research lab with a faculty research mentor, the processes that they are exposed to within that lab environment are similar to the PMPS students, where they engage with hands-on, high level research that result in co-authored papers and conference participation. It is a requirement that after year one of research activities, or in some cases a summer research

experience, students present at multiple research conferences, including one local program conference, a national program conference, and national conferences specific to the students discipline. Students present posters their first year of the program and by year two are giving 20 minute talks guided by PowerPoint presentations.

MSDS program activities differ significantly in that Stacy requires MSDS students to attend weekly seminar meetings where all MSDS students attend. There is one seminar meeting for first year students and a separate seminar meeting for second year students. It is within this seminar class where Stacy performs a majority of her mentoring activities. During year one, Stacy employs a number of high-context activities that work to reach the individual student at a personal level and encourage them to think about their individual backgrounds and how their past experiences have led them to where they are now. She uses four principles (discussed in depth below) to help them understand who they are, what they are passionate about, and how to integrate their individual identities with the new identities and experiences they have at the university as they pursue an advanced degree in STEM fields. During year two seminar classes, Stacy works with students on preparing for the GRE, MCAT and graduate school search and application process (including locating potential graduate programs and helping students construct personal statements.) During year two, Stacy's four principles are utilized to help students make difficult decisions on where they should pursue graduate study and also help students navigate difficult experiences they have on campus.

MSDS principles, origin and practice. During my meetings with Stacy, it was clear that the principles play a significant role in structuring the program and her mentoring activities. The following section details the origin of these principles and how they are

presented to MSDS students. Stacy is clear that her intent of presenting the principles to the students is to bridge the students lived identities as underrepresented students with the development of their identities as scientists, a Multicontextual task. She feels that the students' background experiences, especially as they relate to race, ethnicity and social class, are important to their development as scientists and resiliency in the future. This act explicitly creates a Multicontextual environment by allowing the student emotionally connect who they are as an individual, based on their life experiences, to how they develop their identity as a scientist, which is not addressed in the traditional cultural environment of academia. The principles help merge this personal identity with their developing science identity.

Stacy is clear that her intention is to bridge alternative cultural environment with the traditional academic environment through this specific type of mentoring. Along with these principles, Stacy engages in multiple discussions about "imposter syndrome" that students develop as they pursue and complete their advanced degrees. Imposter syndrome "refers to people who have a persistent belief in their lack of intelligence, skills, or competence….They are convinced that other people's praise and recognition of their accomplishments is undeserved, chalking up their achievements to chance, charm, connections, and other external factors" (Young 2011) and is especially prominent among women and students of color.

During one of my discussions with Stacy, I encouraged her to think back to when she developed the principles and the experiences that led to their creation. She discussed that it was her experiences as a young, Native American and Hispanic female student at a prestigious undergraduate university that she first noticed a need for alternative academic

cultural information to underrepresented students. Stacy described her experience at her prestigious undergraduate institution as difficult, disheartening, intimidating and in an environment where she felt neither welcome nor understood. These feelings of isolation led her to switch to a non-STEM major, and eventually leave the university and pursue a path toward self-understanding by visiting different cultures around the world. The following is narrative from Stacy about this journey:

> REBECCA: -- you mentioned that your experience at [Prestigious University] maybe wasn't the greatest?
>
> STACY: Yeah, but I have a lot of nice poetry classes.
>
> REBECCA: So I was wondering if there was something about that? Was there something about being at [Prestigious University] or those experiences that just made you think, "Wow, there's just something that's not working for everyone here"?
>
> STACY: Absolutely, I do the thing that I didn't get. There was nobody there who understood I was coming from a small town, who talked to me like a human being. The girls in the dorm, they had a lot more than I did. They would dress me up in their Gucci stuff, and send me out on a date. I could never replicate that look. They thought I was like a museum item, because I still believed in mortal sins. It was like doors shut all over the place, and I felt-- because I had gotten in on the waitlist, I felt like the stupidest person at [Prestigious University], but it wasn't true. But I did not-- it was this impostor syndrome, this stereotype threat. It was everything that you could imagine.
>
> REBECCA: And you don't know that at the time?
>
> STACY: You don't know it at the time----so you just think you don't fit. You just think there's something really wrong with you, and that you're not smart enough to do this. And then, I went freshmen year. My dad had just died, and my calculus teacher was very sweet. She said, "If you need anything, come talk to me," but I never would've gone and talked to her. I got a C in my chemistry class, and I went to talk to the professor. He said, "Well, I don't know how important academics is." He said that, "Maybe it's not important at all." He said, "Maybe you should just quit school, go home, get married, and cook for your husband." Pile that on top of isolation, and you're toast…so I found myself in the library crying. I reached up for a book and pulled it down. It was a book of poetry. I thought, "This is it. I should be an English major." So I switched my major [from chemistry], and then I tried to get in the poetry section. But the problem is, I'd been in Catholic schools for 12 years, grown up in a

> little tiny town, and all my poetry was indistinguishable from Hallmark cards because I had no life experience whatsoever. So one of the teachers told me I had to go out and get some life experience before I could be a poet [chuckles]. I went to Austria with [Prestigious University] and realized I wasn't German. Then I went to Mexico. That's how I got my life experience, but I had the lowest self-esteem you can possibly imagine. Had I had the principles at [Prestigious University], it would've changed my entire experience. I probably could've been president of [Prestigious University] or something like that. Which I'm not regretting, but they're tools that can help the students calm down and be strong. I hope they buy into them.

After Stacy left her prestigious university, she began reading a lot of religious books and material on eastern philosophies like the I Ching and from the Dalai Lama. She also connected with cultures in Mexico and the Maori in Australia. She began to reflect on her background and how her own personal background contributed to feeling isolated during her undergraduate years at the prestigious university. She describes this time in her life as a "walk-about" where she really began to understand her path and connect with what was important to her.

After this self-discovery, she re-entered a STEM degree program and completed her bachelor of science in STEM, followed by a Master of Science and Ph. D. in biochemistry. Over the years, Stacy worked to become a nationally renowned researcher in the field of biochemistry and was a member of several national STEM organizations where she played leadership roles. However, the feelings of isolation and disappointment at the current lack of racial and ethnic diversity within these settings remained. Here, Stacy remembers a particularly isolating experience that she had while attending a national STEM research conference, followed by a grant writing meeting at a national level that made her realize the lack of STEM diversity was still an important issue:

> STACY:…but it's the lack of respect for things that more traditional people might hold as sacred that is really difficult. But I remember one time when I was-- long time ago, I was in an audience for a seminar, and there was another Hispanic woman and

> 200 non-minorities. A talk was being given by an anthropology professor who is studying blood types, and they wanted to figure out what the origin of Hispanics was. So what they did was to get blood from all the people in jail who identified as Mexican-American or something like that. Anyway, they start doing this blood analysis, and they realize that there's a lot of mixture of Native American and Spanish. So then somehow, they start talking about rape and that we all came from rapes. And they were all laughing. There was a lot of laughing and talking about this. The woman and I-- I don't how she felt. I think she felt the same way. It just felt like you were naked out there on some operating table. It was horrible. It was just a horrible feeling. There's a lot of times-- for instance, I was just on a grant group. We were putting a grant together. These people came up with a model for something, and I had a reaction to it. I didn't like it - the way it looked. I said to them... I said, "Look, I have an emotional reaction to this. I don't particularly like the way that it-- it doesn't feel right - the way that this model is." I said, "But for you to know whether it's me personally or whether it's a cultural reaction, I think it's a cultural reaction. But for you to know, we need more US-born minorities in this group."… They called up the head of the group and said that I was completely out of line and that I shouldn't have done this. He had to call me up and tell me that. It really created a bad feeling for me in the whole group, and that was just this year.

Here, Stacy discusses an exchange she had as a board member for a STEM committee at the national level. She discusses that the lack of diversity in these environments is not always recognized by the majority members of these organizations:

> STACY: So I'm getting this-- I went to [National STEM Organization] just recently, and they had-- I don't know what happened. It was some kind of mistake, that they were on this committee - were 18 men and 3 women. So we're back to the '50s, in terms of women. And they're talking about the meritocracy, slapping each other on the back, and really happy with how things are going…I'm the only minority. So this meritocracy is working so well because we're not there and because [chuckles] I'm there just to make sure that somebody brings up the issues about minorities not getting served. They didn't even notice. They didn't even notice that there weren't any women there. The guys were so happy. They just didn't even notice that we were feeling totally weird, and they were calling us by everybody else's name. So they called me, "Holly" and "Molly". They called Holly, "Stacy." It was really out there. So if I have to go through this stuff - and I'm tough - the students, it's more.

Stacy came to her current institution to run a research lab in biochemistry where she recruited and trained undergraduate and graduate biochemists. During her time at the university, she was approached about the MSDS program and if she were interested in taking

it over. Stacy reluctantly accepted, because she knew that the cultural taxation experienced by serving as a P.I. for such programs could be detrimental to her career as a scientist (see Padilla 1994). And, in fact, she believes that it contributed to the eventual closure of her research lab. However, Stacy saw the value of investing in Native American and other underrepresented students as close to her heart:

> STACY: Closing my lab was horrible - was hard. It was really hard, because my identity was as a scientist. But what happened with MSDS is that I had to follow my heart. I can't tell the students to follow their hearts, and then when my heart says, "You can't watch these Native American kids being tossed out on their ear with bursar's holds and a big loser on their forehead. You can't just walk by..." I don't know how people live in this institution with this crap going on.

As Stacy took over the role as P.I. for MSDS, she thought very deeply about the lessons that she wanted her MSDS students to learn and take with them as they entered the STEM environment that she had experienced as a female, Native American and Hispanic researcher. Drawing on this experience, her readings of eastern philosophy, and her knowledge of Native American culture, she developed four guiding principles for herself and her MSDS students which ultimately help students understand what Collins 2000 discusses in terms “politics of empowerment.” Here, Stacy discusses these principles during an uninterrupted narrative.

<u>Principle 1: Know your heart</u>

> STACY: So we start with a principle which is, "Know your heart." That isn't just do what you want to. It's pay attention to all your values, all the things you care about - your family, whatever else that you really care about. And pay attention to those things that within this context [STEM education] that make you happy to think about. So I tell the kids to get a journal, and the first third are just writing down things that when you think about, make you happy. And that knowing your heart won't tell you where you're going to be in five years, but it helps you figure out where to put your foot next. I'll come back to that, because I use it a lot now with them developing their graduate school applications. It's the last summer before making their applications, we use all this stuff.

Principle 2: Look for the positive

> STACY: The second principle is to look for the positive and blessing in everything. I'm sure that Dalai Lama says the same thing. But it's that-- for instance, the native kids have experienced overt racism on a regular basis. So when somebody's a creep to you, you have two immediate positives. That is you're not them, and you're not married to them. So the kids laugh [chuckles] when I say that. Laughter's really good because it gives you a second to realize that you choose how to react. But you don't have to get in the trenches with somebody. If it's a long-term thing and you need it fixed, come back and get your team. You don't have to-- that person can't make you feel any way, do anything. You're not connected with that person, so that's good.

She continues…

> And then, it's something the students don't work on [without the principles]. It's really how to reframe things. How do you look at something that's very negative and turn it into a positive? And there are some things that are difficult or impossible maybe to do it with, but it helps because negative things are like weights on you. They drain you, so to keep your eye on positives or be able to work on it. So if somebody steals your computer. I said, "What happened to somebody this week?" "Well, somebody stole my computer." "What's the good thing about it?" "Well, I had it backed up." "Well, that's great. That's a relief. And you didn't get hurt?" "No." "And didn't take anything else?" "No." So we kind of look at it that way. I use this principle a lot. Actually, people who work with me in the program have to use these principles also because they'll help you stay positive, and the students have to have that. It's a leadership principle. I always tell students, "When the dung hits the fan, that there are two responses. One of them is, 'Oh, no. There's manure everywhere.' And the other response is, 'Oh, manure. This is great. I've got the field. Let's go [chuckles].'" I think the ability to reframe and to look at things in different ways is important, and I think it also helps the students become more imaginative. Because the reframing is a very important exercise. They're resistant to it. The first year, they kind of think you're crazy anyway.

