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How Underrepresented Minority Doctoral Students in STEM Fields Experience Graduate School: A Whole-Self Framework

A Dissertation submitted in partial satisfaction of the requirements for the degree Doctor of Education

in

Educational Leadership

by

Melody Bazyar

Committee in charge:

University of California San Diego

Christopher Halter, Chair

Frances Contreras

California State University San Marcos

Rong-Ji Chen

2022

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University of California San Diego
California State University, San Marcos

2022

DEDICATION

It is with deep gratitude that I dedicate this dissertation to all who supported, encouraged, and inspired this work. Writing a dissertation can often feel isolating, but in those moments, I was able to turn to my never-ending support network to help me keep pushing. I hope to make you proud.

To my parents, Ahmad and Mozhdeh, for all their sacrifice and hard work providing my sister and I with endless opportunities. For always believing that I was capable of achieving my dreams, even when it was hard for me to believe in myself.

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LIST OF ABBREVIATIONS

URM	Underrepresented Minority
STEM	Science, Technology, Engineering and Math
PI	Principal Investigator. The PI refers to the student's thesis advisor.

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I would like to acknowledge and thank the JDP leadership and faculty for believing in this program and allowing students to grow and develop into independent researchers. Your professional and personal support does not go unnoticed and is critical to the success of every student who passes through your doors. Huge thanks to Melissa Wolf, our amazing program coordinator, who answered all our questions and ensured we were able to move smoothly across campuses and systems. I would also like to acknowledge all the students who I have had the pleasure of working with over the years, your experiences helped shape me as a professional and taught me so much and was the inspiration for pursuing this research.

VITA

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ABSTRACT OF THE DISSERTATION

How Underrepresented Minority Doctoral Students in STEM fields Experience Graduate School: A Whole-Self Framework

by

Melody Bazyar

Doctor of Education in Educational Leadership

University of California San Diego, 2022
California State University, San Marcos, 2022

Christopher Halter, Chair

Underrepresented minority students (URMs) make up only about a third of undergraduate students enrolled in post-secondary institutions and are further underrepresented in STEM fields. In the United States, only 12% of doctoral degrees

conferred in STEM fields are awarded to underrepresented minority groups. This study aimed to understand the factors that contribute to the retention of URM students' in doctoral programs, specifically in STEM fields, to degree completion, directly from the students' perspectives. By investigating URM students' experiences related to perceived levels and types of support during their doctoral programs, this study contributes to the body of knowledge regarding URM graduate student persistence using a "whole-self" framework approach. Different levels and types of support have been shown to impact URM students' persistence and completion of degree in higher education including multi-faceted institutional supports, social and emotional support, and personal supports. This study explores how the "whole-self" framework helps understand the students' experiences with the different types of support, and how those experiences impact the retention, persistence and successful degree completion of the racially diverse student. Through the experiences of three individual URM students in STEM doctoral programs this study provides key insights into possible areas of focus for institutions and doctoral programs who aim to improve the experiences of their URM student population. The three most prevalent areas of focus across all three cases include mentorship coupled with the recruitment of more URM faculty, financial support, and access to academic success programs. Institutions and programs who prioritize the support of URM students and all students can have the biggest impact by addressing students' needs using the "whole-self" framework. Although the areas of focus can each be acted on separately, institutions and programs will have limited impact on supporting the "whole student" if efforts and resources are only concentrated in one area. Programs and institutions will have the greatest impact in improving how URM students experience their doctoral

program by acting in all the areas of focus, recognizing that these three areas are interconnected.

Keywords: diversity, doctoral training, higher education, race, self-efficacy, sense of belonging, social integration, STEM, support, URM, whole-self framework

Chapter One: Introduction

The populace of the United States is rapidly becoming more racially, culturally, and generationally diverse. The US Census Bureau (2018) projects by the year 2045, Whites will be in the minority of the US population when compared to Hispanics, Blacks, Asians, and multiracial populations. It is estimated by the year 2055 that no single race will represent a majority population in the United States. Millennials, defined as those born between 1981-1996, are the most racially diverse adult generation with 43% being non-White; moreover, they are on track to become the generation with the highest levels of education to date (Frey, 2015; U.S. Census Bureau, 2018). In addition, White Americans make up about 80% of the senior population while racial minorities make up about 44% of Americans under 18 (US Census, 2019, Brownstein, 2010). This large differential in demographics between young and old represents what Brownstein (2010) refers to as "the Gray versus the Browns," causing deep socio-political tensions over social services, education, housing, and resource allocation (p. 14). Noted as a "cultural generation gap," it is a significant political and cultural challenge facing our country today (Frey, 2015).

As racial and ethnic diversity increases in the United States, many industries are confronted with issues of access, equity, and inclusion when serving a more diverse population. Education, like other industries, is not immune to the challenges of changing demographics in their student populations. There is a need for education to respond to the needs of increasingly diverse students. Moreover, in higher education, the representation of diverse students does not keep up with the changes in the general population.

Underrepresented minority students (URMs), defined as African Americans, American Indians/Alaska Natives, and Latinos, are less likely to graduate high school, enroll in, and

complete college when compared to White students (Garces & Jayakumar, 2014; Munoz-Dunbar & Stanton, 1999; Poock, 2007; U.S. Department of Education. Institute of Education Sciences, National Center for Education Statistics; Wilson et al., 2018; Winkleby et al., 2009). At approximately 42%, Black student's college completion rate is 20 percentage points below the 62% college completion rate for White students. (U.S. Department of Education. Institute of Education Sciences, National Center for Education Statistics). Nationally, only about a third of undergraduate students enrolled in post-secondary institutions are racially underrepresented minorities and are further underrepresented at the most selective, elite post-secondary institutions or R1 institutions (Boske & Elue, 2017; Cherwitz, 2005; Wilson et al., 2018). R1 institutions, also known as Research 1 or Doctoral Universities, are defined as Tier 1 or "Very-high research activity" by the Carnegie Classifications of Institutions of Higher Education, a group which is tasked with classifying U.S. colleges and universities. Based on 2021 data, there are currently 131 institutions which are classified as R1. To be designated as R1, these institutions must award a minimum of 20 research/scholarship doctoral degrees and have at least five million dollars in total research expenditures. For institutions below 20 doctoral degrees, they must have awarded at least 30 professional practice degrees in at least two programs (Carnegie Classifications of Institutions of Higher Education, 2018).

For undergraduate STEM fields, URMs are even further underrepresented across all institutions (Hernandez et al., 2013; U.S. Department of Education, Institute of Education Sciences, National Center for Education Statistics; NSF, 2014). As designated by the National Science Foundation (NSF), STEM fields are defined as fields pertaining to Science, Technology, Engineering, and Mathematics. The NSF lists approved STEM fields which encompass many areas of study. This includes, but is not limited to, the disciplines of physical sciences like

chemistry, physics, computer sciences, civil engineering, environmental engineering, electrical engineering, and systems engineering. Fields in the life sciences include biology, physiology, neuroscience, genetics, and genomics. Material sciences composed of mathematical fields like statistics, topography, and analysis. STEM also includes astronomy, psychology, anthropology, policy, sociology and urban and regional planning (NSF, 2014). Based on the depth and breadth of the list created by the NSF, it is clear STEM fields touch many aspects of modern life and industry. Given the reach of STEM fields it is important to understand URMs' persistence in STEM fields. Graduate education refers to academic programs awarding advanced degrees at the masters and doctoral level.

Statement of the Problem

According to the National Center for Education Statistics (NCES, 2021), the number of doctoral degrees conferred in the United States has nearly doubled since 1980, however the diversity of those receiving doctoral degrees have not reflected the increase in diversity in the general population. In the 2019-2020 academic year, only 18.8% of all doctoral degrees conferred were awarded to URMs even though URMs make up 31% of the population. Graduate level enrollment and degree completion by URMs is even lower in STEM fields. Of those completing doctoral degrees in STEM fields only 13% were URMs. (U.S. Department of Education. Institute of Education Sciences, National Center for Education Statistics).

With America's shifting demographics and a lack of representation at the level of doctoral training, our society faces many challenges in competing globally, but also in the creation of new and diverse knowledge. Increasing racial diversity in graduate education in STEM fields is a known issue of social justice and equity (Ampaw & Jaeger, 2011). The United States is unable to produce enough scientists, engineers, and other STEM professionals with

advanced degrees to meet the global needs of a changing world, thus decreasing the competitiveness of American graduates in a global economy (Ampaw & Jaeger, 2011). Creativity and diversity in our national knowledge base, and global competitiveness can be achieved by increasing racial diversity at the doctoral level. Racially diverse doctoral programs also create a pipeline for a diverse professoriate which more resembles the general population's shifting demographics. By increasing racial diversity among professors in higher education, URM students can see themselves reflected in academia, identify more directly as STEM professionals, and find mentors who look and may have similar experiences to themselves (Ampaw & Jaeger, 2011; Chandler, 1993; Hernandez et al., 2013; Monroe & Chiu, 2010; Robnett et al., 2018). This diversification of the professoriate creates an atmosphere where learners of all races are not only welcome but encouraged to learn (Ampaw & Jaeger, 2011; Chandler, 1993).

Purpose of the Study

Many studies have reviewed different approaches to the recruitment and retention of racially diverse students and measured their efficacy and success, yet there is a continued inability to increase racial diversity in STEM fields at the graduate level (Griffin & Muniz, 2011). The purpose of this study was to understand the factors that contribute to the retention of URM students' in doctoral programs, specifically in STEM fields, to degree completion, directly from the students' perspectives. Retention of URM students is critical to expanding both the STEM workforce and diversifying the professoriate. Many studies focus on deficits to explain the lack of URM students in STEM fields and frame the retention rates as a failure on the part of the URM student (Harper, 2010). By investigating URM students' experiences related to perceived levels and types of support during their doctoral programs, this study aimed to

contribute to the body of knowledge regarding URM graduate student persistence. Different levels and types of support have been shown to impact URM students' persistence and completion of degree in higher education. This includes multi-faceted institutional supports, social and emotional support, and personal supports. Lived experiences, as defined in the Sage Encyclopedia of Qualitative Research Methods, encompass the students' "human experiences, choices, and options and how those factors influence one's perception of knowledge" (Given, 2008). To best understand the factors leading to retention and degree completion in URM students, it was important to understand their lived experiences and how those experiences shape their perceptions of support using an anti-deficit approach. There is little known about the lived experiences of racially diverse URM students once they enter their doctoral programs in STEM fields and how their experiences compare to those of their white counterparts and further, if those experiences have any impact on the retention, persistence and successful degree completion of the racially diverse student.

Research Questions

This study will investigate the following research questions:

1) In what ways do URM students experience and perceive support from their programs and institution during doctoral training?

   a. What strategies do URM students' use to access resources and opportunities (for example, academic, financial, and health and well-being related)?

   b. In what ways do URM students connect their own participation in equity, diversity, and inclusion efforts to the institution's commitment (or lack of) to equity, diversity, and inclusion?

c. What kinds of social and emotional support provided or created by their institution and doctoral program mattered most to URM students?

2) How do URM students' lived experiences and perceptions of their institution, program and other sources of support contribute or inhibit their persistence in the doctoral program?

Research Methodology

This study aimed to understand URM students', in STEM fields, experiences related to perceived levels and types of support during their doctoral programs. Three participants were identified for the study. This multi-case study used brief survey data to identify participants as well as participant narratives collected from multiple semi-structured interviews which highlighted the student's experiences. An online survey was used to determine eligibility to participate in the study and allowed for students to self-identify as potential participants. The online survey collected information on which factors were influential in selecting their graduate program, how the student views the climate on campus, and questions that help with understanding the student's science self-efficacy, sense of belonging, and level of social integration. This online survey aided in preparing for each case and the interview questions asked. More detailed discussion of the online survey is included in the following sections. The interviews were semi-structured, by design, to gain a deeper understanding of the experiences and perceptions of URMs. The first interview with each participant helped guide the questions asked in the second interview, including digging deeper into things mentioned by the participants and to get clarification. Recognizing that every individual brings with them a set of experiences that informs why and how they move through their academic careers and acknowledging that students are whole people navigating complex lives while also navigating academic pursuits, I aimed to allow the "whole-self" of the student, and their experiences, to take the lead in the

interviews. The semi-structured nature of the interviews allowed for themes and patterns to emerge while s honoring the student's "whole-self". It also gave me the ability to probe further in my inquiry than a structured interview protocol would have allowed. I also reviewed documents from the institution and programs regarding their vision, mission, and goals, and any specific diversity efforts the institution or programs may be pursuing. I also looked at institutional and program specific supports which are already in place specifically to address the needs of URM students. This review was to help better understand the context of the students' experiences. Using an iterative system of coding, each interview was reviewed multiple times to allow for common themes and experiences to take shape and emerge.

The first portion of this study included an online survey which was administered to respondents who selected to participate. The online survey had six respondents. From the online survey, three URM students in STEM based doctoral programs were recruited. The three participants were at different stages of their doctoral program of study, and attending a large Southern California R-1 institution. The basic demographic data collected in the survey was used to ensure survey respondents met inclusion criteria for the study and allowed me to pre-screen potential participants. The data collected in the survey also helped me identify the participants and prepare for the interviews with each participant and guide the course of the inquiry based on responses from the survey. There were not enough respondents to the survey to analyze the data quantitatively or to provide meaningful descriptive statistics. Each participant represents one case, and each participant was interviewed two times approximately 4-6 weeks apart, totaling roughly 3 hours of interviews for each participant. The interviews allowed for participants to meaningfully comment on types of support available to them and their experiences accessing

these supports. Participants were also asked to review their interview transcripts as another method of data validation to ensure authenticity and avoid misrepresentation of the data.

Limitations of this Study

Due to the small size of the sample and limited scope of institution type and program, this study was not intended to be generalizable. Although some descriptive data was collected, the use of quantitative data, which is often used in social sciences to help with generalizability, was not be possible with this study design and was neither the goal nor the outcome expected from the researcher (Maxwell, 2013; Merriam & Tisdell, 2016). Another limitation of this study is that interviews were conducted via Zoom due to the COVID 19 pandemic which presented some barriers to building trust and rapport between the researcher and the participants. Lastly, this study focused on one geographic region of the United States, which had its own inherent limitations of demography and socio-political culture which further limited the scope of the findings. I hope that the findings presented here will help spark conversations and future studies that will further delve into issues of retention of URM students in doctoral programs in other disciplines and institutions as they relate to systems of support.

Significance of Study

"Culturally proficient leaders focus on learning how to serve the academic and social needs of all demographic groups of students, rather than how to change and assimilate members of target groups." (Lindsey, 2016, p. 45). Recognizing the systemic oppression underrepresented minority students face throughout their education can inform educational leaders on ways to increase racial diversity at the doctoral level (DiAngelo, 2011; Kumashiro, 2000; Leonardo, 2004; MacIntosh, 1989; Singleton & Linton, 2006). By leveraging cultural proficiency and giving power to the voices of URM students, leaders can create solutions and increase diversity

and representation at the doctoral level in STEM fields while also creating equitable and inclusive environments in higher education campuses and in STEM fields. (Ladsen-Billings, 2014; Lindsey, 2016; Zamudio et al., 2011).

There are gaps in the literature about how racially diverse URM doctoral students' attitudes toward higher education and their experiences evolve as they progress through their doctoral training. It is valuable to gain a better understanding of how racially diverse URM students experience PhD programs in STEM fields and what types of support they find valuable. Most importantly, this study aimed to add to the understanding of experiences and choices faced by racially diverse URM doctoral students and understanding the intersectionality of their identities and if those intersections impact their decisions in choosing their programs of study and institutions and their academic success (Zamudio et al., 2011). Educational leaders in STEM can shift institutional and STEM discipline level beliefs and assumptions on which students can and cannot succeed in higher education. This helps improve the outcomes of URM students in STEM based doctoral programs and aids in the URM student's successful degree completion. Increased doctoral degree completion directly impacts the pool of URMs who may choose to pursue careers in academia furthering the goal of diversifying the professoriate and the STEM workforce. Addressing diversity in doctoral training in STEM fields exposes the inequities and adversity diverse students face and shines light on needed changes in current practices, policies and beliefs which contribute to the systematic exclusion of underrepresented students in higher education (DiAngelo, 2011; Garces, 2014; Munoz-Dunbar & Stanton, 1999; Poock, 2007; Wilson et al., 2018; Winkleby et al., 2009; Zamudio et al., 2011).

Conclusion

Exploration into the experiences of URM STEM doctoral students helps inform institutions and doctoral programs of what factors contribute to retention and persistence to degree for these students. This allows programs and institutions to reflect on their own practices and also helps illuminate areas in which supports are not being implemented or are mismatched with the needs of the students and where to focus resources to reach all students. This exploration can also guide programs and institutions on which areas they can improve in supporting their students and in creating inclusive and equitable environments where all students feel supported and can succeed. Although each institution will face unique and different challenges in the face of addressing diversity in graduate education at their site, the information collected from URM doctoral students about their lived experiences may guide further inquiry in areas of improvement and changes that better address the needs of the students at their institutions.

Chapter Two: Literature Review

This literature review examines issues relating to the lack of racial diversity in Science, Technology, Engineering, and Math, also known as STEM fields, at the doctoral level (NSF, 2014). To help increase diversity at the doctoral level in STEM fields, it is important to understand the challenges faced in recruitment and retention of URMs into undergraduate STEM majors and their further persistence onto graduate school, specifically the doctoral level. Common issues of recruitment and retention of diverse doctoral students in STEM fields will be reviewed including merit-based admissions practices used by many R1 institutions, sense of belonging in STEM programs for URM students, and targeted recruitment and inclusivity on campuses. Further, different educational theories surrounding support types and systems will be reviewed, in the context of summer bridge programming, to more fully shape ways in which doctoral programs can help URM students succeed and feel welcomed on campuses and in their doctoral programs through systems of support.

This review also features the early educational challenges faced by racially diverse students in this country, broadly referred to as the "achievement gap." It will also briefly discuss the "opportunity gap" in order to highlight how opportunity gaps in math and science contribute to the shortage of STEM professionals, nationally, and the lack of URM students pursuing and persisting in STEM fields in higher education, rather than focusing the issue as a failure of the URM student (Harper, 2010, Hernandez et al., 2013, Flores, 2007, Whittaker & Montgomery, 2012). These academic achievement and opportunity gaps, specifically those in math and science, are often referred to as the "leaks in the pipeline," a common metaphor explaining why

students in the United States, particularly URMs, are "leaking out" of the STEM pipeline from primary to secondary education and then from secondary to post-secondary education.

The Leak between College and Doctoral Programs

Issues of Recruitment and Retention

Although underrepresented minorities and non-underrepresented minorities enter the undergraduate level at approximately the same rates in STEM fields, there is a large "leak" between the undergraduate and graduate level which is the greatest baffle to URMs remaining in the STEM workforce (Allen-Ramdial & Campbell, 2014). Many studies have reviewed different approaches to the recruitment and retention of racially diverse students and measured their efficacy and success, yet there is a continued inability to increase racial diversity in STEM fields at the graduate level. Professional organizations such as the National Academy of Sciences, the National Academy of Engineering, the Institute of Medicine, and the American Association for the Advancement of Sciences (AAAS) have all called for an increase in the recruitment and retention of racially diverse students in STEM fields and to increase diversity in STEM professionals, highlighting the importance of addressing the lack of URM students and diversity in STEM fields (National Academy of Sciences, National Academy of Engineering, Institute of Medicine, 2010; American Association for the Advancement of Sciences, 2011; President's Council of Advisors on Science and Technology, 2012).

Admissions Processes and Practices

Admissions processes serve as the gatekeeper to doctoral education and typically help maintain the White dominant status quo (DiAngelo, 2011; Kumashiro, 2000; Leonardo, 2004; MacIntosh, 1989). Many doctoral programs use merit-based admissions practices relying heavily on grades and standardized test scores to rank applicants, but what they overlook are

these measures are not culturally sensitive and have been shown to inordinately handicap students from underrepresented groups (DiAngelo, 2011; Garces & Jayakumar, 2014; Munoz-Dunbar & Stanton, 1999; Poock, 2007; Wilson, DePass, and Bean, 2018; Winkleby et al., 2009; Zamudio et al., 2011).

Little is known about doctoral admissions practices, as each institution and/or program may have a different practice or sets of measures used in evaluating candidates, but there are major themes involved in admissions practices helping to address the disproportionate amount of White and Asian students versus URMs in STEM fields at the doctoral level. Merit-based admissions practices, or those based on "achievements", measured by test scores, grades, institutions attended, and access to experiences, are the most heavily relied upon metrics when evaluating applicants to doctoral programs and disproportionately benefit White and Asian students. This practice can screen out URMs due in part to the cumulative effects of opportunity gaps. Using diversity as a measure of success is less common and less understood by most reviewers, which aids in perpetuating the disproportionate representation of Whites and Asians in doctoral programs when compared to URMs.

Racial and socioeconomic differences in testing performance on the GRE are well-studied and add to the body of evidence showing graduate admissions committees' heavy reliance on GRE scores in admission decisions negatively impacting diversity efforts. (Boske & Elue, 2017; Bersola et al., 2014; Moneta-Koehler et al., 2017; Pacheco et al., 2015; Potvin et al., 2017). No correlation has been found between future student productivity and test scores, previous grades, previous research experience, or faculty interviews with applicants (Hall et al., 2017).

Recently, there has been a shift in the perceived value of standardized tests, such as the GRE, as a measure of success in graduate education. Some programs and institutions are beginning to move away from using standardized testing as a required measure in reviewing applicants. Many STEM-based programs now indicate that GRE scores are optional for applicants, however this has not been widely adopted nationally. Students applying to multiple institutions may still be responsible for submitting competitive scores for certain programs creating yet another barrier to applying to graduate education. There is also no indication that optional score reporting versus no score reporting for applicants change how applications are reviewed by admissions committees.

Faculty's attitudes, understanding and perceptions of graduate education, application materials, and perceived admissions best-practices were shown to influence admissions committees when deciding which applicants to admit (Bersola et al., 2014; Boske & Elue, 2017; Munoz-Dunbar & Stanton, 1999; Posselt, 2014, 2018; Quarterman, 2008). Although many institutions claim to value diversity and inclusion, the opaqueness, subjectivity and loose-coupling of graduate admissions practices across programs and institutions can get in the way of achieving those goals (Boske & Elue, 2017).

Targeted Recruitment of Diverse Candidates and Campus Climate

One study looking at trends in PhD productivity and diversity in chemistry departments at 50 U.S. institutions, found the departments with the most success in increasing diversity were those who increased recruitment efforts for diverse candidates and had specific plans in place to support diverse students (Laursen & Weston, 2014). Targeted diversity recruitment is done in multiple ways. Traditional recruitment methods used by many institutions include forming relationships with potential applicants through graduate fairs, summer research programs, and

campus visitation programs (Griffin & Muniz, 2011). They also found building relationships with faculty from campuses with a high minority population can help increase recruitment of racially diverse doctoral students (Hernandez et al., 2013; Whittaker & Montgomery, 2012). These targeted diversity recruitment methods also influence how students choose their program.