Principle 3: Embrace who you are and bring it to the table

> STACY: Anyway, the third principle is, "Embrace who you are and bring it to the table." That is, that you are the embodiment of all these ancestors who've gone before you. So all the family stories are things that you own. And that experience, that learning, and that knowledge is part of what you contribute to the dialog at the table. But the other thing is your narrative. Students don't remember their childhoods a lot. Just left home, so they haven't thought much about it. But if you ask them about their narrative, it would be, "I was born here. My parents are so and so, and I went to school here." So what I try to do is to get them to go back into their childhoods and think about events that they can remember. We start off with things they can

remember, either through smells or tastes or feels or whatever. And then, gradually explore childhood.

There are two goals of that. One of them is to help them understand how they got to be the person they are. Did they show creativity early on? Did they show inquisitiveness? Did they show optimistic behaviors? What sort of things? Then also, if they have really negative things in their histories, to be able to then work principle two with it so that you can reframe it. So that if you're in a job interview and somebody asks you, you don't start crying. So that you begin to see yourself not as damaged goods or have a deficit model for your childhood, but where you begin to see yourself - if you had these hard things - as a survivor, a teacher, a learner, and a leader through all this stuff. So that the students become stronger because of bad experiences.

Principle 4: Stick the landing

Then last one is, "To stick the landing or finish well." That's when you're done with something at the end of the day or the end of the semester or the end of the program or whatever, that you go back and you acknowledge the relationships that made it possible for you to succeed, and make sure that the place is better for your having been there.

Stacy finishes this narrative with a broader look at the principle work overall.

Those are the four principles that we work on. I would say, some years, I'm more successful than other years of getting mastered. But when I do the-- right now, I've got students. I'm getting ready to do their letter of intent for graduate school. Right this minute - which is May, June before their senior year - some of the students are experiencing what I'm calling graduation panic. It's like they just joined MSDS. They were all excited, "Sure, I want to do research. I want to get my PhD. Yeah, yeah, yeah, yeah." But it seemed like graduation was an eon away. Now, they're getting to the point where they got to put their letters of intent together. And maybe they feel like they're engaged to be married to a stranger or they're prisoners of this path or something. So if a student's feeling that way, we have to really go through the exercise of knowing your heart again, "What is it that you really like to think about? What do you love about biology? What do you love about the lab? What do you love about research? What do you love about all this?" If it's not what they love, then they should go off and do something else. This is the time when a student will decide to bail from the program or that they want to go get a law degree or something like that. So we'll work on their heart, then we work on their narrative. The narratives are powerful that these kids have, but you've got to get it so that it's a positive thing. I always have these letters, and I characterize them as from *The Jerk*, Steve Martin's movie, but "I was born a poor, black child." I don't want any of my students to feel sorry for themselves. We're not victims. You can't be a leader if you feel like you're a victim. We just have to get to a point where you were poor. Man, that's great

> [chuckles]. You've suffered this or that or 15 other things. You're amazing. You're really amazing. It's a miracle that you're here. There's a reason for you-- just the dialogue we have is all to strengthen them and to make anything that they've got in their past that somehow upsets them-- because it is just a negative drag on them and keeps them from being successful. Then after that, we'll write the letter of intent. It'll be a little bit about their childhood or why they have a good characteristic of being a scientist. Then they'll write their research thing, and then where they're going to work. But when they interview for the job, they have to want to be there. They have to step forward. They have to bring it to the table. So that's principle three, and knowing your heart. You have to put all this together. You want them to offer you the position. You can always say no afterwards, but you can't say no if they don't offer it to you.

Stacy discussed that her goals for the principles were born teaching undergraduate STEM lecture classes and noticing that students lacked creativity, inquisitiveness and passion for their work that she saw as integral to a career in the sciences. Her goal was to develop a knowledge that would stimulate this creativity and bridge the personal world of students with the academic world of the university, a Multicontextual endeavor. She took notice of information that she saw as "missing from the traditional environment" and from her years of experience working with underrepresented students and developed the principles to work as a tool box to rely on during identity development within academia and sources of empowerment to overcome difficult situations that she saw as inevitable (see Collins 2000).

I completed all of my interviews with MSDS students prior to talking with Stacy in depth about her mentoring style or the four principles. It is important to note that all of the MSDS students mentioned the principles in one way or another without probing during their interviews and how they primarily had a positive impact on the student:

> REBECCA: What do you think are some of the most valuable things you get from MSDS? What are the good things you get out of the program?
>
> CLAIRE: Bonding, we're all really close. You learn a lot about yourself, they teach you the 4 principles and they want you to apply that. So you do learn a lot about yourself and what you want.

REBECCA: Have you found it to be helpful when you're trying to navigate your academics?

CLAIRE: Yeah, it's kinda balancing everything, what I want to do and what is best for me. Just to think about to positive in everything.

CLAIRE: Yeah. This second year of MSDS is the one that I'm enjoying the most. The first year, it was cool. I feel privileged, I don't know if that's the word but I just feel that this is really cool and I know I have advantage over other students who will be getting into grad school or applying to grad school because of the fact of the lab. But also, I think Stacy as a scientist - we know she's as a scientist - she's amazing. And having someone of her caliber, watching our backs and checking that we-- guiding us, I think that also has a great impact because it's like-- when I Googled her before I started MSDS is like, "Really [chuckles]? Oh my god." And how many times her papers have been cited and everything. She's very unusual that she has that scientist quality, but then she has this very strong perception or developed concept with the four principles. And so the first year, the four principles were like, "Okay, yeah." I mean they're positive. They're cool. I understand. But I don't think they had an impact on me the first year. Seriously, it was just like reading something nice. But then somehow, I don't know if it is that she nails it so much, or somehow they just gain life - the principles. It's like - know your heart. I remember thinking, "Will I ever?" I know that's really weird, but--I don't know my heart? I probably will at my death. I'm like, "I don't know." See the positive in everything, and embrace who you are. They have meaning - they became alive when I started feeling myself out. And grad school and what's coming, and do I have what it takes? Am I doing what I want really? Because there was a time that I thought "My god, undergrad is so hard. If I'm struggling now with my feelings, and what I'm thinking, and school, am I going to be able to?" I just imagine grad school is going to be 10 times this. So then her principals were like, "Okay, that makes sense" but not the first year. The second year is like "Ah." Embrace who you are. And it's weird, because at some point, I feel like, "Is this a cult or something [laughter]?" But then I see what she sees - I think I have a little taste of what she sees. She goes for the psychological part because I think that's what have to stopped me at some point, or make you feel like, or make me feel like I don't know if what it have what it takes. Nobody in my family has done that and that's another thing. You don't have that model in your family. You don't grow up seeing your parents talking about academics or like, "Your next step is college. Let's check it out."

However, in a few instances (3), students of color, while very grateful for Stacy and her support, mentioned feeling overly-burdened by the information and that being exposed to the bias and discrimination in the MSDS environment (which they had not personally experienced) actually contributed to increased anxiety about the future and a sort of identity

crisis in the individual. DuBois discusses this in terms of "the veil" and the double-consciousness that exists among people of color in majority environments. The prejudices of white people – and they can be real or anticipated - elicit "self-questioning, self-disparagement, and lowering of ideals" among people of color (Edles and Appelrouth 354). The internalization of the oppressive sentiments shapes the lives of the people of color and becomes a form of oppression in and of itself. Here, a Hispanic, female biochemistry MSDS student discusses how learning about potential bias and discrimination that she *may* encounter in her future and her status as a MSDS student creates insecurity, rather than relieves this. Many of the students who reported having a hard time with the MSDS program locate their difficult experiences in being told that as minorities they will face problems and they attribute their successes to the program rather than their own personal work:

> ISABEL: I'm always thinking of, "Why am I responding this way? Why am I feeling what I'm feeling?" I guess in a way that helps, at the same time it can drive you crazy. The talk about the impostor syndrome, but I don't think they talk about it deeply enough, where I could see a benefit. I think the benefit is, I know it's there. And I know I'm not the only one, but I wish I could just dissect it. And okay, "What is it? Why is this affecting [me]?" And most important, "How do I get to this other point?"
>
> REBECCA: Where you're not feeling like that?
>
> ISABEL: Exactly. With that I just decided that I going to build self-confidence, and just do not beat myself down. I don't have any fancy thing. It's just like, "Okay you're doing it, you are proving yourself that you are capable of doing it," but then you have all this, sorry for the word, all this social garbage, social conventions and expectations like, "Oh, I'm not 22," you know? What else, people talking, after you go to grad school - since you're going to come from [current institution], which is a very, very small-- I don't think people realize how negative they can make things, even though they think they're helping you, it's like why are you telling me that [current institution] is not well recognized, or that I'm going to be seen lower?
>
> REBECCA: Yeah.
>
> ISABEL: Why are you telling me this when you know that I'm moving? If you're going to address this, address this in a different way.

REBECCA: Do you feel like some of that information when they're saying this, "You're coming from [current institution], so you're going to have to prove yourself."

ISABEL: Exactly.

REBECCA: Does that make it worse?

ISABEL: Yeah. I just like, "Why?" In a way you're telling us, "Oh, you are great students. You have what it takes," and whatever. "But yeah, you might not be good enough, and be aware of that." I guess that's good, but at the same time it's just-- I don't want to be walking into grad school with this load. I mean, I have enough with myself [chuckles], you know?

REBECCA: Do they ever tell you why they say things like this? Or who's saying-- is Stacy saying that, and your PI--?

ISABEL: Yeah, she has mentioned that. My PI no-- my PI is a great PI as a scientist. But he doesn't merge in the personal. He doesn't tutor that way at all. So I wouldn't even feel comfortable talking to him about that. He's a good person, and he reads me so well because sometimes he's like, "Okay, what happened, are you okay?" "Yes, I'm fine." "I don't believe you" "Yes, I'm fine [chuckles]." So I'm sure I could talk to him, but we don't have that line of communication. I guess I would do it if I'm forced like - I don't know what-- who else to talk - probably, but otherwise, he would not be my option. I think I'm just deviating to everything?

REBECCA: No, you're good. Does MSDS help you with those more personal dynamics ever?

ISABEL: Yes and no. That's just so weird. Because Stacy really wants to hit those spots. For her, I think her heart is really into the personal, not into the academics. If you're having academic problems, she will help you or she will direct you to someone who will help you, or to her. But she is more-- she is there more of for the issues that I'm having. She's there for that. It would not be fair to not mention that. She is-- I think her heart is on that. But, I don't know. I don't know if just talking to someone and telling her how I feel and my self-doubt and all that. I don't think just saying it makes a difference because she is-- I think you just have-- God, it's a hard question because you just have to deal with it. I think that's what I've been doing. It is not about being fearless. She sometimes said that she suggests that we are fearless, and I am not fearless - I am not - but I do think I am brave because regardless of my fear, I keep moving and keep doing it. Even if I'm scared like, "Okay, well, sounds scary. Yeah, deal with it. Just keep doing it and do the best you can." But now, for instance, going to grad school is like, "Do I really have what it takes? Do I really have it, or what I think I have is really the endorsement from Stacy and the MSDS, and the lab experience?" And then I think, "Well, no my grades speak by themselves," but then

> it's like, "Okay, that's cool, you're being given material that you need to learn, and regurgitate to teachers," but that's not grad school. And so that's the next fear.
>
> REBECCA: Do you feel like after your experiences at [current institution], and it can be course work, MSDS, working in the lab, that you're prepared for graduate school? Do you feel confident in that next step?
>
> ISABEL: Academically-wise, yes. I think I have good work ethics, I have proved to myself that I rise to the occasion…That's the thing, I get scared, self-doubt, and everything. But I don't know how I do it, I just keep doing it. Somehow I'm able to compartmentalize fear and psychological issues and my performance. I somehow do it, but I don't block them. That's something because I think if I block that I will just explode. But I think I'm somehow kind of like just walk and take a little bit of fear and handle that, and then I keep doing my stuff and then, "Okay. I'm done with this." I don't know.