When applying to programs and during the recruitment process, URM students consider many factors when selecting their program of study. URM students considered factors such as faculty and student diversity, community diversity, quality of facilities to be more important in their decision making when compared to non-URMs (Bersola et al., 2014; Maton, et al., 2016; Whittaker & Montgomery, 2012). Faculty quality was also an important factor in the selection of the doctoral program for URM students. (Bersola et al., 2014). Other factors considered important for URM students when selecting a doctoral program were institutional factors such as research quality, faculty access, program reputation, and campus climate for racially diverse students. These factors should be considered in approaching how graduate education is managed and conducted (Lipschutz, 1993).

Four key institutional action areas to build agency of the scientific community to create greater diversity at the doctoral level and in the STEM workforce are 1) aligning institutional culture and climate; 2) building inter-institutional partnerships; 3) building and sustaining critical mass; and 4) ensuring, rewarding, and maximizing faculty involvement (Allen-Ramdial & Campbell, 2014; Maton, et al., 2016). These four action areas touch on many key components of campus climate, culture, and faculty involvement in increasing the recruitment and retention of racially diverse doctoral students in STEM fields. Institutions acting in these four areas to increase support and critical mass of URMs, creating a climate which is inclusive, and creating

collaborations between institutions, the STEM workforce can also begin to address leaks in the pipeline for underrepresented minorities (Allen-Ramdial & Campbell, 2014; Whittaker & Montgomery, 2012).

Research shows the importance of institutional changes and goals towards inclusive, culturally and racially diverse campuses, in increasing racial diversity in doctoral training. It also shows the value of institutional level factors like faculty representation, faculty accessibility to students, and faculty involvement in the recruitment and retention of racially diverse doctoral students in STEM fields (Hernandez et al., 2013; Whittaker & Montgomery, 2012). Faculty representation and STEM identity development is especially important to URM students, as research has shown that identity development and recognition are significant contributors to success in STEM fields (Carlone & Johnson, 2007; Rodriguez et al., 2019).

One area in which many university campuses attempt to show their institutional dedication and plans towards inclusivity are in their "Diversity Action Plans." In a qualitative review by Iverson (2007) of 20 U.S. land-grant universities, the findings show that although these action plans are meant to demonstrate commitment to diversity and inclusion, they can serve to reproduce racial inequity through educational and institutional policies as they "describe people of color as outsiders to the university, disadvantaged and at risk before and after entering higher education, and in this discursive framing, propose strategies aimed at individuals to compensate for deficiencies" (Iverson, 2007, p. 588). Challenging the dominant white narrative of diversity action plans and giving voice to the silent and excluded members of campuses can create more actionable and sustainable efforts toward diverse and inclusive campuses. (Bernal et al., 2002; Solorazano et al., 2000). However, the issue with recruitment goes back further than

the transition from undergraduate to graduate admission. The transition from secondary to post-secondary may also contribute to the gaps.

Bridging the Gap between Secondary and Post-Secondary Education

Academic transition programs are well studied and are typically designed to help students transition from high school to college (Ashley et al., 2017). These types of programs are referred to by many names, however for this review they will be referred to as summer bridge programs as they help "bridge" the gaps created by the leaky pipeline described earlier, and help support recruitment and retention of racially diverse students in higher education in STEM fields. They also aim to prepare students for many of the challenges and barriers to entering higher education. Only summer bridge programs which are designed for URM students and focus on STEM fields were reviewed.

There are many summer bridge programs that aid in the transition between high school and undergraduate education, however, there are fewer programs which focus on the transition from undergraduate to graduate education. This review briefly examines three major areas of support that are the focus of summer bridge programs which have been shown to help mediate issues of recruitment and retention in higher education and can aid in the persistence of URM students through undergraduate education onto graduate education. I hope to use the foundational ideas of summer bridge programs and their impact on students transitioning from high school to undergraduate education to investigate if these ideas have any application to the transition of undergraduate education to graduate education. Further, if these same ideas help improve URM graduate students' retention, persistence, and experiences with support through their doctoral training.

The majority of summer bridge programs focus on a combination of the programming goals which can be categorized as academic success supports, psychosocial support, and institutional goals. These programmatic goals are grounded in educational and psychological theories which have been shown to aid in recruitment, retention, and persistence of students in higher education (Bandura & Schunk, 1981; Bandura, 1986; Maton, et al., 2016; Tomasko et al., 2016). These theories center on self-efficacy and STEM identity development, sense of belonging, and social integration. The programming support components and educational theories will be used to conceptualize this research, and will be defined in more detail later in this review.

As mentioned earlier, these programs are grounded in educational theories like Tinto's Theory of Social Integration, Bandura's Theory of Self-Efficacy, and Strayhorn's theories on sense of belonging which give credence to the programming goals provided to participants (Ashley et al., 2017; Maton, et al., 2016). Other theories including Carlone and Johnson's (2007) theory of STEM identity development and focus on strength-based practices from psychosociocultural (PSC) approaches are also closely integrated in the use of the three guiding theories (Gloria & Castellanos, 2007). Using components and overlaps of each of these three guiding theories, which will be discussed in more detail later, I conceptualize the framework for their study to guide the inquiry into the factors that contribute to or inhibit the retention and persistence of URM students in doctoral programs, as it pertains to their perceptions of and interactions with different types of academic, psychosocial and institutional supports.

Albert Bandura's Theory of Self-Efficacy states that one's belief of one's ability to accomplish a task or goal can positively impact their ability to reach that goal. (Bandura &

Schunk, 1981; Bandura, 1986; Hernandez et al., 2013; Maton, et al., 2016; Strayhorn, 2008, 2018; Tomasko et al., 2016; Trujillo & Tanner, 2014). STEM identity development also plays a critical role in a students' sense of self-efficacy (Carlone & Johnson, 2007; Rodriguez et al., 2019). Strayhorn's theories on sense of belonging focus on how college students perceive connectedness and belonging to their institutions and programs. These include factors like feeling respected, feeling valued, and feeling like they matter to the community they are joining (Strayhorn, 2008, 2018). Studies have shown that a strong sense of belonging is associated with better persistence, retention, and degree completion rates for all students, but even more so for URM students (Bandura & Schunk, 1981; Bandura, 1986; Maton, et al., 2016; Strayhorn, 2008, 2018; Tinto, 1975, 1987; Tomasko et al., 2016). Sense of belonging helps to further develop ideas of integration. Tinto's Theory of Social Integration touches on the impact on persistence of students in a discipline or institutions based on their social integration to that institution or discipline (Tinto, 1975, 1987).

Lessons from Summer Bridge Programs

Many summer bridge programs focus on improving the academic success of students who participate in the program. This helps aid in both the recruitment of well-prepared students to STEM fields and the retention of those same students in STEM fields (Ashley et al., 2017; Gandara & Maxwell-Jolly, 1999; Hernandez et al., 2013; Maton, et al., 2016; Wilson et al., 2014). One academic area of focus for bridge programs is helping students achieve the foundational knowledge of their respective STEM field (Ashley et al., 2017; Gandara & Maxwell-Jolly, 1999; Wilson et al., 2014). In most programs this serves as remediation for math and science courses or strengthening basic knowledge and skills needed in the domain areas, as in order to close the math and science achievement gaps. As not all students entering college or

graduate school have had the same exposure to the rigor and level of coursework they will be facing in the future, these programs focus on leveling the playing field and making sure students are given academic support and content specific support to help them be successful in their pursuit of STEM in higher education (NAEP, 2015; Wilson et al., 2014).

Another major component of academic success programming in summer bridge programs is access to research opportunities (Ashley et al., 2017; Hernandez et al., 2013; Maton, et al., 2016). Many students who participate in summer bridge programs have not had an opportunity to participate in any research nor have been in a lab or research setting prior to attending college or during their undergraduate careers (Hernandez et al., 2013; Maton, et al., 2016). The opportunity for students to engage in an authentic research setting, communicate with other scientists regarding scientific problems, use technical scientific language also acts on the psychosocial factor, self-efficacy. (Bandura & Schunk, 1981; Bandura, 1986; Hernandez et al., 2013; Maton, et al., 2016; Stryker & Burke, 2000; Tomasko et al., 2016; Wilson et al., 2014). These research opportunities allow students to accomplish tasks and run experiments in lab settings which can lead to improved belief that they are capable of doing science in a real scientific setting thus increasing their sense of self-efficacy. These experiences also contribute to the development of the students STEM identity. A strong sense of STEM identity increases students' feelings of belonging in a STEM environment as well as empowering them to recognize themselves as a member of the STEM community which has been shown to improve their ability to persist within STEM fields (Carlone & Johnson, 2007).

Psychosocial support is integral to the recruitment, persistence and retention of STEM students in higher education. (Ashley et al., 2017; Hernandez et al., 2013; Trujillo & Tanner, 2014; Tomasko et al., 2016; Wilson et al., 2014). Psychosocial supports help build students'

self-efficacy, membership in the STEM community, networking with other members of the science community and identifying mentors and how to build mentor-mentee relationships. This layered onto academic supports like access to authentic research opportunities and foundational knowledge also help increase self-efficacy. Science self-efficacy and STEM identity development have been shown to relate to persistence, tenacity and achievement in educational settings (Bandura & Schunk, 1981; Bandura, 1986; Carlone & Johnson, 2007; Chemers et al., 2011; Hernandez et al., 2013; Maton, et al., 2016; Rodriguez et al., 2019).

Mentoring and community building are typically built into summer bridge programs (Ashley et al., 2017; Baker & Lattuca, 2010; Maton, et al., 2016; Robnett et al., 2018; Wilson et al., 2014). Summer bridge programs tend to attract faculty who are engaged and invested in URM students and their future academic STEM success (Maton, et al., 2016). Opportunities for URM students to interact with and develop quality mentor relationships with STEM faculty and professionals can not only improve students sense of STEM identity and satisfaction with their academic performance, but also help build social capital and a strong STEM network (Baker & Lattuca, 2010; Carlone & Johnson, 2007; Robnett et al., 2018; Stryker & Burke, 2000). Mentorship relationships also allow students the opportunity to discuss important factors like educational planning and career development with their mentors (Baker & Lattuca, 2010; Chemers et al., 2011; Maton, et al., 2016; Robnett et al., 2018). These psychosocial support components help URM students build their STEM identity and increase feelings of belonging in graduate level STEM programs and is grounded in Tinto's theory of social integration, discussed briefly earlier.

One last component of summer bridge programs is meeting institutional goals. Many summer bridge programs work to increase interest in STEM fields and to entice students to

identify with, select STEM majors, persist in STEM fields and pursue STEM doctoral programs (Ashley et al., 2017, Bandura & Schunk, 1981; Bandura, 1986; Carlone & Johnson, 2007; Chemers et al., 2011; Maton, et al., 2016; Tomasko et al., 2016). Increasing interest in STEM, coupled with the students' sense of preparedness, has been shown to positively impact the recruitment and retention of URM students into STEM fields in many summer bridge programs (Tomasko et al., 2016). Summer bridge programs also explicitly state a goal of recruiting students to their institutions. By doing this the host institution uses summer bridge programs as a means to increase the diversity of their own programs (Ashley et al., 2017; Tomasko et al., 2016). Campus climate, faculty involvement, and diverse representation are also components of institutional goals supported by summer bridge programs and are related to targeted recruitment efforts explained earlier. These secondary to post-secondary education summer bridge programs may offer insights to supporting students who enter graduate programs, but currently these programs are not as common.

Promising Work in Graduate Education- A Guide

One example where the same ideas of support linked to educational theories used in academic transition programs, were implemented for the transition from undergraduate to graduate school is the Smooth Transitions for Advancement to Graduate Education (STAGE) program. The STAGE program was designed as an eight-week research intensive summer program which helped students get a "graduate school experience" and ease their transition from undergraduate to graduate education. Students participated in the program at the University of Louisiana, Lafayette and were under the mentorship of four faculty members. The program focused on partnerships with five Historically Black Colleges & Universities (HBCUs) in the region to recruit participants. The STAGE program's focal point was not only academic support

components like other programs, but also mentoring and supporting underrepresented students and creating networks of colleagues and mentors. Over the three years this program was piloted, 44% of all STAGE scholars attended graduate school, 56% of those attended graduate school in a STEM discipline, 47% have careers in STEM (Eubanks-Turner et al., 2018). Combining academic success supports, psychosocial supports, and institutional goals better prepares URM students who participated in summer bridge programs to achieve higher education pursuits in STEM fields and helps combat some of the disparities experienced by URM students in K-12 education which create barriers to entry into higher education and will be discussed next. This program was just one example of how using the core ideas of academic support, psychosocial support, and institutional goals in the transition from undergraduate education to graduate education can have high levels of success with their participants in STEM persistence. Using the lessons learned from this study and evidence of success in summer bridge programming, the researcher aims to identify if self-efficacy, sense of belonging, and social integration contributes to the persistence of URM students during their doctoral programs. I will also try to understand how students perceive and utilize different types of support and if these core ideas from summer bridge programming are missing from the graduate educational experiences of URM students.

Achievement and Opportunity Gap in K-12 Education

Early educational disparities are a main cause of the "leaky STEM pipeline" and these disparities can follow students through the course of their education, as discussed above. Understanding these disparities also helps understand the goals of targeted support programs like the summer bridge programs discussed earlier and how we can better address these disparities in the form of supports offered to URM students. Disparities in educational outcomes like standardized test scores, grades, graduation rates, and college enrollment, reflect the

challenges faced by school leadership and teachers, in responding to the needs of a changing population that is becoming more racially and ethnically diverse in the United States. (Gandara & Maxwell-Jolly, 1999; Hernandez et al., 2013; Quinn & Cooc, 2015; Whittaker & Montgomery, 2012). These disparities are referred to as achievement gaps and touch on issues of social justice, access, equity and inclusion as education struggles to address the needs of the increasing population of racially diverse learners. These disparities are often approached from deficit-based inquiries rather than achievement focused thinking (Harper, 2010).

Although there are many factors contributing to the achievement gap, which will not be discussed here, it is valuable to understand racial disparities in academic achievement and outcomes in the United States. Achievement gaps have been well documented in primary and secondary education and research has shown the effects of these disparities or achievement gaps can have a cumulative effect as minority students progress through primary and secondary education into post-secondary education. This results in lower levels of minority students accessing undergraduate training, and further, graduate level training at the doctoral level (Eubanks-Turner et al., 2018; Garces & Jayakumar, 2014; Munoz-Dunbar & Stanton, 1999; NAEP, 2015; Poock, 2007; Posselt, 2014; Wilson et al., 2018; Winkleby et al., 2009).

Before further diving into the achievement gap and its impact on URM students pursuing higher education, it is also important to touch briefly on the opportunity gap. According to the Glossary of Education Reform (2013), an opportunity gap is defined as "the unequal or inequitable distribution of educational results and benefits between different groups of students." These opportunity gaps are the result of many unequal and inequitable distributions of resources to students. This lack of resources tends to disproportionately impact URM students' achievements and when coupled with the achievement gap help paint a more complete picture of

what URM students face while navigating primary education. As Flores (2007) reports in their examination of math education, findings show that African American and Latino students have less access, when compared to White students, to things like computers, teachers who are experienced, teachers who hold high expectations for achievement for all students, and equitable per student funding at their schools. These systemic biases, deficit-oriented teaching, and structural inequities, such as school funding based on income and neighborhood, create environments in which students are not achieving at equal rates due to unequal resources and access (Strutchens & Silver, 2000). These opportunity gaps will be more clearly seen when looking at the disparate "achievement" between URM students and White students.

Math and Science Achievement and Opportunity Gaps

The United States has been unable to keep up with the global need for the STEM workforce (Ashley et al., 2017; Tomasko et al., 2016; Estrada et al., 2016). The Programme for International Student Assessment (PISA) measures academic skills of 15-year-olds, in areas such as math and science literacy and reading ability, across many developing and developed countries. According to 2015 PISA data, the United States ranked 38th out of 71 countries in math and 24th in science, further showing the inability of the United States to compete globally in STEM fields (PISA, 2015).

To more deeply understand the leaky pipeline to STEM fields and the results of the achievement gaps in education in the United States, it is important to look at primary and secondary math and science student performance. The National Assessment of Educational Progress (NAEP, 2015) reports on educational outcomes for fourth, eighth and twelfth graders via assessment tests which measure students' levels of proficiency in different academic areas. The NAEP rates students' literacy in different subject areas in three categories: basic,

proficient, and advanced. The most recent reports released by the NAEP in 2015 and 2019, shows 41% of fourth-graders were assessed as "proficient" or "advanced" in math, dropping to 34% in eighth-graders and dropping even further to 25% of twelfth-graders. In science, 38% of fourth-graders, 34% of eighth-graders and 22% of twelfth-graders were rated proficient or better, with an alarming 40% of twelfth-graders rated as "below basic" (NAEP, 2015, 2019).

When reviewing this same data while examining race, it becomes even clearer URM students are not achieving math and science literacy at the same levels as their White and Asian classmates. The persistence of poorer math and science outcomes in primary and secondary education for URM students, when compared to White and Asian students, are additionally indicative of the leaks in the STEM pipeline (Hernandez et al., 2013; Quinn & Cooc, 2015). Looking at the math assessment data for twelfth grade URM students, it shows URM students scoring on average 20-30 points lower than their White and Asian counterparts. In science, URM students are scoring 25-35 points lower when compared to non-URM students (NAEP, 2015; National Science Board, 2018). This data clearly shows national trends of students' math and science engagement and literacy dropping as they progress through primary and secondary education, even more so for URM students, which directly impacts STEM persistence into higher education (Gandara &Maxwell-Jolly, 1999; Hernandez et al., 2013; Quinn & Cooc, 2015).

Examining the highest levels of math and science courses taken in high school are also a strong predictor of students' access to STEM fields in higher education (Tyson et al., 2007; Wang, 2013). This is where the opportunity gaps are most indicative of URM success or lack of in STEM fields. Not all secondary schools provide students with the same access to math and science course offerings or advanced placement courses which are often viewed as

"gatekeeping" courses to undergraduate STEM majors (Tyson et al., 2007; Wang, 2013). Many STEM majors require students to have taken courses like calculus, physics, and chemistry in order to be prepared for their introductory math and science courses at the undergraduate level. Wilkins et al. report that only 22% of Latino and 25% of African American high school graduates were enrolled in the college track courses at their high schools (Wilkins et al., 2006). "Often, inequalities in achievement are perceived as the result of a hierarchy of competence" (Flores, 2007, p. 40). This creates greater disparity for students who did not have access to that coursework in secondary school as they are underprepared for the rigor and knowledge base necessary to succeed in post-secondary institutions (Tyson et al., 2007; Wang, 2013). The opportunity gap takes into consideration that students who receive less opportunities and resources to learn, are viewed as less capable than students who are given more opportunities to learn and are viewed as having higher aptitude and ability (Flores, 2007).

Understanding racial disparities in math and science achievement/opportunities in the United States and its effect on the pipeline STEM and higher education is crucial to understanding barriers to entry for URM students and recruitment and retention of URMs into STEM fields in higher education, specifically the doctoral level (Whittaker & Montgomery, 2012). "The image of a pipeline is a commonly advanced explanation for persistent discrimination" of minority groups in the professoriate (Monroe & Chiu, 2010, p. 303).

Guiding Theories on Student Experiences

Addressing diversity in doctoral training in STEM fields exposes the inequities and adversity diverse students face and illuminates needed changes in current practices, policies and beliefs which contribute to the systematic exclusion of underrepresented students in higher education (DiAngelo, 2011; Garces, 2014; Munoz-Dunbar & Stanton, 1999; Poock, 2007;

Wilson et al., 2018; Winkleby et al., 2009; Zamudio et al., 2011). Recognizing the systemic and systematic oppression that underrepresented minority students have faced throughout their education and that those experiences can help shape their perceived levels and types of support can help inform anti- racist educational leaders on ways in which to increase racial diversity in higher education at the doctoral level (DiAngelo, 2011; Kumashiro, 2000; Leonardo, 2004; MacIntosh, 1989; Singleton & Linton, 2006).

Educational theories concentrated on recruitment, retention, and persistence of URM students like Tinto's Theory of Social Integration, Bandura's Theory of Self-Efficacy, and Strayhorn's theories on sense of belonging, give insight into what doctoral programs and institutions can offer in the forms of support to their students.

Support Theories

Self-Efficacy. Building students' sense of self-efficacy is a critical psychosocial component to be considered by doctoral programs. Albert Bandura's Theory of Self-Efficacy states one's belief they can accomplish a task or goal can positively impact their ability to reach said goal. In education, self-efficacy plays a large role in students' perceptions of their own abilities and has been shown to have a mediating effect on perseverance, academic achievement, and self-regulated learning (Bandura & Schunk, 1981; Bandura, 1986; Hernandez et al., 2013; Maton, et al., 2016; Strayhorn, 2008, 2018; Tomasko et al., 2016; Trujillo & Tanner, 2014). Science self-efficacy has been shown to relate to persistence, tenacity and achievement in educational settings (Bandura & Schunk, 1981; Bandura, 1986; Chemers et al., 2011; Hernandez et al., 2013; Maton, et al., 2016). STEM identity development also contributes to students' sense of self-efficacy and their persistence to degree. STEM identity development helps students understand and interact with the STEM community and culture. Recognition of STEM identity

especially aids in the integration of URM students' in the STEM community and contributes to their success in STEM fields (Carlone & Johnson, 2007).

Underrepresented minority students more often attend smaller undergraduate institutions with less access to research opportunities which can negatively impact their sense of self-efficacy (Allen & Zepeda, 2007; Maton, et al., 2016). Many underrepresented minority students have not had an opportunity to participate in any research nor have been in a lab or research setting prior to attending college or during their undergraduate careers (Hernandez et al., 2013; Maton, et al., 2016). The opportunity for students to engage in an authentic research setting, communicate with other scientists regarding scientific problems, use technical scientific language also acts on the psychosocial factor, self-efficacy (Bandura & Schunk, 1981; Bandura, 1986; Hernandez et al., 2013; Maton, et al., 2016; Stryker & Burke, 2000; Tomasko et al., 2016; Wilson et al., 2014).

Feelings of Belonging. The importance of a student's feelings of belonging in higher education cannot be overlooked when attempting to understand the ways in which institutions can increase diversity at the doctoral level in STEM fields (Strayhorn, 2008, 2018). Strayhorn's theories on the sense of belonging states college students' perceptions of support, feeling connected, experiencing mattering, respect, and value is related to their persistence, retention, and completion of degrees. This has been shown in many studies to be even more important to URM students in STEM (Bandura & Schunk, 1981; Bandura, 1986; Maton, et al., 2016; Strayhorn, 2008, 2018; Tinto, 1975, 1987; Tomasko et al., 2016). Students from underrepresented minority groups often do not feel they belong in predominantly White institutions which can create barriers to the retention and successful completion of degree (Quarterman, 2008; Strayhorn, 2008, 2018). Findings show a student's sense of belonging was a

strong predictor of retention, and focusing outreach and activities including specifically social factors can positively impact a student's persistence in higher education settings (Davis et al., 2019; Strayhorn, 2008, 2018). This, and other similar findings are not surprising when considering the factors influencing diverse students' doctoral program selection and decision making.