It is clear that exposing students to this information and trying to prepare them for a career in a field still characterized by inequity and discrimination (as is experienced by faculty and students at all the university's in the study) at higher levels is a tricky task. What is the best way to encourage students to merge their personal biography into their developing science identity, while educating them about current inequities and difficulties they may face, without scaring them away from the institution and creating insecurities based on their personal biographies? A student of color cannot be "just" a scientist or "just" a person of color. There is a consciousness that exists as a developing scientist of color within a population of majority white scientists. Whereas it is possible for students of color to understand the oppression faced in higher education from behind the veil, it is difficult for white individuals to see. As these students experience higher education, they are learning what exists on the other side of "the veil,' and this recognition can be a form of oppression itself. The task of balancing cultural context is not trivial. Incorporating too much high-context activity without the balance of low-context can result in student departure.

Theoretical Implications: Support for a Multicontextual Model in STEM Education

Findings from this study suggest that the programs involved operate under a Multicontextual framework. The major concepts of Multicontext (MC) theory that emerged from the interviews and were empirically supported by the quantitative survey results will be discussed individually in the remainder of this chapter. I revisit some quotations from above in this section as well as introduce a few new ones. Since I was only able to distribute the online survey to PMPS students, all frequencies in the following tables refer only to PMPS respondents. The major concepts from Multicontext theory that emerge include the following: Interaction, Space, Association, Learning and Systems. For a more detailed explanation of these concepts, see Appendix A: Multicontext Concepts. Qualitative and quantitative data are presented together as each theme is discussed individually. Each of the tables represents one concept of Multicontext theory that emerged from the qualitative data. For each concept, I have included a short description from Multicontext theory followed by the behaviors and practices that participants discussed during interviews. Descriptive results from the online survey that include the percentage of respondents that disagree or agree with statements measuring the concept are included.

Interaction and space: Creating a safe space with community and mentorship

One major tenant of Multicontext theory stresses the importance of interaction that occurs between players in a cultural space. In a low-context environment, interaction is characterized as lacking personal emotion and emphasizes the avoidance of interfering in colleagues' personal lives. In a high-context environment, recognition of personal emotions is important. It is important to check in on the emotional status of individuals and is seen as important for group morale. While the university and STEM in particular are characterized

as being low-context in the arena of interaction, I found that participants in the PMPS program often discussed their interactions in a more high-context manner. This facilitated the development of community amongst faculty and students.

Table 25: *Data on Interaction*

Interaction	Description	Practice		
	Short term interpersonal feedback	Checking in on emotions, multicultural mentors		
		Disagree	Neutral	Agree
As a result of PMPS, I developed a close connection with a faculty member in my field of interest.		9.94	18.71	71.35
PMPS provided me an opportunity to be a part of a community.		4.71	21.76	73.53
During my time in PMPS, I developed deep, family-like connections with faculty and students.		13.09	21.43	65.47
A faculty approached me and invited me to do research with him/her funded by PMPS.		33.93	10.12	55.95
Before PMPS, I felt like I did not belong at my institution.		60.11	20.83	19.05
Being part of a campus community is important to me.		8.33	13.64	78.03

Table 25: Data on Interaction presents empirical evidence suggesting a Multicontextual approach to interactions in PMPS. Over 70% of student participants agreed that participating in PMPS gave them an opportunity to be a part of a community on campus where they developed deep, personal connections to a faculty mentor. Of the respondents, 65% agreed that the connections they developed with peers and faculty were “family-like” connections. While the university can sometimes be seen as impersonal where individualism is celebrated,

nearly 80% of respondents mentioned that being a part of a community on campus was important to them, suggesting that these individuals value a more high-context approach to interaction in higher education.

During interviews, students noted that their relationships with their PMPS faculty were different from their relationships with faculty outside of PMPS. Some students mentioned feeling intimidated by non-PMPS faculty and as if they were just a face in a large crowd of students. One Hispanic, female senior student noted, “I feel like its [PMPS] helped me look at faculty members the same now. But I felt really intimidated beforehand…It's made me feel more comfortable in an academic setting than I ever have before.”

It was common for students to note that they previously felt intimidated by faculty. Student experiences with their PMPS faculty mentor helps students to see faculty in a less intimidating, more approachable manner. Remember how this woman’s interaction with her PMPS faculty mentor challenged her to deconstruct what she described as “the wall” she had put between her and faculty members in the past. By deconstructing this wall, she was finally able to visualize herself as a future faculty member, “Honestly it felt like there was a wall up between being a student and knowing a faculty member…you don't really see them as a peer. So I think the PMPS program has really helped that relationship of feeling that I am going to be that and almost like I am.”

Before their PMPS experience, students felt intimidated by faculty that they encountered. This impersonal relationship with faculty led some students to feel as if there were an invisible barrier between who they were and where faculties are professionally. However, their work with PMPS faculty mentors gave them the opportunity to know faculty on a more personal level and realize that they were not fundamentally different people than

the students. Deconstructing this invisible wall allowed students to better see themselves as being a faculty member in the future.

Interview participants also mentioned that the exposure to a community of like-minded scientists and the support that comes from that community as a benefit to their participation (40). This community included the research lab environment that consisted of at least one P.I. (the faculty mentor), graduate students (12) who play a role in mentoring the undergraduate students, other undergraduates with various levels of experience that participate in co-mentoring activities (10) and other underrepresented students at all levels (undergraduate, graduate, faculty).

The concept of "space" in Multicontext theory is inextricable related to interaction. Interaction inevitably affects the use of space and how space is created and maintained. In low-context environments, space is characterized as having many boundaries where individualized and private areas are important and there is less sharing of personal property. In a high-context environment, space is characterized as being communal where privacy is less important and personal property is shared. A lab setting may naturally produce either low or high-context environment. However, when lab environments were discussed during the PMPS interviews, language suggested a tendency toward Multicontextual lab environments that value privacy, individual interaction with faculty, but also the opportunity to be a part of a community where peer mentoring is utilized.

Table 26: Data on Space presents empirical evidence that suggests a Multicontextual approach to space is valued by PMPS participants. While a majority of students note the importance of privacy and the ability to meet with faculty one-on-one, over half of the students agreed that working in groups was preferred over working alone and a majority

noted that being a part of a community is important. In the family-like communities discussed previously, a team approach to mentoring develops organically. While the faculty mentor plays a leadership role and has frequent contact with her or his PMPS undergraduate, they often employ the help of graduate students to teach the students procedures and get them up-to-date on experiments.

Table 26: *Data on Space*

Space	Description	Practice		
	Space is communal	Lab (not one-on-one); study groups; diverse environments		
		Disagree	Neutral	Agree
PMPS provided me an opportunity to be a part of a community.		4.71	21.76	73.53
Being part of a campus community is important to me.		8.33	13.64	78.03
I prefer open, direct communication.		1.52	2.27	96.21
I prefer to work with a group of students, rather than by myself.		9.16	36.64	54.2
I prefer meeting with faculty one-on-one.		4.55	18.94	76.52
Having privacy is important to me.		3.12	15.62	81.25

Remember how these professors discussed how they utilize peer mentoring in their labs:

> So, you can couple students together to get them to share their experiences and have a better opportunity and better chance to do what they want to do. Many of these students have a vision, and some of them feel like they can't achieve what they're trying to get at because they don't have somebody in the family or somebody that is going to give them a path. If you help them get a path, many of them can do it. – *White, Male, Professor, Medicine*

An associate professor of psychology discusses how this co-mentoring environment also benefits the advanced students that are in the co-mentoring relationship in terms of self-confidence and a sense of belonging to the lab environment, “New students come in and now they can show the other students how things are done. They gain a lot of confidence...that boosts their confidence and also makes them feel that that they belong to a lab. This is somewhere where they’ve acquired some mastery.”

Students described their relationships with their faculty mentors in very positive terms (16). The most common descriptions of mentors included that mentors were “awesome,” very supportive, experienced, and accessible. A junior in the life sciences discussed how working with someone that she sees as experienced and caring towards undergraduates inspired her to want to “be like him” in the future.

Another student discussed how this supportive and kind relationship that she developed with her faculty mentor made her challenge her view of professors as being “scary,” “prejudiced,” and busy:

> …. something really valuable [that] I found with them is a support kind of community maybe. Because they [faculty mentor and graduate student mentor] were really friendly people, both of them…I always thought professors were kind of scary or prejudiced or really busy. But these people gave me their time to teach me something. That's really valuable and you really appreciate that when someone does that...when you start building some of that confidence, I realized that they took that time out of their busy lives to help an undergrad. – *Female, Hispanic, Junior, Physics*

The interactions described by both students and faculty highlight the importance of checking in on emotions and creating a space where this is valued within the STEM environment. Not only does it help the student feel like they are a part of a community, but it also influences their self-confidence and motivation to continue. Aside from a communal, group feel from the labs, students were attracted to being a part of a diverse community on

campus, especially one where they were surrounded by other students of similar backgrounds (19):

> I was surprised that the PMPS officers, like [Name], she's Hispanic. And [Name], she's from Peru. Stuff like that. [Name] is Spanish, or part-Spanish. All these people are from different cultures. I feel like, 'cool.' I felt very accepted coming in. I guess that's something that I really appreciate about PMPS, because I've also worked research in the physics department and it's quite different there. You don't see any [Hispanics] (chuckles). I'm probably the only Hispanic female in physics. – *Female, Hispanic, Junior, Physics*

Students talked about diversity of the communities in a variety of ways, including having a female P.I. (when many of their instructors were male), working with other students from underrepresented backgrounds, being in environments where they felt comfortable speaking Spanish, and being around people from other disciplines. Nearly one-third of the students mentioned that they enjoyed being around students and faculty from other disciplines and learning their perspectives on common research problems

Being exposed to a diverse community of scholars was comforting to the underrepresented students who participated in PMPS. It let them know that they were not alone and belonged in the academic environment where everyone was smart and capable, regardless of their skin color. Remember this quote from above:

> Being with PMPS it's nice to know that there are lots of minorities out there, but they are just as smart. They are just as good as everybody else regardless of skin color. They have so much more to contribute. And it's nice to be part of that community. – *Female, Hispanic, Senior, Biology*

Association: Humanizing STEM fields to attract students

In Multicontext theory, the concept of association refers to the degree to which individuals are personally connected to people and the world around them and how individuals deal with success in their professional lives. In a low-context environment,

personal commitment to other people is low. Being nice to others and the development of personal relationships is not as important as the job at hand or advancing one's career. Success means to be recognized and seeking publicity or to stand out in order to "get ahead" is highly valuable. On the contrary, in a high-context environment, personal commitment to people is high. It is important to build trusting relationships that are long term and stable. Success in a high-context environment means being unobtrusive where talking about accomplishments is boastful and humility is valued. In higher education, a low-context approach to association is clearly valued and rewarded while high-context association is seen as passive and weak. However, I found evidence to support a Multicontextual approach to association from the PMPS interviews and survey data. This primarily occurred as students found ways that their PMPS research and work benefited people and communities around them, or had an "altruistic" purpose. Students also learned to value self-promotion through presenting their altruistic work.