Conversely, there is also research showing racially diverse students do not feel welcome or develop a sense of belonging, particularly in predominantly White universities (Ancis et al., 2000; Quarterman, 2008). A study of 538 students at predominantly White universities uncovered African American students had more negative experiences, felt greater racial hostility, less equitable treatment, and greater pressure to conform to stereotypes when compared to White and Asian students (Ancis et al., 2000). This study, and others like it, show not all students experience campuses and their education in the same ways. In her book, *Multiplication is for White People,* Delpit discusses the experiences of African American students as they "negotiate blackness on campus". Research demonstrated Black students are more likely to have feelings of invisibility in the classroom, and feelings of hypervisibility outside the classroom (Cabrera & Nora, 1994; Delpit, 2012; Sue et al., 2008). These feelings can impact students' academic achievement and persistence which ultimately affects the retention of racially diverse students at the doctoral level and in higher education (Strayhorn, 2008, 2018; Tomasko et al., 2016; Trujillo & Tanner, 2014). Just as campus climate is an important factor to URM students, a feeling of belonging and self are important to their academic performance, retention, and overall successful completion of degree. Institutions and programs focused on supporting students and creating a sense of belonging will likely have better ability to recruit, retain, and train more racially diverse students at the doctoral level (Strayhorn, 2008, 2018).

Mentorship and Social Integration. Tinto posits that when students feel both academically and socially integrated, this integration can contribute to the retention and persistence of students in STEM fields (Tinto, 1975, 1987). Building a sense of scientific community helps students socially integrate (Gandara & Maxwell-Jolly, 1999; Hernandez et al., 2013; Maton, et al., 2016; Tinto, 1975, 1987; Wilson et al., 2014). As shown by Carlone and Johnson (2007), integration in the STEM community also aids in the development of URM students' STEM identity. Mentoring and community building are an important component of psychosocial supports for URM students pursuing STEM fields. (Ashley et al., 2017; Baker & Lattuca, 2010; Maton, et al., 2016; Robnett et al., 2018; Wilson et al., 2014). Both the personal and professional development of graduate students have been shown to be greatly impacted by mentor relationships. Effective faculty-student mentor relationships can improve academic and career development (Johnson & Hume, 2002). Providing the opportunity for URM students to have multiple and high-quality mentor relationships with STEM faculty and professionals has been shown to improve students sense of STEM identity and satisfaction with their academic performance as well as building their social capital and STEM network (Baker & Lattuca, 2010; Robnett et al., 2018; Stryker & Burke, 2000). Strong mentors also provide useful advice to participants regarding educational planning and career development which can have an impact on their educational trajectories (Baker & Lattuca, 2010; Chemers et al., 2011; Maton, et al., 2016; Robnett et al., 2018).

Networking is another psychosocial component that is related to the mentor-mentee relationships (Ashley et al., 2017; Baker & Lattuca, 2010; Wilson et al., 2014). As discussed earlier in the review of summer bridge programs, networking between incoming students with current students and faculty can increase students' social capital, sense of belonging, and

strengthen their identity as members of the STEM community (Gandara & Maxwell-Jolly, 1999; Hernandez et al., 2013). Building a sense of scientific community helps socially integrate students and as Tinto suggests, this aids in students' persistence and retention in STEM fields (Gandara & Maxwell-Jolly, 1999; Hernandez et al., 2013; Maton, et al., 2016; Tinto, 1975, 1987; Wilson et al., 2014).

Conceptual Framework: A "Whole-Self" Framework Approach

While these theories individually help us to understand different types of support that contribute towards recruitment, retention, and persistence to degree of URM students in STEM fields, they do not adequately address the unique experiences of URM students in STEM doctoral education. Therefore, I have pulled together the most relevant parts of these support theories in a unifying attempt to represent what I refer to as the "whole-self" framework to examine student perceptions of their doctoral training.

Understanding that URM students may have differing experiences throughout their education, when compared to white students, and acknowledging the impacts of racism and race in education including factors like lack of access, microaggressions, and unequal or inequitable opportunities, this "whole-self" framework allows me to give space for these factors in their analysis of how those experiences might impact student's interactions with different types of support. Through this "whole-self" lens, I hope to identify if a student's level of self-efficacy, sense of belonging, and social integration have any mediating effects on if and how student's access different systems of support through their programs, institutions, or personal and academic relationships. Further, through this framework, I will be able to learn more about how the psychosocial factors influence how students access and perceive the different types of support and what their experiences are. This will aid in elucidating if there are connections

between the educational theories above and if they have an impact on ways in which URM students relate to systems of support academically, financially, socially, and emotionally. I hope this lens will allow URM students to bring their "whole-selves" into the data collected through in-depth interviews. Through honoring that space, it will allow for further understanding of the URM student's perceptions of themselves, their personal, programmatic, and institutional relationships and the impact of those perceptions.

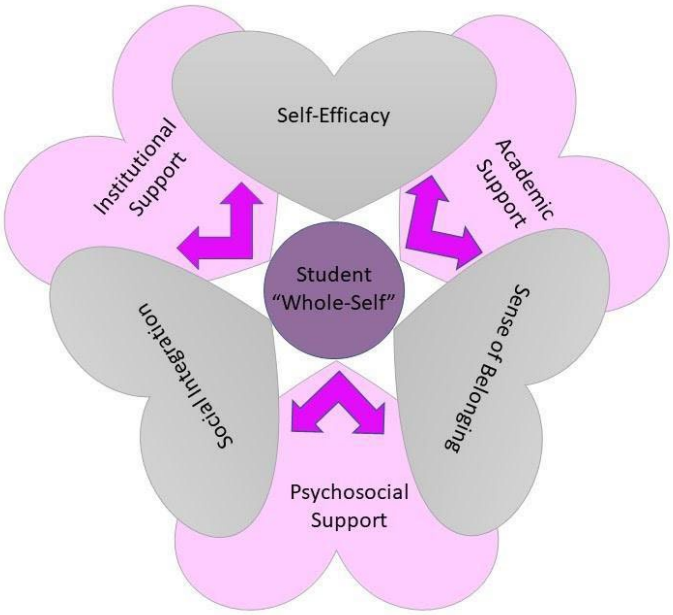

Figure 2.1: Conceptual Framework- "Whole-self" Framework Approach

Recognizing the identities and cultures of URM students and creating systems in which these students can thrive and feel welcomed is crucial in addressing and minimizing the historical effects of institutionalized racism in education. Working from the lived experiences of the student and their "whole-self" in the center, it can be shown how the overlays of these different theories and practices intermingle with each other and can help explain the factors and experiences that influence the persistence and degree completion of URM students while in their

STEM doctoral programs. Giving power, strength, and opportunities to diverse voices and stories can be the shift needed to increase underrepresented student's mass in doctoral education in STEM fields by understanding how URM students experience their doctoral programs and support and will be the lens through which this study will be conducted.

Chapter Three: Methods

To best understand the factors leading to retention and degree completion in URM students, it was important to understand their lived experiences and how those experiences shape their perceptions of support. This study aimed to understand the URM students' lived experiences and perceptions of support during their doctoral programs to shed light onto factors that contribute to the retention of URM students' in doctoral programs, specifically in STEM fields. By investigating URM students' experiences related to perceived levels and types of support available during their doctoral programs, this study will add to the body of knowledge regarding URM graduate student retention. This study employed a multi-case study design to collect narrative data on participants. This multi-case study utilized two semi-structured interviews per case. Further, participants were asked to review interview transcriptions for accuracy and as a validation tool. This helped highlight the narrative of the student's experiences. Initial data was collected in the form of an online survey that allowed potential participants to self-identify as participants in the case study. The online survey collected data which verified if the participants met the inclusion criteria of the study. It collected socio-demographic information as well as information about the student's current institution and program of study. The interviews were semi-structured, and aimed at addressing the research questions outlined previously regarding student retention and systems of support. The semi-structured nature of the interviews allowed for themes and patterns to emerge and most honored the "whole-self" of the student and their experiences. Both the first and second interviews conducted with each case, gave me the ability to probe further than a structured interview protocol would allow. The data collected in the first semi-structured interview helped me triangulate possible mediating factors that related to the research questions, as well as guide the

questions asked in the second interview. Together, with both interview transcripts and the participants' review of the interview transcriptions, I was able validate data uncovered during the interviews. The participants review of the transcriptions also served to "member check" the data collected during each interview.

I transcribed each interview myself to allow for preliminary data analysis and early themes to emerge for each case and between cases. I also reviewed each participant's first interview to create the semi-structured protocol for their second interview. This allowed me to probe further into certain topics as well as investigate themes that surfaced in other cases that might not have emerged in the first interview. After each interview was transcribed and verified by the participant, I began to hand code the data in the transcripts. Using an iterative system of coding, each interview transcript was reviewed multiple times to allow for common themes and experiences to take shape and develop. Each case was reviewed individually as well as in the context of the data uncovered in the other cases. I also reviewed documents from the institution and programs regarding their vision, mission, and goals, and any specific diversity efforts the institution and/or programs may be pursuing, as well as institutional and program specific supports which are already in place specifically to address the needs of URM students, and more generally available for all students.

This study focused on recruiting three URM students in STEM based doctoral programs at a large and competitive R1 institution in Southern California to represent three individual cases in this multi-case study. For the purpose of this study, only students enrolled in STEM doctoral programs were recruited. Email calls for participation in the research study were sent to staff and directors at campus community centers for racial and cultural groups which focus on equity, diversity, and inclusion for both their approval and dissemination to their student

populations. From the survey data, students were able to self-identify to be contacted for multiple in-depth interviews and reviews of interview transcriptions designed to member-check data collected in the interviews. Representation was sought for doctoral students at all stages of doctoral study. This allowed me to understand the differences between cases at different time points in their programs of study and how that might impact the participants opportunity to interact with or utilize certain types of support. Using students who were at different points in their programs of study was also helpful to my understanding of perceptions of support and if they differ as students move through their programs of study. This may also helped identify points in the doctoral careers of URM students where certain factors may be more critical to their retention as it relates to types of support.

Research Design

Combining data from multiple interviews and document collection, this study used a multi-case study approach to help identify factors related to URM doctoral student retention in STEM based doctoral programs. The survey component, collected first, contained more broad descriptive data on the targeted population and most importantly, helped identify individuals to interview, presenting narratives of real voices and experiences (Merriam & Tisdell, 2016). The online survey also collected data on the factors that influenced the student's graduate program selection, how the student experienced the racial climate on their campus and in their program, as well as helping to measure the students perceived self-efficacy, sense of belonging and level of social integration. The data collected in the survey was used as a jumping off point to inform the first interview protocol. The data collected in the first interview was used to guide the questions asked in the second interviews. This allowed inquiry into areas which were new and unexplored in the extant data.

Participants

Participants were recruited from STEM based doctoral programs at a Southern California institution. This includes but is not limited to programs in bioengineering, bioinformatics, biological sciences, biomedical sciences, chemical engineering, chemistry, cognitive science, computer sciences, data science, global health, material sciences, mathematics, math and science education, neurosciences, physics, quantitative biology, and structural engineering.

Due to the COVID19 pandemic, universities had moved to mostly remote instruction at the time of data collection. URM doctoral students in STEM fields who identify as African Americans, American Indians/Alaska Natives, and Latinos were asked to participate in this study via a recruitment call. Participants were identified via electronic communications. Email calls for participation and a recruitment flier were sent to staff and directors of campus community centers for dissemination to their students and to partner student organizations on campus. As discussed in the literature review, there are lower rates of enrolled URM doctoral students across the country, so a more targeted approach to recruitment was used to identify participants. Due to this limited population, using campus community centers to disseminate the call for participation leveraged resources and relationships that already existed between URM students and these centers. These centers are designed to enhance diversity and inclusion on campus by creating spaces that offer support to students from underrepresented identity groups. There are multiple racial and cultural centers on this campus that allowed for more targeted recruitment of participants who identify as part of an underrepresented identity, cultural, or racial group. The call for participants asked potential participants to complete a survey regarding their experiences surrounding graduate school, accessing different types of support along with some demographic and background information. There was potential that students who are advised by

or have peripherally interacted with me in their professional setting chose to participate in the survey. I was aware of my positionality and incorporated methods into the data collection process to reduce personal biases and reactive effects that can occur when someone is both an insider and outsider to the community they are working with (Emerson, et al., 2011, p. 4). I also informed each participant of my professional role on campus, so they were aware of my positionality. At the end of the survey, respondents indicated if they would like to be contacted for more in-depth interviews. The online survey data was completed anonymously with the opportunity for respondents to identify themselves for in-depth interviews at the end of the survey. Interviews were conducted via Zoom to maintain the safety of both the researcher and the participants. This multi-case study recruited three URM graduate students at different stages of STEM doctoral programs who completed the online written survey and identified themselves as potential participants. Each participant represented one case and was interviewed twice, totaling approximately 3 hours of interviews for each case.

To participate in the study, students must identify as a member of underrepresented minority (URM) groups. For the purpose of this study, only African Americans, American Indians/Alaska Natives, and Latinos students were eligible to participate. Those students were also enrolled in a STEM based doctoral program at time of participation. Using two-tier sampling methods, URM students who completed the survey opted-in to being contacted for multiple in-depth semi-structured interviews and also agreed to review interview transcriptions to validate findings from the interview data. Those students who agreed to be contacted for interviews, represented students from different programs and different stages in their doctoral programs of study.

Research Questions

1) In what ways do URM students experience and perceive support from their programs and institution during doctoral training?

   a. What strategies do URM students' use to access resources and opportunities (for example, academic, financial, and health and well-being related)?

   b. In what ways do URM students connect their own participation in equity, diversity, and inclusion efforts to the institution's commitment (or lack of) to equity, diversity, and inclusion?

   c. What kinds of social and emotional support provided or created by their institution and doctoral program mattered most to URM students?

2) How do URM students' lived experiences and perceptions of their institution, program and other sources of support contribute or inhibit their persistence in the doctoral program?

Data Collection

Online Survey Data

An online survey was administered to respondents who selected to participate. This survey collected basic demographic data regarding race, field of study, age, institution in which they are enrolled, gender, and income level. The survey also collected data on past educational experiences, including if they were first in family to attend college, first in family to attend graduate school, names of past post-secondary institutions attended, GPA when applying to doctoral program, past majors or areas of study, GRE scores, and participation in any pre-graduate education preparation or summer bridge programs. In addition, the survey also collected data regarding how the student selected their current institution. This section of the survey included questions about any specific recruitment activities the student was involved in,

how they experienced their application process, how many programs they apply to, were they given application fee waivers to apply at their institution, did they interview or visit the campus prior to selecting their program, what kind of financial support the student was offered (if any) in the form of tuition and fees, stipend, fellowship, scholarship, and/or student employment as a teaching assistant or student researcher, if there were other factors that influenced their choice, location of institution, rankings, reputation, cost of living, diverse faculty and/or student body. The final section of the survey assessed the student's perception of climate on the campus and different types of supports available to them at their current institution. This section addressed issues surrounding race, equity, diversity, inclusion, representation, mentorship, and belonging within their specific program and the institution.

Data collected from the survey was entered into a secure database. The basic demographic data was used to ensure survey respondents met inclusion criteria for the study and allowed me to pre-screen potential participants. In total, there were six respondents to the online survey, only four of which met the inclusion criteria for the study. All four respondents that met the inclusion criteria were contacted for their consent to participate in the study. Three respondents agreed to participate and one respondent did not respond to further inquiries to participate in the study. There were not enough respondents to the survey to analyze the data quantitatively or to provide significant descriptive statistics. The data collected in the survey also helped me identify the participants and prepare for the interviews with each participant and guide the course of the inquiry based on responses from the survey about their past educational experiences and familial backgrounds. Survey questions are included in Appendix A.

Qualitative Interview Data

As students completed the survey and began to self-identify as potential participants, I reached out to those respondents that indicated they would be willing to be contacted for more in-depth interviews. Each participant was asked if they were willing to participate in at least two interviews and review the transcriptions of each interview for accuracy. Students who met the inclusion criteria and who agreed to participate were scheduled for their first interview. The first interview with each case asked questions about their experiences at their current institution and their educational experiences in their doctoral programs as they relate to different types and systems of support. The interviews also collected a brief history on the student's family background, previous educational experiences and how they decided on their current program. These interviews were semi-structured, lasting approximately 1- 1.5 hours each, and allowed for the interviewees to address what they find valuable about their experiences in graduate education as diverse students as well. Approximately 4-6 weeks after the first interview with each participant a second interview was scheduled. The second interviews were also semi-structured and based on data that was emerging from the first interviews. The second interviews aimed to dig deeper into certain things discussed during the first interview and to ask clarifying questions. The second interviews lasted approximately 1-1.5 hours each. These interviews combined, were used to identify common themes and threads of diverse students' graduate school experiences, but also allowed for comparison among each separate case, illuminating commonalities and differences in each case's experiences. Further, the interview process also allowed me to probe further and understand if the students' other non-racial underrepresented group identities impacted or informed their experiences, this included identities such as gender,

disability status, pregnant or parenting, identifying as LGBTQ, or mixed-race, or immigration status.

Although interviews can be assumed to be low risk to participants, students interviewed were given the opportunity to pick a pseudonym to help protect their identities and promote more truthful and candid discussion surrounding interview questions. Interviewees were given the opportunity to skip any questions that may have introduced emotional distress or discomfort. They were also given the option to stop the interview at any point. Interviews were conducted with participants via Zoom. Due to the surge in COVID cases in the fall and winter, it was not possible to conduct interviews in person.

Data collected from the interviews was recorded as both and audio and video file, and was transcribed verbatim by the researcher. Interview questions were created from the existing knowledge base regarding barriers to recruitment and retention of diverse doctoral students in STEM fields, institutional climate, support systems in place at the institution, perceived representation and diversity of the institution as well as addressing areas where there are gaps in research. The basic data entered in the online survey was also used to prepare for the interviews and allowed me to ask more targeted questions to each individual participant based on their responses from the screening survey. I reviewed each transcript and interview multiple times and identified common themes within the groups of respondents, as well as differences. The interviews served as the majority of the qualitative data of the study, meant to identify the experiences of each case and across cases. A more detailed mapping of interview questions and follow up interview questions is included in Appendices B and C.

Post-Analysis Validation- Interview Transcription Review

Each participant was informed that they would be contacted for at least two interviews totaling in approximately 2-3 hours of interview time. After the first interview, participants were asked to review the transcription of the interview to ensure accuracy and authenticity. Participants were allowed to offer edits or ask for certain topics to be redacted or clarified. Respondent validation or member checking served was another tool used to help validate the researcher's understanding of data collected in the interviews (Maxwell, 2013; Merriam & Tisdell, 2016). Soliciting feedback from the students interviewed helped me gain further clarity and helped further validate my findings. Member checks are the most important tool in ensuring that findings and data collected are not misinterpreted by the researcher (Maxwell, 2013; Merriam & Tisdell, 2016). These participants review of their interviews safeguarded against any mis-representation of the experiences shared with the researcher.

Document Collection

Document collection also served as a qualitative data source. The researcher hoped the documents collected could help recreate the landscape in which the students find themselves and in the construction of the environment in which students are experiencing their graduate education which could have added to the context of the participants perceptions of support and climate. These documents could also help with better understanding the student's perceptions and experiences. I used publicly available data such as websites and official communications from departments and campus leaders to investigate campus climate and diversity efforts at the institution of interest. These documents included things such as campus and departmental vision and mission statements, diversity statements, statements on current social and political climates, resources available to students, student organizations and mentorship programs available. The

document collection also allowed me to identify what, if any, supports are highlighted and available to students, and if student experiences with these supports were congruent with the vision of the supports.

The collection of these sources of data along with the interview data and quantitative data, allowed me to triangulate my findings and helped to reduce researcher bias (Fielding & Fielding, 1986, Maxwell, 2013). In addition to reducing bias, the use of multiple data sources helped decrease the threats to validity that can occur in qualitative interpretations of data (Maxwell, 2013). A more detailed map of survey, interview and follow-up interview questions are included in Appendices A, B, and C.

Data Analysis

Online Survey Data

Online survey data was used mainly to identify participants and verify if the students who self-identified as potential participants met the inclusion criteria. The online survey was completed by six respondents during participant recruitment. Due to the low response rate on the survey, the data collected in the survey was not analyzed quantitatively and no descriptive statistics were able to be shared in identifying commonalities and differences between the survey data and the interview data. Of the six respondents, only four respondents met the inclusion criteria for the study. Using the online survey as a screener for eligibility was a useful method to identify potential participants. The four respondents that met the inclusion criteria were contacted with more information about the study and request for their consent to participate in the study. Of the four qualifying respondents, three respondents agreed to participate and one respondent did not respond to further inquiries to participate in the study. The data collected in the survey also helped me prepare for the first interview with each participant by reviewing their

responses in the screening survey. This included data about their past educational experiences, familial background, and information about their current institution. This data was reviewed from a qualitative approach and themes and thoughts began to emerge that helped guide the semi-structured interviews and the types of topics that I chose to discuss with each participant and how they pertained to different types of support available to students.

Qualitative Interview and Document Data

Qualitative interviews were recorded, transcribed, and reviewed by the researcher, first, to identify main themes and to prepare for the follow-up interview with each case. I used brief memoing to track the emerging themes and reactions to the coding process to help in asserting my findings (Maxwell, 2013). The memoing also allowed me to quickly reference reoccurring themes between participants and identify any differences that were emerging. I chose to transcribe the interviews, verbatim, myself to gather a deeper understanding of the narratives and help make meaning of the experiences that were shared by the participants. The verbatim transcription allowed me to revisit the data repeatedly and understand more fully the contexts of what the students were sharing. The transcription process served as my first round of data analysis. I was able to identify major themes as well as smaller more nuanced topics discussed. The hand transcription also allowed me to make note of physical cues and reactions from the participants and make note of those in the transcription. This served very useful as I moved to open coding as I already had some major themes identified. Through the process of open and iterative coding, I was able to identify the most prevalent themes and sub-themes in the data and once again go through documents collected and transcripts to further understand the data through the process of more focused coding (Emerson et al., 2011; S. Fine, personal communication, February 22, 2020; J. Kolman, personal communication, February 1, 2020;

Maxwell, 2013). During the open coding process, I first used printed transcripts and many different colored highlighters to identify themes that were emerging. Through the open hand coding of the data, I was able to identify many different themes in the interview transcripts. These themes were kept in a spreadsheet and through a more focused coding process, each occurrences of a theme were tracked, both for each case and in total over all three cases. I then reviewed the list of all the themes identified through the iterative coding process and started to identify umbrella themes which better represented the more specific or smaller themes identified. For example, participants might have mentioned things related to financials or money, like cost of living, stipend levels, transportation costs, or affordable housing. Although each specific instance is important, they were grouped together to better represent the financial considerations and experiences of the participants in my analysis. The transcribing process and open coding process illuminated ideas and themes and helped identify patterns as they emerged in the cases (Emerson et al., 2011; Maxwell, 2013). All emergent themes were coded, through an iterative coding process. The components and theories used to create the "whole-self" framework were used to guide the analysis of the data. Many themes were identified as they related to the framework, while other themes also emerged. The themes identified in the transcription and open coding process were used when reviewing interview transcripts and documents collected (Emerson et al., 2011; Maxwell, 2013).