Table 27: *Data on Association*

Association	Description	Practice		
	Commitment to People	Altruistic Research		
		Disagree	Neutral	Agree
It is important that my research improve the world around me.		1.52	10.61	87.88
I enjoy praise for my academic accomplishments.		7.81	28.12	64.06

A large majority (88%) of students who completed the online survey noted that it was important that their research improved the world around them. During interviews, students

mentioned being attracted to the research projects that the faculty mentors were working on because they saw the work as a place where they could help communities around them and make the world a better place (21). Remember how this student's initial reluctance to become involved in serious research was displaced by feeling the need to help a community:

> I was like, 'oh my god, I don't want to do this.' But I feel that I have to. There is a community living there. This research is going to help what is going to happen in the future here–the future generation…I link it to that because I want to help people at the same time I am doing science. I don't want to do science…without people who make use for it…Believing [in] the problem, [is] believing in the solution. Believe that you will get because it's better for our society. That's what I believe. – *Female, Hispanic, Senior, Geology*

Another student discussed how initially she was unsure of the research that her faculty mentor was working on until he encouraged her to learn about the problem by watching a popular movie about how the problem impacts real people. This allowed her to connect personally to the issue. "I was like, 'oh, this is an actual problem.' So that's where I started my research. It might be so simple to watch a movie, but it actually helped connect what I'm doing."

Some students even mentioned that they decided to forego their pre-medicine plans to do academic research because they saw research as a place where they could impact more people and make a larger impact on the world around them:

> Well, I'm from a third world country so uh the reason I wanted to be a doctor is because I wanted to help people. But it's not enough. Doctors help, but if they don't solve healthcare problems, technology by itself won't do it. So we need to provide tools and stuff to the doctor to do their job. – *Black, Male, Senior, Engineering*

Hands-on experiences with high level work and the opportunity to participate at an advanced level contributed to increased confidence in themselves and their own capabilities. Here, a senior engineering student discusses how she now thinks about people doubting her

abilities. "Actually, sometimes I [think], if people don't believe in us, look who I am, look where I am standing, look where I am going to be, and once I get my PhD. no one can ever tell me something that I cannot do."

Some students were initially confused at why faculty chose them to work in their lab. Over the course of their PMPS experience, they were able to gain the confidence in themselves that they were capable of doing this type of academic work:

> I would say when I first started, I thought the man [faculty mentor] was crazy, because I had no idea what was going on. But now when I think about science and math and everything, I understand it to the point where I'm helping others, I'm teaching others. I didn't think I would ever have that understanding, but people actually come to me, fellow classmates come to me – *Hispanic, Female, Junior, Chemistry*

Many other students mentioned having confidence in their future plans as a result of the skills they have developed during their PMPS funded experience, often a result of the hands-on research in which they participated.

Learning: Creating realistic opportunities to perform

The concept of learning in Multicontext theory is broad (see Chávez and Longerbeam 2016). It addresses how knowledge is acquired, what types of thinking are important and which learning styles are valued. In a low-context environment, knowledge is based on logical reasoning where analytical thinking is valued. Learning is focused on the individual, often involving following lists of directions. In a high-context environment, knowledge is contextual and comprehensive thinking is important. Learning is group oriented and active, often through demonstration.

Table 28: *Data on Learning*

Learning	Description	Practice		
	Hands-On Through Demonstration; Group Oriented	Hands-On Research; Research Teams; Peer Mentoring		
		Disagree	Neutral	Agree
I learn best through reading and memorization.		40.63	25.78	33.6
I learn best by applying material in a hands-on way (e.g. through lab experiments, etc.)		1.56	5.47	92.97
I learn best when a list of instructions is given to me to follow.		12.5	21.09	66.41
I learn best after seeing a demonstration from an instructor.		2.36	10.24	87.4
When I work, I have a set schedule that I stick to.		13.28	25	61.72

My empirical work (see Table 28) suggests that participants in PMPS value Multicontextual learning environments. A large majority of students (93%) noted that they learn best when they apply material in a hands-on way or after seeing a demonstration (87%). However, two-thirds of students (66%) agreed that they learn well from reading a set of instructions, which is low-context learning. This lends support to the argument for Multicontextual learning environments by highlighting the effectiveness of incorporating some low-context methods – such as instructions – into high-context environments (as program sponsored PMPS or MSDS labs are run) in order to facilitate program success. However, results from our interviews suggest that the hands-on and realistic research that students participate in through PMPS was one of the activities that attracted them to STEM

that they valued most. Most students discussed that the opportunity to learn and participate "hands-on" real research (22) that was fun (15) was what drew them to these experiences:

> I think the one thing that caught my interest was that it was just researching. It was a whole new environment. As I was telling you yesterday, I grew up in a low-income family...in school we didn't have those opportunities. We were given textbooks, and that was our research. So just being able to go into a lab just caught my interest, because I never had that opportunity. So I was like, "yeah, I would love to do this hands-on." – *Hispanic, Female, Junior, Chemistry*

All of the students involved in faculty-led research experiences discussed the hands-on experience with high level, advanced research as the most significant experience they had with PMPS. Students were able to work with faculty on advanced research projects that are often funded by larger organizations such as the National Aeronautics and Space Administration (NASA), the National Institutes of Health (NIH), and the National Science Foundation (NSF).

Many students and faculty described PMPS research as "more realistic." A professor of Biochemistry noted that, "[t]hey (PMPS students) are doing research, they are really doing research, okay? I mean they are doing things that nobody has done before. It is original research." Another faculty noted the fundamental differences between a PMPS project in a traditional classroom, including the general and formulaic nature of a traditional classroom:

> You're not going to duplicate the experience in an actual research lab in a lab class…You're exposed to a much more focused area of science. So the students have to learn in detail about some area, whereas the lab classes are generally trying to cover a broad area of science, given skills that are broadly applicable and knowledge…but then just the understanding of okay, this is what science is. This is what scientific research is like…they're not going to get that experience just from classes. – *Male, White, Associate Professor of Physics and Astronomy*

This realistic research experience also prepares them to make informed decisions about what they want to do after they graduate. According to faculty, this informed decision

may not happen if they just had classroom experiences. The experiences that students have in PMPS funded research environments are described by faculty as more realistic research settings than what the students are exposed to as part of a traditional academic environment. This realistic experience allows students to experience what real academic research is like and encourages them to think about whether or not they want to pursue this type of work in the future. The benefits to this are that students enter graduate school with less risk of departure because they have a realistic idea of what type of work they are getting into. It also gives student participants an advantage as they apply for graduate school, as admissions committees are increasingly looking for realistic research experiences to minimize the risk of graduate student departure. Faculty note that this exposure does not occur in a typical STEM classroom.

Multicontextual systems: Creating opportunities to become engaged

The final concept of Multicontext theory that emerged from my empirical work focused on Multicontextual systems. A low-context system is characterized as a traditional scientific field where context is not important and teaching is technical. Analyses are focused on large, quantitative data where scientific thinking is emphasized. A high-context system is characterized by disciplines that are more directly involved with contextual thinking, research about living organisms and people. Practical thinking is valued and teaching is personal. Empirical evidence from my study suggests PMPS creates Multicontextual learning environments.

Table 29: *Data on Systems*

Systems	Description	Practice		
	Disciplines – Traditional Scientific; Thinking is Practical and Personal	STEM LC; Applied Research; Develop Connections to Research Problems		
		Disagree	Neutral	Agree
What I do with my PMPS research is different than what I do in a typical class at my college.		8.83	17.65	73.53

The survey results show that a majority of students (nearly 74%) noted that what they do in a traditional classroom environment at their institution is very different than what they do with PMPS. Interview data highlight these differences. In comparison to the hands-on, realistic research experiences supported by PMPS, typical classroom environments that include labs were described as general and formulaic. An associate professor of Chemistry and Biochemistry noted how he saw these two environments as "fundamentally different":

> This (PMPS supported research) is fundamentally different. Because like these experiments, in a classroom setting, the outcome is clear so they go in there, they have like a cooking instruction on a sheet, they do their thing and then at the end of one or two or three sessions, this is done…that's fundamentally different from the (faculty) lab where we give them projects that are open-ended. – *Male, Hispanic, Associate Professor of Chemistry and Biochemistry*

A student who had recently graduated and just started a Master's degree program in the life sciences agreed that her PMPS experience prepared her for a more realistic view of the world of science by requiring much harder work, independence and patience. These skills, she noted, were important as she entered the next stage of her professional career working on other research projects:

> Being in the lab in a class is so much easier. They're holding your hand…but conducting research, it's not all black and white. There are so many grey areas and I think working with Dr. [redacted] he really taught me that and he pushed me to understand that it's not going to be easy…I think that's helped me with my other research projects outside of lab. – Fe*male, Hispanic, Post-Senior, Life Sciences*

Students described what they do in a traditional classroom environment as general formulaic. In these settings, they were not granted opportunities to work independently or engage creatively by setting up their own research protocols. Since classroom lab work is already pre-set to be successful, students are not given the opportunity to understand that in science, things do not always go as planned. In the PMPS supported environments, they are exposed to this aspect of science and given the opportunity to troubleshoot and learn what to do when something does not go right. They are able to learn all of this relatively independently compared to the classroom environment, where protocols are pre-set and the lab instructor "holds your hand" through the experiment until all goes as planned.

Multicontext Theory in Practice in PMPS

As I began this project, I was interested in determining whether an assimilationist model of student retention (Tinto 1993), that seeks to identify specific barriers that URMs face and subsequently helps students assimilate into a dominant academic cultural context in order to promote persistence and achievement is still viable, or whether an alternative Multicontext theoretical framework that has proven useful in understanding the process of change in institutional culture called "Context Diversity" (see Ibarra 2001, 2005) is a better explanatory framework.

The study revealed that a Multicontextual theoretical framework (Ibarra 2001) was an important element in attracting and developing URM students to pursue STEM-related research in graduate school. The interviews suggested that elements of a Context Diversity

model were indeed, evident in the occasions when the PMPS program and mentors changed the context of academic culture in teaching undergraduate students to become scientists:

> Rather than recruit and retain populations, context diversity strives to create a learning community replete with myriad ways to *attract* diverse populations and have them *thrive* in an academic or workplace environment. Results are measured not only by how well we attract them, but also by how well we enhance campus cultures to improve upon the academic and work performance for *all* students, faculty, and staff. Rather than strive to increase diversity using just structural [Affirmative Action programs] or multicultural [ethnic studies] models, the focus is on finding ways to study, apply and eventually build diversity *into* the higher education system, if you will, *into* the context of our learning communities and beyond (Ibarra 2005:7).

The findings in this chapter suggest that major concepts in Multicontext theory have emerged over time within one highly successful program and can be attributed with student success within that program. Furthermore, this new model has the potential to reframe academic departments and institutions in order to promote system institutional success in increasing the number of underrepresented students in STEM rather than forever focusing on changing a student to fit in to an imbalanced system. These include a Multicontextual approach to interaction, space, association, learning, and systems in STEM education.

STEM fields and higher education institutions would increase their ability to serve underrepresented students in STEM by focusing on creating STEM communities where lab environments support the development of close, diverse communities, where students feel at home and comfortable working with their peers and their faculty. Faculty members can facilitate this community by embracing the importance of checking in on the emotional needs of their students as well as embracing racial and ethnic cultural difference and seeing these differences as an asset to their team. STEM fields will have better luck attracting underrepresented students into their disciplines by highlighting how STEM research can be altruistic in nature and essentially impact the lives of individuals in the world around them.

It is important to not separate the context and importance of STEM research from ideals of humanism and altruism. By emphasizing the altruistic, humanistic components of STEM research, individuals will not only be attracted to the field, but they will thrive through personal motivation to remain in the field to make a difference.

Learning within traditional low-context STEM environments (including traditional classrooms and labs) was described as formulaic, unrealistic and "general." The learning environments developed through PMPS were described as hands on, team oriented, applied, and realistic where students were able to connect their work to real problems in the world. This generated excitement among students and a desire to stay within this exciting field. A majority of faculty and students noted that this Multicontextual learning system was more of an exception within their PMPS environments rather than the rule at their institutions. Individuals and institutions interested in improving STEM education and minority retention in STEM fields will be well served by reimagining their learning environments so that they espouse Multicontextual learning rather than the traditional low-context practices that define the field today.