Data Security

Audio recordings of interviews and written survey transcripts were stored on the researcher's password protected personal computer. Only the researcher has access to this data. Handwritten notes and jottings were secured in a private and locked file box in the

researcher's home. Files (both electronic and hard copy) will be retained for a maximum of three years, after which the data will be destroyed by the researcher.

Participants identities were protected through the use pseudonyms used for interviewees and redaction of study sites. The use of Zoom also helped in protecting anonymity and privacy, as both the researcher and participant were able to find a private location to meet for interviews, creating a safe and private space for the participants.

Positionality and Issues of Validity, Reliability, Trustworthiness of Data

As a STEM PhD program coordinator serving a large graduate student population at a highly ranked and competitive R1 institution, I interact with STEM doctoral students of all races every day. Although most of my day-to-day interactions are based on academic requirements, advising students of campus resources, and providing guidance on different policies and procedures, I also spend time getting to know my students as people. This has benefited both me and the students I serve as we are able to build trust and address issues that may not be strictly academic but may be impacting the students' academic progress and productivity. I take a "whole-self" approach when advising students, as I think every individual brings with them a set of experiences that informs why and how they move through their academic careers. Students are also people navigating complex lives while also navigating academic pursuits, and I feel acknowledging the student as a whole is an opportunity for me to best advise and support the students I work with.

I was aware of my positionality and that it might have some influence on the questions I asked and the data I collected. This awareness was very important in validating my findings. One major challenge I anticipated was that my role as a program coordinator for doctoral students may create some changes in the behavior of those students interviewed, as

some participants had the potential to be students I work with in my professional capacity. This *reactive effect*, which is the "ethnographer's participation on how members may talk and behave" (Emerson et al., 2011, p. 4) was checked and noted in jottings and memos. Although I anticipated the reactive effect might pose some challenges, none of my participants seemed to experience this. On the contrary, all participants were informed of my professional position working with graduate students and felt more at ease when talking with me. Each case also asked questions about different resources available and I was able to provide some benefit to my participants by referring them to resources available to them as students due to my "insider knowledge" of the institution and helped create a more trusting environment with the participants.

Another helpful method I use in my professional practice is reflecting on my own subjectivity. My professional relationship with the students did not impact how the interviews felt and I was able to provide some objectivity and advise them on resources available to them, while also maintaining a collegial relationship. Although I am friendly with my students and we have a strong rapport, I am also not their friend or confidant. This line between the "I-Thou"and the "We" is very fine, but for the purposes of this study, my professional boundaries proved useful in my interviews with each student. Even further, I also checked my own subjectivity as it relates to the "Community Maintenance-I" that Peshkin describes (Peshkin, 1988). As a member of the community that these students are part of, I made sure that my interview protocol and the types of questions I asked were not only written to maintain my personal sense of the community, but allowed the interviewee to present their experience of the space freely without being led to reinforce my view of the community (Peshkin, 1988; Seidman, 2006).

Another method I employed, in an effort to reduce my personal biases and assumptions, was relying on multiple sources of data, an iterative and systematic coding process, and member validation to understand if the themes that emerge are consistent or not through the data that was collected. (Emerson et al., 2011; Lincoln & Gouba, 1985; Maxwell, 2013).

Lastly, as a graduate student, I also had to be aware of my own position, assumptions, and expectations of what graduate programs might look and feel like. This position proved to be important to me as both an insider and outsider to the students I interviewed and aided in building rapport and trust (Emerson et al., 2011; Peshkin, 1988; Seidman, 2006).

Limitations of this Study

Due to the small size of the sample and limited scope of institution type and program, this study was not generalizable. Although the use of demographic data is often used in social sciences to help with generalizability, this was neither my expected goal or outcome. Another limitation of this study was that interviews were conducted via Zoom due to the COVID-19 pandemic. I was able to still build rapport with the participants, but was unable to build the trust that an in-person interview would have allowed for. I was able to gather some data on body language, posture, and other physical cues, which also helped guide the interviews, but the Zoom environment limited the ability to gather even richer data that would have been possible through an in-person interview. Lastly, this study focused on only one geographic region of the United States, which has its own inherent limitations of demography and socio-political culture, further limiting the scope of the findings. I hope that the findings will help spark conversations and future studies that will further delve into issues of retention of URM students in doctoral programs in other disciplines and institutions as they relate to systems of support.

Chapter Four: Cases and Findings

In this chapter, I will present the three cases collected in this study. Each case will represent one student, identified by their pseudonym, and their unique experiences as doctoral students in STEM fields at a large R1 institution in Southern California. Each case will be presented with a background of the participant, major themes that emerged from the interview data, and will close with how that participant's experiences with support work within the "whole-self" framework that was created to conceptualize the study.

Each case represents a student at a different point in their doctoral studies. Joy is a first-year student just starting her doctoral journey. Stephanie is a fourth-year student and has recently advanced to candidacy, a major milestone for doctoral student progress. Lastly, there is Dres, a student at the end of his doctoral career and preparing to graduate. These cases can be viewed independently and can also be viewed together, highlighting many similarities between each case while also showing how each case experienced certain aspects of their doctoral programs differently. The "whole-self" framework provides a lens through which each student's experiences can be viewed and provides further insight into how multi-faceted systems of support can help support URM doctoral students in STEM fields to degree completion.

At the end of this chapter, the "whole-self" framework will be presented as a method which can be used to identify how students interact with and experience different systems of support through their doctoral studies. It will also show the relationship between the different levels and types of support and how student's experiences, both positive and negative, in one area, may impact how they access and experience support in another area. Ultimately, using the "whole-self" framework method, identifies areas in which resources and efforts can be focused

to help support URM students in STEM doctoral programs to persist and successfully complete their programs of study through to degree completion.

Case 1: Joy Myrtle- The Enthusiastic Enzymologist

Joy Myrtle is an aspiring enzymologist originally from Los Angeles, who studies Biochemistry. Joy, who identifies as Latina, Jewish, and Middle Eastern, considers her identity as "very diverse". Joy is the oldest of nine kids and was homeschooled by her mother from kindergarten through high school. She describes her love for science beginning when she was only 5 years old, when she told her parents she wanted to be a physician. The child of immigrants, Joy's parents were pleased that their child wanted to pursue a career in medicine. Joy recounted the challenges later in convincing her parents that she wanted to pursue her career as an "academic doctor", something that was not a familiar career trajectory for her parents.

Joy's father, who immigrated from Mexico at the age of 17, received his GED, and although he aspired to complete his education, had to stop his studies to "provide for his family". Joy's mother, a high school graduate, worked as a teacher in a private school. Although she never completed her teaching credentials, her past teaching experience positioned her well to homeschool her children. Joy loved being homeschooled. Her mother tailored her curriculum towards her love of science and she shared that her experiences being home schooled helped remove any distractions that may be present in a more traditional school and classroom setting. She described that one of her favorite parts of homeschooling was the "luxury of field trips". Home schooling provided her family with the freedom to travel, visit family in other parts of the country, visit museums and arboretums, and take many trips to the library.

After high school, Joy transitioned to her local Community College. Although she was academically prepared for the rigor of college coursework, she described feeling like she had less "street smarts" than her peers who attended traditional public high schools. Her extroverted personality was a surprise to many people at the Community College, who expected homeschooled students to be introverted and struggle with social interactions.

After attending Community College, Joy transferred to a 4-year university and received her B.S. in Biochemistry. During her time at her undergraduate institution, she was a MARC (Maximizing Access to Research Careers) scholar, a program designed to develop diverse undergraduate students and help them transition into higher education in biomedical research. The MARC program provides participants with the opportunity to conduct original research with faculty mentors, fosters interaction between professors and graduate students, provides a monthly stipend, and gives students access to seminars and summer research internship with collaborating institutions nationwide. During her time in the MARC program, she conducted research involving the mutation of the active site of tyrosine phenol lyase for synthesizing larger tyrosine derivatives to produce neurological disease treating drugs. Her love of enzymes only grew with each opportunity to learn and discover more about their role in many different biological processes. Joy enthusiastically declared, "I'll go wherever the enzymes take me!".

Currently, Joy is a first year PhD student in the Chemistry and Biochemistry program under the Chemical Biology track. She recently joined a lab where she is working on developing her own research project, studying mitochondrial RNA with the guidance and support of her thesis advisor. Joy loves teaching and hopes to be able to incorporate teaching as one of her main goals after completing her degree. Joy aspires to win the Nobel Prize for developing enzymes that degrade plastics and will help make the world a better place. Outside of the lab, she

enjoys reading mystery novels, exploring new places, skating, trying new granola and cookie recipes, and watching anime with her husband.

Joy was interviewed twice, ten weeks apart. Together we spent over 3 hours discussing her past educational experiences, her family life, her love of enzymes and science, her research goals, and the factors that were critical to her decision to not only attend her current institution but also those that helped propel her to where she is today. Joy discussed both the strengths of her current institution and opportunities to improve her experiences. Overall, Joy felt like she had all the tools to succeed academically, focusing on the many types of support, including institutionally, academically, and social and emotional supports, that have helped her and will continue to support her towards the completion of her PhD. The following analysis will focus on major themes surrounding institutional supports and factors, academic supports and factors, and psychosocial supports. Each major theme will present sub themes that were uncovered through the iterative process of data review and analysis. Although each theme and sub theme can be analyzed independently, it is the interconnectedness and the layering of each finding that help support the "whole-self" framework which was developed to conceptualize this study. This interplay of themes will also guide the final analysis, showing the utility of applying the "whole-self" framework, described earlier, in considering ways to improve the retention of URM students.

Theme 1: Institutional Supports and Factors

There are many factors Joy considered when choosing her doctoral institution and program of study. Before deciding on her current program, Joy relied on the advice of many different people. Her husband and family served as a main source of support for her during this time, as did her mentors from her undergraduate institution and her close friends. While talking

with Joy, many sub-themes related to institutional support and factors were revealed. These sub-themes are described in more detail below.

Theme 1a: Campus Location, Benefits, and Diversity

When deciding on an institution, one of the things highest on Joy's list was location, specifically proximity to her family and her husband's family. Having grown up with a tight-knit family, she felt it was valuable for her to stay nearby. She also explained that her mother-in-law had recently passed away and it was a top priority for her and her husband to stay in the Southern California region, where they could be close to her husband's family during a challenging time. Although she was considering other local institutions and out of state schools, which will be discussed next, she stated, "So yeah, we wanted to stay close to the family, support my father in law and my brother in law, and just kind of be there, because we were thinking, it would be too much if we went to another state." Joy said that her family, husband, and husband's family provided a strong support network for her, so being able to access that support by staying in close proximity weighed heavily in her decision making. More details about her family support network will be discussed in subsequent themes. The importance of staying close to her social and emotional support network was a top priority for Joy and her academic success when choosing an institution and program of study.

As location and proximity to family was a top priority for Joy when selecting her institution of study, Joy was also very excited about applying to another institution in the same geographic region as her current institution. She told me that her original hope and plan was to attend this other institution stating, "I mean, the pioneers, a lot of the pioneers of Chemical Biology techniques are at <other institution>". Although Joy was ultimately not admitted to this other institution in Southern California, she did state that they offered a more generous financial

support package than her current institution, which is another important factor that Joy considered and will be discussed in more detail in the next section. She also stated that this other institution didn't offer as many opportunities for graduate students to teach, which was another important factor that will be discussed later. In our discussion, Joy thought that not being admitted to that other institution led her to deciding on her current institution, as she also had offers of admissions to other programs in less desirable geographic locations. She said that both had access to great science, the quality of the programs was high, but that her current program most aligned with her list of priorities when making her final decision. Her current institution provides access to housing which will also be discussed in more detail in the coming themes, access to childcare, and the opportunity for her husband to find employment, which the other institution she hoped to attend did not. Institutional support and factors like access to teaching opportunities and ability to work on the science she was interested in show how the institutional factors can influence students' belief of their self-efficacy and can help support their identity as a scientist. This also plays into students' perceptions of how they can socially and academically integrate into their institution and program of study, aligning their academic and future goals with what the institution is able to provide.