With regard to the issue of cultural assimilation of URM's in higher education today, there is evidence that students seem not only reluctant, but resistant to this kind of social pressure to conform, especially among Latino populations (Ibarra 2001). The interviews with PMPS participants revealed a tendency for student participants to respond well to faculty mentors when mentors acted to facilitate their process of learning to become scientists, and when students were welcomed into their labs and recognized for their contributions to the research.

The interviews did not reveal any problems derived from cultural differences between mentors and students or the need to "remediate" their students in order to help them fit into the cultural fabric of their STEM labs. In fact, faculty mentors frequently mentioned how they appreciated learning from their PMPS students and their best advice to other mentors was to spend time listening carefully to their PMPS students to learn more about their rich cultural backgrounds.

Identity formation, that is learning to become a scientist via PMPS mentors, can be perceived as a form of cultural assimilation, but in this program, the mentors are not attempting to replace someone's racial or ethnic identity with the professional identity of a research scientist. It was observed that the process of helping students to become good research scientists included no mention of cultural differences causing dissonance among student/mentor relationships. In fact, many students mentioned the cultural diversity of faculty mentors as a benefit of the program and faculty mentors noted the importance of recognizing and valuing the diverse backgrounds of their students. If any changes occurred in roles and relationships, the process of acculturating students into an additional occupational or professional role of a scientist in specific academic cultures was clearly evident. The program does have a positive effect on both students and faculty with the emphasis on inclusion rather than assimilation.

Identity, Diversity, and Institutional Transformation Revisited

It is clear that students are attracted to "realistic research experiences" that go beyond the context of classroom or classroom-based lab experiences that are deemed "formulaic." Students frequently responded to the positive attributes of the program, and how they thrived on the ability to be creative, the freedom to make mistakes, and on the unexpected

approachability of lab leadership–all components of community building within the construct of the Context Diversity model. In our analysis, there is evidence to project that assimilationist models are no longer capable of explaining how and why programs such as these are successful. But so far, the facts indicate that the PMPS is an exceptional program on the cutting edge of a new paradigm for diversity in higher education, and importantly, it is successful in preparing and encouraging more and more underrepresented students to pursue an advanced degree in a number of important STEM fields.

The future of Affirmative Action policies and the expansion of more authentic diversity initiatives are intertwined with the ability to understand how to develop integrated identities for all students in higher education. Integrated identities not only benefit students, who will be more academically successful, but also for the institution in terms of student success and happiness and degree completion. This can propel the development of diverse student bodies at all levels in the academic pipeline even in post-Affirmative Action political environments. Context diversity models, which focus on policies that foster inclusion and diversity beyond personal characteristics (race, class, gender difference) may be seen more favorably than current policies of access and retention that focus on distributing resources based on individualized racial classifications (Epperson 2011). Documenting the benefits of alternative, diverse spaces on campus and speculating about the effects of the removal of these programs can play an important role in the future of diversity initiatives in higher education.

CHAPTER 5: CONCLUSION AND OPPORTUNITIES FOR FUTURE WORK

In this work, I argue for a more nuanced understanding of success for underrepresented STEM students, which includes racial and ethnic minority students as well as women. I present evidence that traditional models of student recruitment and persistence are outdated and in need of serious revision. In order to improve these frameworks, theoretical and empirical models must be revised, including incorporating an authentic intersectional approach to understanding student identity and experience as well as introducing Multicontextual theory and concepts in studies of student socialization and persistence.

As I started this project, I was skeptical of traditional assimilationist models that encourage student identity development in a one-directional manner. In other words, I questioned the legitimacy of programs and environments that encourage students to suppress important parts of their identity in favor of the dominant cultural values. My critique was that this type of assimilationist identity development has the potential to lead to a disjointed academic, science and personal identity. Disjointed identities lead to unhappy scholars and potentially ineffective scientists at risk of departure from the field.

In my analysis, there is evidence to project that assimilationist models are no longer capable of explaining how and why programs, such as PMPS and MSDS, are successful and that these programs offer more support in building more complex academic identities that encourage individuals to find who they are within academia and to "bring that to the table." The empirical findings indicate that PMPS and MDMS, while different in technique and approach, are programs on the cutting edge of a new paradigm for diversity in higher education. More importantly, they are successful in preparing and encouraging more

underrepresented students to pursue an advanced degree in a number of important STEM fields.

First, my research suggests that student success, especially for underrepresented racial and ethnic minority students, must engage with multiple aspects of self-identity. Experiences of these students must be understood beyond one-dimensional measures of identity and require a careful, intersectional approach. If scholars studying issues of equity, inclusion and identity look only at one part of identity – such as race *or* gender *or* class, important pieces of their experience become hidden. It was clear that Hispanic students' experiences vary by their gender identification, and women's experiences vary by their racial identification. By looking at *only* Hispanics or *only* women in studies of identity development and equitable schooling environments, a nuanced understanding of how these unique social locations impact experiences and identity become lost.

Furthermore, the measurement of these categories of analysis must go beyond typical, sometimes superficial, practices of institutions. Noting the multi-level nature of race, including one's self-identification, how others perceive them, and capturing their lived experience with that identity is necessary for *real* understanding of how these important aspects of identity structure the experiences and opportunities of students that live them.

I also wanted to understand how to influence long term, institutional transformation in higher education. University reform should be focused at multiple levels, including the institutional (cultural context) and the individual (including students *and* faculty) (Edwards 1999) with efforts made to impact both. However, many reforms fall short of this multilevel reform, due to the lack of emphasis on the intermediate, departmental level. Traditional thought in higher education often notes this level as composed of autonomous faculty who

adhere to a certain discipline's mode of thinking and doing (Edwards 1999; Toulmin 2001) where "departmentally defined intellectual turf lines change very slowly" (Edwards 1999, pp. 19). In this sense, the academic department is in a contentious relationship with its surroundings, where its inability to change slows or makes impossible broader institutional change which effects individuals. Sustainable institutional transformation must then evolve from the current system rather than work from the outside to over-throw it (Edwards 1999). This means that departments still need to be autonomous units defined by boundaries, yet those boundaries must be more "porous." Here, "faculty members must be able to move more flexibly to assignments outside of the department. Joint appointments and interdisciplinary work, and collaboration with scholars in other departments must…be supported by informed critical evaluation…eligible for significant rewards" (Edwards 1999, pp. 26). This would involve taking a "broader view" of faculty work and its merit and incorporate modes of thinking and "reasoning" beyond rationality, beyond purely mathematical or economic analyses and incorporate research that values the "subjectivity" of the subject (Edwards 1999).

In order for this transformation to occur, individuals should be more critical in their approaches to problem solving, engaging with others outside of our disciplines and from different backgrounds. Practical experiences of individuals within a situation are important when understanding such a situation. All of these things support a view incorporating a greater emphasis on interdisciplinarity and the valuing of all types of knowledge, whether it arises quantitatively (stressing logic, objectivity, rationality) or quantitatively (valuing the subjectivity of key individuals, life experiences, and the practicality that can come from engaging with a community) (Toumlin 2001). If institutions are to compete in a broader,

more diverse world, serve the increasing numbers of diverse students as well as train all students in communicating in an increasingly Multicontextual world, it is necessary for institutions to reframe traditional pedagogy to embrace Multicontextual cultural environments. Ibarra (2001) argues that:

> To survive this challenge institutions must seek ways to correct imbalances in their academic cultures and realign educational priorities in a way that will build a new and inclusive community of scholars based upon equal measures of comprehensive knowledge (concrete connected knowledge and active practice) and analysis based knowledge (abstract analytical knowing and reflective observation). (249)

Scholars interested in studying cultural context and change in higher education must consider the nuanced approach to student success that incorporating Multicontextual theoretical models provides. Instead of just looking at how students are either socialized successfully into the dominant cultural context of traditional higher education or not, and instead of merely locating "barriers" and faults within students who resist dehumanizing socialization practices, it is necessary to turn our empirical gaze upwards to the institution and look for pulse-points of change in the traditional cultural environment that allow students to develop integrated science identities with their important personal biographies. It is clear from this study that bringing the "personal" – high-context – into the "professional" life of an academic – low-context – students is not seen as a weakness by prominent faculty mentors, but can be used as a tool to help engage underrepresented STEM students into professions where they still lack a critical mass of leaders who "look like them." Achieving an appropriate balance of high-context practices within low-context environments is a balancing act, but lessons on how to do this successfully can be learned from this empirical work.

Finally, higher education scholars interested in facilitating authentic diversity must add Context Diversity to the traditional models of diversity that currently only address

structural diversity (numerical representation), multicultural diversity (cultural awareness) and interactive diversity (exchange of diverse ideas). By adding "Context Diversity" to this framework, which focuses on reframing the cultural context of higher education policies, procedures and processes (essentially, cultural changes) can result in institutional transformation by being more inclusive of the reflexive identity development of diverse students.

Facilitating Multicontextual cultural environments in higher education can result in a greater attraction of these students to these fields and help them thrive as they work towards their professional goals. This can ultimately result in greater numbers of underrepresented students represented within STEM graduate education, the faculty and beyond. Once these students position themselves as leaders in these fields, they likely will mentor other underrepresented students in the same way they have been trained, thus leading to greater, long-term, authentic cultural change and equity in these fields.

Increasing the likelihood of STEM degree completion for underrepresented STEM students will remain an important issue in the sociology of education, especially as the United States moves into a post-Affirmative Action political climate. It is important to understand the processes that encourage these students to not only pursue a degree in STEM, but that facilitate their participation STEM environments and contribute to their advancement into graduate programs and beyond. This does not only impact the individual level, in terms of individual degree completion and advancement. It also contributes to greater institutional transformation that will facilitate equity for these students in higher education even if Affirmative Action type initiatives lose their political and financial backing.

Exploring the experiences of women and minority students in their pursuit of these degrees and the faculty that mentor them along the way can help us understand where the traditional academic environment is failing and where to focus attention for pulse-points of change. Understanding how to incorporate tenants of a Multicontextual environment into higher education's traditionally low-context environment is a jumping off point. For example, it is clear that students are attracted to "realistic research experiences" that go beyond the context of classroom or classroom-based lab experiences that are deemed "formulaic and unrealistic." Students frequently responded to the positive attributes of the program, and how they thrived on the ability to be creative, the freedom to make mistakes, and on the unexpected approachability of lab leadership–all components of community building within the construct of the Context Diversity model.

Furthermore, students are attracted to the inherent altruism of scientific endeavors as well as the ability to transcend disciplines in order to impact communities around them at the world at large. Emphasizing this tenant of STEM education could facilitate the attraction of minority students and women into these fields as well as contribute to their persistence in their schooling. Students thrived in environments where they felt like there were other students who were like them, whether in terms of gender or racial/ethnic identity or in terms of experience level. Incorporating more of a peer-mentoring, team-like structure into traditional classrooms could make these environments more inviting and supportive for these students to which community and peer relationships are important.

If the university needs to transform in order to serve a more diverse student body, it can focus on areas that require low financial burdens while promoting great levels of student success. Understanding and emphasizing the role of diverse community and communal

STEM environments, personal interaction with faculty and peers that acknowledges and supports individual background, teaching STEM in a more hands-on, realistic way while emphasizing the altruistic nature of the field, and connecting STEM to the world beyond academia are good jumping off points. Furthermore, to facilitate a truly integrated identity for these young scientists, it is important to recognize and acknowledge their sometimes unique backgrounds and encourage them to find where they fit within a broader STEM environment and how to "bring it to the table" as Stacy would say.

The future of Affirmative Action policies and the expansion of more authentic diversity initiatives are intertwined with the ability to understand how to develop integrated identities for all students in higher education. Integrated identities not only benefit students, who will be more academically successful, but also for the institution in terms of student success, happiness and degree completion. This can propel the development of diverse student bodies at all levels in the academic pipeline even in post-Affirmative Action political environments. Context diversity models, which focus on policies that foster inclusion and diversity beyond personal characteristics (race, class, gender difference) may be seen more favorably than current policies of access and retention that focus on distributing resources based on individualized racial classifications (Epperson 2011). Documenting the benefits of alternative, diverse spaces on campus and speculating about the effects of the removal of these programs can play an important role in the future of diversity initiatives in higher education.

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APPENDICES

Appendix A: Multicontext Concepts

Low-Context		MC	High-Context	
Interaction	**Long term interpersonal feedback:** They avoid interfering with or intervening in others' lives. They take colleagues' mood shifts for granted, attributing them to personal problems that should be ignored.		Interaction	**Short term interpersonal feedback:** Constant checking on emotional status of others is important for group morale. Though this characteristic is attributed to women, HC people in general are especially attuned to slight mood changes among friends and colleagues.
Space	**Space has more boundaries.** LC people need more social distance for interaction with little if any touching or contact during conversation. Personal space is compartmentalized, more individualized, and private.		Space	**Space is more communal.** HC people are more comfortable interacting within close social distances, and constant non-intimate touching during conversation is normal. Personal space is shared, and involvement with others is encouraged.
Association	**Personal commitment to people is low.** Relationships start and end quickly. Many people can be inside one's circle, but boundaries are blurred. They are often highly committed to their job or career. Written contracts are important.		Association	**Personal commitment to people is high.** Relationships depend on trust, build up slowly, and are stable. They are careful to distinguish who is in their circle. People are deeply involved with each other. They have a strong tendency to build lifetime relationships. Written contracts are less important than bonds of personal trust.
Learning	**They learn best by following directions.** They assemble or combine facts according to rule they memorize. Things are spelled out with explicit explanations even in an apprenticeship model. Theoretical and philosophical problems are treated as real.		Learning	**They learn best by demonstration.** They learn by hands-on methods: observing and mimicking others, practicing it mentally and physically, demonstrating it to others, and by apprenticeship. Real life problems are as important as theoretical and philosophical ones.

Low-Context		MC	High-Context	
Learning	**Learning is orientated toward the individual.** They prefer to approach tasks and learning individually. They tend to work and learn apart from others. Teamwork means individuals are assigned specific tasks to accomplish.		Learning	**Learning is group oriented.** They prefer to work in groups to learn and solve problems. Some groups prefer constant talking (interacting) in close proximity when working or learning.
Time	**Time is monochonic.** They emphasize schedules, compartmentalization, and promptness. They do one thing at a time and may equate time with money and status. Change happens fast.		Time	**Time is polychronic.** They emphasize people and completion of transactions. They do many things at once (multiple tasking) and do not equate time with money or status. Change happens slowly for things are rooted in the past.
Culture	**Formal culture is team orientated.** Teams consist of individuals with specific skills who are brought together to work on projects or tasks. Their work may be linked, but it is sequential and compartmentalized (handled off to others).		Culture	**Informal culture is group orientated.** Individuals with general and/or specific skills come together to work as a group to complete projects. Work is interactive, and individuals are not territorial about specific tasks.
Systems	**LC Disciplines** They may favor traditional scientific fields that tend to conduct analysis with methods that often eliminate context (separate information from context). Research analysis usually deals with large numbers of quantitative and easily measured variables; results are more deterministic and context is less important. New research projects are directed toward strongly projected, predetermined outcomes.		Systems	**HC Disciplines** They may favor disciplines that are more directly involved with contextual thinking and research about livings systems and people. Research analysis is more qualitative and probabilistic and requires attention to variables in which cultural context is important. New research projects are clear about the direction and methods of analysis, but projected outcomes are less predetermined and more open-ended and flexible.

Low-Context		MC	High-Context	
Systems	**Scientific thinking is emphasized.** They value examining ideas rather than broad comprehension of real-world applications. Linear thinking is ultra-specific and inhibits a broad mutual understanding of multilayered events.		Systems	**Practical thinking is valued.** They value application of knowledge in real world events (social skills). Interconnected thinking fosters creativity and broad comprehension of multilayered events.

Appendix B: Online Survey

[PROGRAM] Participation

1. Which of the following activities did you participate in through [PROGRAM]/. Please check all that apply.

	Individual research with a faculty mentor/sponsor
	Summer research experience
	Peer study group
	[PROGRAM] research conference presentation in Arizona
	Presentation of [PROGRAM] research at non-[PROGRAM] sponsored research conference
	[PROGRAM] Summer Bridge program
	Skill Building Workshop (e.g. GRE Prep; Applying to Graduate School Workshops, etc.)
	Other: Please Specify

2. Which of the following activities did you NOT participate in through [PROGRAM]/ that you wish you would/could have? Please check all that apply.

	Individual research with a faculty mentor/sponsor
	Summer research experience
	Peer study group
	[PROGRAM] research conference presentation in Arizona
	Presentation of [PROGRAM] research at non-[PROGRAM] sponsored research conference
	[PROGRAM] Summer Bridge program
	Skill Building Workshop (e.g. GRE Prep; Applying to Graduate School Workshops, etc.)
	Other: Please Specify
	N/A

[PROGRAM] Activities and Feedback:

3. Please indicate the extent to which you agree or disagree with the following statements on **community and mentorship**:

	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
As a result of [PROGRAM], I developed a close connection with a faculty member in my field of interest.					
[PROGRAM] exposed me to new opportunities.					
[PROGRAM] provided me an opportunity to be a part of a community.					
During my time in [PROGRAM], I developed deep, family-like connections with faculty and students in my discipline.					
Before [PROGRAM], I did not know that I could do undergraduate research.					
I had been rejected from other undergraduate research opportunities before being accepted into my [PROGRAM] opportunity.					
A faculty approached me and invited me to do research with him/her funded by [PROGRAM].					
Before [PROGRAM], I felt like I did not belong at my institution.					
There is a real commitment to diversity on my campus.					
I am a member of an ethnic organization on campus. (E.G., Mexican American Student Association, etc.)					

4. Please indicate the extent to which you agree or disagree with the following statements on **abilities and skills**:

	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
As a result of [PROGRAM], I became more confident in my abilities as a scientist.					
I was anxious and unsure about what was expected of me in [PROGRAM].					
After my [PROGRAM] experience, I was more confident in my abilities to complete my degree.					
I frequently use knowledge from multiple disciplines in my academic work.					
As a result of [PROGRAM], my writing has improved.					
My participation in [PROGRAM] helped me improve my GPA.					
I feel very comfortable in my research lab.					
I feel like I have the basic knowledge to run a research lab.					
I feel confident working independently on my research.					
I feel confident asking my research mentor questions.					

5. Please indicate the extent to which you agree or disagree with the following statements on **professional research and experiences**:

	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
My [PROGRAM] experience did not teach me anything new about what it means to be a professional in my field.					

I am glad I decided to participate in [PROGRAM].					
Through [PROGRAM], I gained a better understanding of how to apply to graduate school					
In my [PROGRAM] research, I am often frustrated when things do not turn out the way they are supposed to.					
I have published a paper from my [PROGRAM] research.					
Before [PROGRAM], I had not considered going to graduate school.					
My [PROGRAM] experience gave me a better understanding of what is expected of me in my field of interest.					
What I do with my [PROGRAM] research is very different than what I do in a typical class at my college.					
My [PROGRAM] research experience was too short.					
I had no troubles completing my [PROGRAM] research on time.					

Student Status:

6. What is your current student status?
    a. Undergraduate Student
    b. Graduate or Professional Student
    c. Other [explain briefly]

7. In which school are you currently enrolled (or, were you enrolled in as an undergraduate student?)
    a. Southwest University
    b. Down South University
    c. Selective University
    d. Private University

e. Southern Community College
f. Other: [Specify]

8. During your [PROGRAM] activities, at which school were you participating? (Note, this may be different from the school where you are obtaining your degree.)
a. Southwest University
b. Down South University
c. Selective University
d. Private University
e. Southern Community College
f. Other: [Specify]

9. What is your class standing?
a. Freshman/first year
b. Sophomore/second year
c. Junior/third year
d. Senior/fourth year
e. Fifth-year senior or more
f. Graduate Student
g. Other [specify briefly] _____

10. Did you transfer to your current college/university from a community college?
a. Yes
b. No

10a. (SKIP LOGIC, if any yes in Q10) Why did you choose to begin your education at a community college? (Select all that apply.)

	Less expensive.
	Establish a strong GPA.
	Closer to home.
	Easier admission.
	Smaller school/classes
	I had family responsibilities.
	I had medical issues.
	The location was more convenient.
	Learn study skills
	Other: [Specify]

10b. (SKIP LOGIC, if any yes in Q10) When deciding to transfer from a community college to your current institution, how important were each of the following reasons?

	Not Important	Somewhat Important	Essential
To fulfill degree requirements			
Quality of education			
Research opportunities.			
The location was more convenient			
Courses I needed to take were not offered at this college			
To challenge myself academically			
To take classes to explore my interests			
To earn a degree or certificate that is not offered at this college			
Changed my career plans			
Felt like I didn't "fit in" at my college			

Was bored with my coursework			
Wanted a better social life			
Had family responsibilities			

11. At the time that you were a [PROGRAM] student, what was your undergraduate major? Please check the box to the **LEFT** of the major. (Select **up to TWO** if you are a double major.)

12. What do you think you will be doing in fall 2015?
- a. Attending your current (or most recent) institution
- b. Attending another institution
- c. Entering graduate school (either at my current institution or another institution)
- d. Don't know/have not decided yet
- e. Not attending any institution
- f. Other: [Specify]

13. What is your current GPA (on a 4 point scale)?
- a. 3.0 - 4.0
- b. 2.0 - 2.99
- c. less than 2.0

College/University Experience:

14. The following questions ask about your **overall college experience (in general)**: Please indicate the extent to which you agree or disagree with the following statements:

	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
Being part of a campus community is important to me.					
It is important that my research improve the world around me.					
I prefer open, direct communication.					
I prefer to work with a group of students.					

I would rather work alone than as part of a group.					
It is not important for my research to have an impact on the world around me.					
I prefer meeting with faculty one-on-one.					

	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
I prefer talking to faculty as part of a group.					
I learn best through reading and memorization.					
I learn best by applying material in a hands on way (e.g. through lab experiments, etc.)					
I learn best when a list of instructions is given to me to follow.					
I learn best after seeing a demonstration from an instructor.					
Having privacy is important to me.					
I tend to work very quickly.					
When I work, I have a set schedule that I stick to.					
I do not like getting attention for what I have done.					
I enjoy praise for my academic accomplishments.					

15. Have you personally experienced any of the following forms of harassment/discrimination while attending college:

	Yes	No
Ability/disability status		
Age		
Citizenship status		
Political beliefs		
Race/ethnicity		
Religious/spiritual beliefs		
Gender		

Sexual orientation		
Socioeconomic status		

16. Please indicate how often you have personally experienced the following forms of harassment/discrimination while attending college:

	Never	Seldom	Sometimes	Often	Very Often
Verbal comments					
Written comments (e.g., emails, texts, writing on walls)					
Exclusion (e.g., from gatherings, events)					
Offensive visual images or items					
Threats of physical violence					
Physical assaults or injuries					
Anonymous phone calls					
Damage to personal property					
Other: [Specify]					

Student Self Evaluation:

17. Rate yourself on each of the following traits as compared with the average person your age. We want the most accurate estimate of how you see yourself.

	Above Average	Average	Below Average	Don't Know
Academic ability				
Mathematical ability				
Self-confidence (intellectual)				
Drive to achieve				

18. How often in the past year did you:

	Frequently (Weekly)	Occasionally (Monthly)	Not at all
Ask questions in class			
Support your opinions with a logical argument			
Seek solutions to problems and explain them to others			
Revise your papers to improve your writing			
Evaluate the quality or reliability of information you received			
Take a risk because you felt you had more to gain			
Seek alternative solutions to a problem			
Look up scientific research articles and resources			
Explore topics on your own, even though it was not required for a class			
Accept mistakes as part of the learning process			
Seek feedback on your academic work			
Integrate skills and knowledge from different sources and experiences			

19. Since **entering your current college/university**, how often have you:

	Frequently (Weekly)	Occasionally (Monthly)	Not at All
Missed class due to personal/family responsibilities			
Missed class due to employment			
Received family support to succeed			
Contributed money to help support your family			
Not been able to get into the classes you need because they were full			
Had difficulty in commuting/getting to campus			

Student Long Term Plans

20. How much do you think the [PROGRAM] program has had to do with your academic progress?
    a. [PROGRAM] had no impact on academic progress
    b. [PROGRAM] had very little impact on academic progress
    c. [PROGRAM] impacted academic progress somewhat
    d. [PROGRAM] impacted academic progress greatly
    e. Don't Know Yet

21. What is the highest academic degree that you would like to achieve?
    a. Bachelor's degree (B.A., B.S., etc.)
    b. Master's degree (M.A., M.S., etc.)
    c. Ph.D.
    d. Professional Degree (M.D., D.O., D.D.S., or D.V.M. Ed.D.; J.D. (Law); B.D. or M.Div. (Divinity)
    e. Other

22. How confident are you that you will reach this goal?
    a. Not at all Confident (Probably will not complete degree)
    b. Somewhat Confident (Want to complete, but it may not happen)
    c. Very Confident (Definitely will complete degree)

23. Did your educational goals change at all as a result of your participation in [PROGRAM]?
    a. Yes
    b. No

    23a. (SKIP LOGIC: If Yes to 24) How much do you think [PROGRAM] impacted this change?
        a. Not at all
        b. Moderately (It was one of many factors influencing the change)
        c. Significantly (It was a major factor influencing the change)

    23b. Please briefly explain why you chose your answer.
    [ ]

24. When finished with your education, which area do you hope to by employed?
    a. Academia (Professor, Research Scientist, etc.)
    b. Private Industry
    c. Medical Field (M.D. or Nurse; Etc.)
    d. Don't Know
    e. Other: [Please Specify]

Family and Finances:

25. What is your marital status?
    a. Single, Never married
    b. Married
    c. Divorced
    d. Widowed

26. How many children do you have?
    a. 0
    b. 1
    c. 2
    d. 3
    e. 4 or more

27. During your time as a [PROGRAM] student, which best describes your living situation?
    a. Lived in university housing sponsored or paid for by [PROGRAM]
    b. Lived in university housing not sponsored or paid for by [PROGRAM]
    c. Lived with family off campus (parents, grandparents, aunts or uncles, siblings)
    d. Lived alone off campus
    e. Lived with roommates (not including siblings) off campus

28. At this time, do you have any concern about your ability to finance your college education?
    a. None (I am confident that I will have sufficient funds)

b. Some (but I probably will have enough funds)
c. Major (not sure I will have enough funds to complete college)

29. Please provide your best estimate of your total household income last year. (If your parents or guardians claim you as a dependent, please provide the estimate for their total household income.)

a. Less than $10,000
b. $10,000- 29,999
c. $30,000-49,999
d. $50,000-69,999
e. $70,000- 99,999
f. $100,000 or more
g. Don't Know

30. Outside of the [PROGRAM] stipends, which of the following have you ever used to support your college education? (Check all that apply)

	Aid which need not be repaid (grants, scholarships, military funding, etc.)
	Aid which must be repaid (loans, etc.)
	Pell Grant
	Parental Support
	Help from other family (non-parents)
	Help from other people (non-family)
	Job
	Other: Please Specify

31. Beyond your academic work, on average, how many hours per week do you work for pay?

[Specify]

32. How has participating in the [PROGRAM] program affected your economic circumstances?

a. Not at all
b. [PROGRAM] had a positive impact on my economic circumstances

c. [PROGRAM] had a negative impact on my economic circumstances

33. Do you feel that the stipend you received through [PROGRAM] was enough to compensate you for your work?
    a. Not at all enough to compensate for my time
    b. Somewhat enough – more would have been better
    c. Definitely enough to compensate for my time

34. Do you have concerns about school loans and other debts that will eventually need to be repaid?
    a. Yes
    b. No

    34a. (SKIP LOGIC: If yes to 34) Do your concerns influence your current career goals or educational decisions?
        a. Yes, in a negative way (e.g. not being able to further education)
        b. Yes, in a positive way (e.g. being more motivated to further education)
        c. No, concerns about loans and debts do not influence my career goals and educational decisions

Lifestyle and Health

35. Do you have any type of disabilities or medical conditions that may or may not influence your educational experiences? Some examples might include the following: Learning disability (dyslexia, etc.); Attention-deficit/hyperactivity disorder (ADHD); Physical disability (speech, sight, mobility, hearing, etc.); Chronic illness (cancer, diabetes, autoimmune disorders, etc.); Psychological disorder (depression, etc.)
    a. Yes
    b. No

36. Think about your time in [PROGRAM] and please indicate the extent that you agree or disagree with the following statements related to **health:**

	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
When I evaluate my health based on how I feel, I feel healthy.					
My health status negatively impacts my educational goals?					

My health status has changed in a negative way during the course of the [PROGRAM] program.					
My energy level is adequate for me to achieve what I wanted to while I was in the program.					
My life is very stressful.					
[PROGRAM] increased my stress level.					

Demographics:

37. What is your age? _____

38. How do you identify your gender?
    a. Male
    b. Female
    c. Other: [Specify]

39. What is your sexual orientation?
    a. Heterosexual/Straight
    b. Gay
    c. Lesbian
    d. Bisexual
    e. Queer
    f. Other

40. How do you identify yourself by racial and ethnic group categories [if multiracial check all that apply]
    a. □Hispanic or Latino
    b. □American Indian or Alaska Native; Native Hawaiian or Other Pacific Islander
    c. □Asian/ Asian American
    d. □Black or African American/Black
    e. □White
    f. □Other [please specify]

41. Which of the following most accurately describes your background?

a. My parents/legal guardians and I were born in the United States
b. I was born in the United States; one or both parents/guardians were not
c. Foreign-born naturalized citizen
d. Permanent legal resident
e. Foreign born on student visa
f. Don't Know

41a. (SKIP LOGIC, if you were NOT born in U.S. in 41). Did you complete all of your high school education in the United States?

a. Yes
b. No

42. What is the highest level of education completed by each of your parent(s)/guardian(s)?

	Parent 1		Parent 2
	Some high school		Some high school
	High school graduate		High school graduate
	Some college or Certificate Program		Some college or Certificate Program
	Associate's degree		Associate's degree
	Bachelor's degree		Bachelor's degree
	Master's degree		Master's degree
	Doctoral or Professional degree		Doctoral or Professional degree
	Don't know		Don't know

43. Is English your first language?

a. Yes
b. No

43a. (SKIP LOGIC If yes in 43) With which language do you feel more comfortable?

a. English
b. Other Language

c. Equally comfortable with English and Other Language

Please use this space to state any comments you'd like to share about the [PROGRAM] program or advice to potential [PROGRAM] students.
[ ]

Appendix C: Interview Protocol

Program Non-Student Participants (PMPS and MSDS)

1. <u>Current Status</u>:

(a) Please describe your role in the [PROGRAM] program and tell us how long you have been associated or involved with the program?

(b) What department are you affiliated with at (*name of institution*)?

(c) Are you engaged with any other program(s) aimed at increasing underrepresented minority (URMs) students in the sciences (ex. *Ronald E. McNair; REU; MARC; IMSD; MGE@MSA*)?

<u>DISAFFILIATED</u>

(d) When was your program at (*name of institution*) disconnected from the [PROGRAM] program and why did that happen?

(e) What has been the impact of being disconnected from [PROGRAM]?

(f) Would you want to be re-engaged with the [PROGRAM]/ program at [SCHOOL] again?

(g) What are you doing on this campus to replace the [PROGRAM] program?

2. <u>Program Impact</u>:

(a) How would you describe your (*current/past*) relationship with the [PROGRAM] program central office on the [SCHOOL] campus?

(b) What impact has the program had in your department (p*lease describe*)?

(c) Has the [PROGRAM] program changed the department or campus academic culture in any way (*please describe*)?

(d) Have these changes been positive or negative (*please describe*)?

(e) Have you or any other mentors in the program had any problems or difficulties working with the [PROGRAM] program staff or directors at [SCHOOL] (*please describe*)?

(f) What have been the effects of the [PROGRAM] program on undergraduate students in your (department/campus)?

(g) (*If they have a graduate program*) What has been the effects, if any, of the [PROGRAM] program on graduate students in your department?

(h) What has been the impact of the [PROGRAM] program on faculty in your department? On your campus?

3. <u>Program activities/mentorship</u>:

(a) How long have you been mentoring students at (*name of institution*)?

(b) On average, how often do you have contact with [PROGRAM] students (ex. per week, semester, etc.)?

(c) Did you participate in a mentor orientation or training session offered by the [PROGRAM] staff at [SCHOOL]? On your campus?

(d1) (*If "yes" to item 3c)* Please describe your experience.

(d2) (*If "no" to item 3c*) Would you want to have more training if offered by the [PROGRAM] staff at [SCHOOL]?

4. <u>Program Feedback</u>:

(a) What were your initial expectations of the [PROGRAM] program?

(b) Is the program meeting your expectations?

(c) From your overall experience in [PROGRAM], has the program as guided and provided by the staff at [SCHOOL] been successful in meeting its goals and objectives?

(d1) (*If "yes" to item 4c*) What do you attribute to the apparent success of the [PROGRAM] program by the [SCHOOL] staff?

(d2) (If "no" to item 4c) What do you attribute to the apparent lack of success of the [PROGRAM] program provided by the [SCHOOL] staff?

(e) Do you have any suggestions for ways the [PROGRAM] program could be improved?

(f) Do you have any other final comments or recommendations you'd like to share about the [PROGRAM] program?

[PROGRAM] Student Participants

1. **Current Status:**
   (a) Where are you now in your degree program?
   (b) How much do you think the [PROGRAM] program has had to do with your academic progress?
   (c) What are your educational plans, and how have they changed over the course of your education?
   (d) Who is your faculty mentor in the program?
2. **Program Impact:**
   (a) What are the most valuable things you are getting from the [PROGRAM] program?
   (b) What aspects are helping you the least?
   (c) Are there any kinds of program experiences that you would want to have more of?
   (d) Can you think of anything *(about the program or about you or your life)* that is holding you back from doing as well *(or from learning as much)* as you would like?
3. **Program Feedback:**
   (a) What were your initial expectations of the [PROGRAM] program?
   (b) Is the program meeting your expectations?
   (c) Do you have any suggestions for ways the [PROGRAM] program could be improved?
4. **Program Activities:**
   (a) Tell me about your experiences in the program?
   (b) What is working best (*what activities work best for you*)?
   (c) What would you like to change?
   (d) How are things going with your mentor?
5. **Please describe your experience with [PROGRAM] staff.**

6. **Home & Family background:**
   (a) Could you tell me about your household situation (*where do you live*)?
   (b) Has anything changed while you have been involved with [PROGRAM]?
   (c) How has being in school affected your family life?
   (d) Has the [PROGRAM] program made any difference?
   (e) Have they helped you out, either financially or in other ways?
   (f) Have you helped them?
7. **Financial Issues:**
   (a) How has participating in the [PROGRAM] program affected your economic circumstances?
   (b) Is the stipend enough?
   (c) Do you have other sources of income or economic support?
   (d) Have you had to borrow money to *(help)* support yourself *(if relevant: and your family)*?
   (e) Do concerns about school loans and other debts that will eventually need to be repaid influence your current career goals or educational decisions?
   (f) While you have been in the [PROGRAM] program, have you ever found yourself worrying about how you're going to pay this month's bills?

8. <u>Lifestyle and Overall Health</u>

(a) When you evaluate your health based on how you feel, what do you conclude?
(b) Has your health status changed in any way during the course of the program?
(c) Is your physical stamina *(energy level)* adequate for you to achieve what you wanted to while you were in the program?
(d) How stressful does your life seem to you?
(e) What kinds of ways do you cope with stress?
(f) Has your stress level changed during the course of the [PROGRAM] program?

9. (a) Are there **<u>any other comments</u>** you'd like to say about the [PROGRAM] program?

(b) Do you have any advice for students who may be considering joining it?

Appendix D: Participant Observation Events

Intensive Student Activities	Summary
Summer Bridge	Incoming freshman learn techniques to navigate STEM fields as they enter college. Activities include tutoring, speakers, and peer mentoring.
Peer Study	All student participants are included here. Here students work together with academic material that is often more challenging than their current courses so they can succeed academically.
Undergraduate Summer Research and Graduate School Prep	Students here are typically transitioning between their sophomore and junior year in college. Students participate in summer seminars on research methods, data analysis, ethics, GRE prep and mentoring on graduate applications.
Faculty Directed Individual and Group Research, Publication and Presentation	The students work with a faculty mentor on their mentor's project to give them hands-on training. This program includes an emphasis on publications and conference participation, including an emphasis on international events.
Non-Intensive Student Activities	
Skill Building Workshops	Focus here is on GRE prep and other prep for standardized tests.
Transition Program Academy	This includes printed information to help students transition at various stages in the program, including transition from community college to 4-year colleges and from undergraduate to graduate school.
Faculty Mentoring Institute	This consists of a series of printed material and seminars designed to increase the effectiveness of faculty mentors.
Governing Board Meetings	This is the annual program governing board meeting.

Appendix E: Coding Guide

Attraction Factors

Factors students and faculty list as appealing in research, university and lab environments

- To Research
  - Science is Fun
  - Independence
  - Altruistic Work
  - Community
  - Diversity
  - Hands on/High Level
  - Supportive Staff
  - Interdisciplinarity/Collaboration
- To University/School
  - Diversity
  - Location
- To Environment
  - Friendly
  - Small
  - Challenging

Classroom Experience VS Program Experience

Student and faculty reflections on the difference between a classroom and program experience

- Classroom Descriptions
  - (*e.g.* Formulaic, Boring, Broad, Unrealistic, Low-Context, Definite Pre-Known Answers, Learning Information)
- Program Descriptions
  - (*e.g.* Independence, Hands-On, Realistic Research and Career Situations, Graduate Level Research, Fun, Creative, Engaging, Allows Mistakes)

Demographics

Various demographic and background information

- Affiliations, Appointments, Titles
  - Adjunct
  - Assistant Professor
  - Associate Professor
  - Associate Dean Graduate College
  - Director Diversity Programs
  - Full Professor
  - Regents Professor
  - Senior Sustainability Scientist
- Department
  - Chemical Engineering
  - School of Life Sciences
  - Aerospace Engineering
  - Ag and Biosystems Engineering
  - Applied Technology
  - Biochemistry
  - Biological Health Engineering
- Chemistry
- Civil Engineering
- Electrical Engineering
- Family Studies
- Forestry
- Industrial Engineering
- Mathematics
- Mechanical Engineering
- Bioscience
- Orthopedic Surgery
- Physics and Astronomy
- Psychology
- Formal Education
- Gender
  - Male
  - Female
- Major
- Minor
- -Future Plans
  - Graduate School
  - Professional School
  - Industry
- Race
  - African
  - African American/Black
  - Asian American
  - Indian/Middle Eastern
  - Native American
  - Not Connected
  - Others identify as different minority
  - Others identify as white
  - Technical description
  - White
- Ethnicity
  - Hispanic
  - Central American
  - European
  - Puerto Rican
  - South American
- Spanish, first language
- Rejected from Other REUs
- Started at Community College
- Year in School
  - Freshman
  - Sophomore
  - Junior

Senior
Post-Senior

Diversity

Student and faculty reflections on the impact and importance of diverse environments, including labs, departments, and universities – Includes challenges to fostering diversity

- Benefits of Diversity (Lab and Academia)
  - (*e.g.* Vibrancy,creativity, multiple perspectives)
- Challenges of Diversifying
  - (*e.g.* Cultural Conflict, Other Faculty, Takes Time)
- Current Status
  - (*e.g.* Faculty lab is diverse, Department lacks diversity)
- Tips for Diversifying
  - (*e.g.* Create Lab Family, find common ground in science)

Environment

This section includes factors about environments that students and faculty describe as attractive or unattractive; It includes how program environment is described

- Difficult Academic Environment
  - (*e.g.* isolation, exclusion-opportunities, lack of diversity, questioning citizenship, prejudice, intimidating)
- Supportive Academic Environment
  - (*e.g.* Administrative support, Community of Minorities/Diversity, Inclusive)
- Program Environment
  - (*e.g.* Intimate, inclusive, diverse, supportive mentors, welcoming)

Faculty Impact

- Ability to Support Students
- Helps Efforts to Diversify Lab
- Views on Minorities Change
- Why Faculty Became Involved
  - Cares about minority issues
  - Experienced struggles as minority
  - Financial Support
  - Lack of Diversity in Discipline
  - Other Faculty Recruited
  - Served by Program in the Past
  - Program Invitation

Family and Living

Information on student living and family situations during program experience, including family support, family structure, parental education

- Living Situation
  - (*e.g.* Dorms, Apartment, Roommates, Program funded, Changed/Did not Change due to Program)
- Parental Education
  - (*e.g.* Some high school, College)
- Relationship
  - (*e.g.* Close, Supportive, Influenced Science Career, Doesn't Understand Academia, Not Impacted by Program, Impacted by Program [positive/negative])
- Siblings
  - (*e.g.* count, only child)

Finances and Funding

Student and faculty thoughts on program stipend, financial burdens and concerns, and faculty supply support

- Faculty Impact
  - (*e.g.* helps fund lab, financial necessity allows faculty chance to work with URM)
- Financial Aid
  - (*e.g.* Scholarship, Grants, Work, Family help)
- Stipend
  - (*e.g.* amount, impact)
- Student Debt
  - (*e.g.* Loans; Influences future plans, concerns, financially supports family)

Health and Wellness

Student reflections on their health throughout program

- Health Positive
  - (*e.g.* Coping Mechanisms, Physical Stamina, No Change, Good Health)
- Health Negative
  - (*e.g* Increases stress, Unhealthy Habits Form)

Interdisciplinary

Student and faculty discussions on the rise of interdisciplinary STEM environments, the benefits to students and research, and the challenges of this movement

- Benefits of Interdisciplinarity
  - (*e.g.* Fresh Approach, Innovative, Attracts Students, Promotes Inclusiveness)
- Challenges of Interdisciplinarity
  - (*e.g.* Identity Issues, Support)

Mentoring

Student and faculty reflections on program mentoring, activities, and suggestions for working with URM students

- Activities
  - (*e.g.* Lab P.I., Technical Presentations, Technical Writing)
- Advice for Mentoring URMs
  - (*e.g.* Create community, Share Experiences, Understand Background, financial incentives, discuss bias, frequent contact, recognize abilities, learn to listen, co-mentor)
- Bridging Cultural and Academic World
- Co-Mentoring Style Utilized
- Experience
  - Learned through time/profession
  - Learned through program activities
  - Experience as a Minority
  - Working with Minorities
  - Working with Faculty
- Training (Count, years)
- Student Description
  - Formal
  - Accessible
  - Difficult/Challenging
  - Experienced
  - Exposure
  - Supportive
  - Unique
  - Very positive (e.g. awesome, great)
- Experience
  - (*e.g.* How long mentored students, Learned about mentoring via experience, seminar, talking to other faculty)
- Follows Up with Students
- Frequency of Interaction
  - (*e.g.* Daily, Weekly)
- Grad Students Utilized
- High-Context Mentoring
  - (*e.g.* Promotes Community, Family-Like relationships, Anti-Intimidation, Learning through Interaction, Research Connected to Community)
- Student Description
  - (*e.g.* Friendly, Family, Supportive)

MSDS Principles

MSDS students and faculty discuss the principles that are embedded into the program

- Connect Life to School
- Create feelings of Self-Worth
- Create Shared Culture/Community
- Development of Science Identity
- Help Students Navigate Difficult Situations
- Origin
  - Eastern Philosophy
  - Work with Students
  - Missing Content from Academic World
- Principle One: Know Your Hearth
- Principle Two: Find the Positive
- Principle Three: Bring it to the Table
- Principle Four: Finish Strong

Professionalism

Student and Faculty thoughts on what it means to be a professional/scientist.

- Curiosity
- Hard Work
- Inquisitive
- Passion
- Persistence
- Professional Activities
- Talent

Program Expectations, Goals and Objectives

Student and faculty initial expectations and whether or not these expectations were met; It also addresses faculty thoughts on whether the program reaches its goals and objectives and why

- Goals and Objectives
  - (*e.g.* meets/does not meet goals)
- Expectation Status

(*e.g.* met expectations, exceeded expectations, did not meet expectations)

Initial

(*e.g.* Technical support – money, supplies, students; Research and Professional Experience, Mentoring, None, Recruitment Tool)

Success in Reaching Goals

Program Recommendations

Student and Faculty recommendations for program improvement

Advice for Recruiting and Mentoring URM

Awareness

(*e.g.* Increase marketing of program)

Community

(*e.g.* support local program communities)

Funding

(*e.g.* Don't cut stipends, provide travel funding, supplies funding, improve disbursement)

Mentoring Support

(*e.g.* Seminars for students on graduate school, GRE, etc.)

Summer Research

(*e.g.* extend process, meal plan)

Technical Training

(*e.g.* Applying to graduate school, GRE Prep, Networking)

Recruitment

Faculty thoughts on how to recruit both faculty and URM students into program labs and challenges that arise

Challenges in Recruitment of Faculty

(*e.g.* Small grants, Lack of Awareness)

Challenges in Recruitment of URMS

(*e.g.* Misconceptions about Research, Community Focused Research, Lack of Social and Cultural Capital)

Factors that Make Good URM Candidate

(*e.g.* Pursuing Science, Commitment to Work, Independence, Conscientious)

Recruitment of Faculty

(*e.g.* Actively Recommends, Financial Support, Supplies Funding)

Recruitment of URMs

(*e.g.* Cast broad net, Difficult decision for URMs, Public Outreach/Social Media)

Relationship with Program Staff

Student and faculty description of relationships with program staff at the primary institutions

Negative Relationship (*e.g.* Disconnected)

Positive Relationship (*e.g.* Cordial, Caring, Responsive)

Student Impact

Student and faculty thoughts on how program activities and experiences impact students)

Academic Growth

Accomplishment

Attitude towards field/profession

Balancing Research/Life

Community

Confidence in Abilities

Confidence in Future Plans

Development of Cultural and Social Capital

Early Exposure

-First Time

-Grad/Professional School

-Science as a career

Experience with "Real Science"

Mentoring

Monetary Benefits

Professional Activities

Research Process

Conference Travel

Networking

Presentation

Writing for Publication

Thoughts on URMs and Program Students / Thoughts on working with URMs

Faculty thoughts on what it is like to work with program students and other URM students

Thoughts on URMs

(*e.g.* All humans equal, Lack of Social and Cultural Capital, Embrace that Groups are Different)

Thoughts on Program Students

(*e.g.* Rarely Problematic, Highly Motivated, Altruistic, Graduate Level Researchers, Serious, Hard Working)