During our discussion about how Joy came to the decision to join her current program of study, she also mentioned that she had considered some schools out of state. Joy mentioned that she was also interested in two other institutions, one in the Southern region of the United States, and another on the East Coast of the United States. When making her decision, she considered what kinds of institutional support would be available to her as a student. She mentioned that one prospective institution offered something she cannot get at her current institution which was access to the private sector. She described that the other program on the East Coast would allow

students the opportunity to rotate with labs working in the private sector, also referred to as industry. She thought that this was a meaningful opportunity for students, as she was interested in learning more about that career path and noted that previous experience in industry was highly advantageous for those looking to pursue that career path. She stated, "the more I talked to people who actually work in industry, the more I think, if I ever want to get any kind of industrial job, I need to have some experience beforehand." She also discussed that one of her current professors, who also works in industry, explained that getting a job in industry with a PhD can be a challenge and that getting experience earlier with that career path would be valuable to her. She recounted, "One of the professors I'm TAing for, he has his own pharmaceutical company and he explains how getting an industry position as a PhD is very difficult. The job market is not as available as it would be for someone with a master's or a bachelor's, so I definitely want to get that experience ahead of time."

Joy also mentioned the diversity of the campus a few times when we discussed factors that she had considered important when deciding on her current institution. In regard to the out of state schools discussed above, she also recounted, "I talked to some of my friends who went to institutions outside of California and they told me about all the racist and sexist things their professors said, it's like, "Wow, these professors are getting away with it'." When asked about how diverse she felt her current institution was, Joy shared, "I do see a lot more like Asian American, um Caucasian American, and it does kind of show me there's still some work to be done in terms of the diversity. I don't see that many people that look like me in terms of the Latino side." She further went on to describe,

> I think in terms of diversity and whatnot, there are other Hispanics, which is very, very nice. But I think if I were a different ethnicity, like African American, I'd

> feel welcome, but I still feel a little out of place. I don't think we really have any African American students in our cohort at all.

She recognized that there was more to be done to increase diversity at the institutional level, sharing, “I think they're trying, they haven't made it yet, but they're going towards the right direction. But I think that's kind of more of a long-term issue of who is applying? Who thinks they can make it? And how, I guess the administration, kind of accepts people? But I think they're working towards the right direction.” She posited that although she wasn’t aware of the ethnicity ratios in the city of her current institution, perhaps that impacted the lack of diversity on campus. She further explained, “So, I don't know if there would be like more Hispanics or African Americans that are interested in this program, because I don't know if there are that many around here.” She remained hopeful, despite the lack of diversity she observed at her current institution, stating, “I'm actually pretty proud to be a graduate student who's trying to participate and go in the right direction. I am seeing a little bit of diversity, but like I said, we got a while…”.

Another major factor for Joy, when considering other programs, was benefits that were provided to pregnant and parenting students. She mentioned that this might be something her and her husband would be considering during her time in school so this was a specific support she sought information about. However, when comparing programs and institutions, she found many of the benefit structures for pregnant and parenting students were comparable and therefore, ultimately it ended up not being a final decision point. It is important to note, that overall, she viewed the support for pregnant and parenting parents as lackluster, which is why this consideration fell lower on the list of priorities in deciding on her current institution. When we discussed this factor, Joy said, “A lot of them I think what they have, for you know pregnant and parenting students, they all were about the same, I would say. One could argue that, ‘Hey, at

least the Family Center or the Daycare Center is just right here around the corner from my house.' But I've talked to people who have tried to put their kids in there and turns out there's a waiting list."

As briefly mentioned earlier, another major pull to her current institution was the opportunities for employment her husband could take advantage of. As a large R1 institution, Joy and her husband believed that he would more easily be able to find employment at her current institution. She said they discussed this factor together and he said, "I think since you're a student, you might be able to help me get into employment here." Joy's husband is currently employed at her current institution which also has provided them further financial stability.

Theme 1b: Financial Support

Financial support is a significant factor that is tied directly to many of the benefits discussed above. Speaking with Joy, graduate student financial support was a highly prioritized factor to her success as a student. Growing up, she describes financial instability as a huge consideration for her parents and family.

> I think, coming from a family, where my dad was one that immigrated my family, I mean…Well, my mom's side, they immigrated, her parents immigrated, you're always having money on your mind. So usually my family was like very tight on the dollar, like always stretching a dollar. Because we're always like, "what if something happens, we need to have something for a rainy day", and I still see myself like that to this day.

As mentioned in the introduction, Joy originally thought she would pursue an education and career as a medical doctor. When she started at Community College and discovered that there were options available to become an "academic doctor" and an independent researcher, she began weighing the cost of medical school against the benefits of attending a PhD program, a path she was much more interested. She recounted, "So, hearing everything about, 'Oh, you

know, you're gonna have to take loans, when you go to Medical School'. That was one thing that definitely terrified me." She further discussed her decision to pursue a PhD stating, "So, then there was Grad school, and they were basically telling me, 'Oh, you know we can, we give you a stipend so you get paid to study and to work'", this was an option that she couldn't pass up.

As mentioned earlier in the section on campus location and institutional benefits, it was briefly discussed that Joy originally hoped to attend a program which provided a larger student stipend than her current institution. However, she and her husband weighed the actual cost of attending the other institution and decided that her current institution's stipend, combined with the other benefits provided, gave them more value per dollar. She recounted a conversation with her husband in which he said, "What offsets that balance is the fact that you know we can get housing, we can be so close to campus and all those things." Joy overall felt that her financial support and stipend provided by her program of study was a good value. Recollecting on her decision making process, Joy shared with me that her financial package had helped her and her spouse make a big life change, " I mean it was something that helped both my husband and I moved out from our parents' homes, just start to start our own life, so I think it was definitely the best financial choice for me and I'm not sure I would ever go back I don't think I would ever change something at this point."

In our discussions, Joy stated that she did feel like the work she was doing serving as a teaching assistant while studying and making progress towards her degree, compared to the pay, was a bit low, which meant to me that the financial support could always be greater. With a laugh, Joy told me, "I guess now that I'm actually doing the work, it is nice to get a stipend, but at the same time it's like, 'wow, this is cheap labor'".

Joy also explained an instance where she was faced with barriers to receiving her financial support which created financial hardship for her. When Joy started her program, there was discrepant data entered into the institution's newly launched payroll system which created delays in receiving her stipend. She described an ordeal lasting a few weeks, in which she tried to work with program staff to uncover the cause of the delay. She mentioned that program staff was not the most helpful during this challenging time. When I dug a little deeper into what she was describing she said, "The Department did try. I will say the person in charge of that, I don't know if she's like got a really busy life, or if you know, maybe she had a new baby, or maybe someone a relative passed away. But it was just a little frustrating, because I was sending emails and I wouldn't hear back". This lack of response was not only from her department, Joy was also having a challenging time reaching the payroll office to determine when or how her stipend payment would arrive. This was a frustrating process for Joy to navigate. Having just moved to a new city, and her husband still looking for employment, Joy said that they had exhausted their savings and having not received her monthly stipend made it difficult for them to pay their rent.

> So, I think that was the only time when I just got really frustrated because I was like I'm doing all these things, I'm answering all these things and I'm not getting anything and then they sent my stipend through the mail and it never arrived, so that was even more frustrating. So that's the only time, I would say, I didn't feel supported.

Eventually, the issue was resolved, and Joy has not had other delays in receiving her financial support, but overall the experience left her feeling unsupported by her institution and her program. In a moment where she was feeling financially unsupported, she did mention that the Student Housing Office was very helpful with her request for an extension to her rent payment due to financial hardship.

> I told them 'Hey, I'm not going to be able to pay this because <current institution> hasn't given me the funds yet', they're like, 'Hey just like send in this

> application' and they told me where to go on the website and you know you'll be able to put the request in and they got back to me fairly quickly like they're they were very, very quick, so. I would say the housing is pretty solid in terms of their customer service so yeah.

Joy was also very excited to share that her husband was able to find employment at her current institution which also helped relieve a lot of financial pressure. In our second interview, she reported that things were going very well and that, "he has a great job right now with <current institution> and they're thinking about hiring him full time for clerical positions, so that's even better."

Joy also discussed campus support for basic needs and helping provide food security to students. She said that she uses the program designed for graduate students and she found it very helpful, especially during the time where she had not received her stipend payment. She described her experiences, "I know we have a food bank which is really just a walk away. I know there's a graduate student one, and there's the general student one, but I usually go to the graduate student one and that's been very, very helpful." She also discussed that a state supported program was available to those who needed assistance with food, but that with her husband's income and her stipend combined, they earned too much to qualify for extra assistance. In addition, she mentioned that sometimes there are food truck events on campus, and if you are a parenting student or student family you can get a free meal, which Joy viewed positively.

Theme 1c: Housing

As mentioned previously, access to student housing was another factor that Joy prioritized when selecting her program. When we met, Joy described how she came to her current living situation in graduate student housing. She explained to me that originally, she had not been offered graduate housing as part of her admissions package to her current institution,

which was a bit disappointing. After a conversation with someone, Joy found out about a program, through the institution, that provides priority over waitlists and guaranteed graduate student housing for five years, for students who qualify. Typically, graduate students are only allowed to utilize two years of graduate housing, to allow for more students to take advantage of the below market rates and proximity to campus. She said that she emailed her prospective program and asked if she was eligible, and ultimately secured a spot in this program and the ability to live in student housing for the duration of her time in her graduate program. To be eligible for this program, students must be admitted to a graduate program and be identified by their prospective program of study as a recipient of an offer to the enhanced housing program. In our second meeting, I followed up on how this housing offer impacted her academic success. Joy commented, "I think I would be so stressed if, during my second year I'd have to go look for housing. Oh no, that would be so stressful. So, it really takes this load off my shoulders just not having to worry about it, is amazing." Removing the pressure of finding housing in the middle of her program was valuable to Joy and she believed it absolutely helped her focus on her academic pursuits and completing her degree.

Although she was happy that she qualified for the program and able to take advantage of the benefit, she did mention that, "It was just kind of frustrating that I had to look at it, but at the same time it's like I understand they probably don't want to like fully publicize it because they don't, they might not have, as many offers to give." Even though Joy had to take the initiative and identify herself as a potential eligible student for this program, she was very satisfied with her housing situation, mentioning, "we were able to get this beautiful little apartment" with a huge smile.

Theme 1d: The Science

Another factor Joy considered when deciding on her institution and program of study was access to the science she was interested in studying. She discussed how she came to learn about the field of biochemistry in her transition from Community College to her undergraduate institution and how that combined all of her research interests. In discussions with her research mentors she explained how her interests in enzymes were more clearly aligned with biochemistry. “At the time, I think I was a microbiology major, because I thought, well, there’s microbiomes so I could probably study a lot of enzymes in there and they're like, ‘No, try biochemistry. Like that is very heavily enzyme based’.”

Joy stayed true to her love of the science of enzymes when considering which program she would attend. “And that's kind of where it influenced us to where I was going to apply. I wanted to look for programs that were like, pretty good when it comes to enzymes but also like fascinating, for like very strong hold in terms of like Chemical Biology. And I found that the areas in Southern California were like very rich in terms of Chemical Biology.” Her current institution also offered her the opportunity to work on enzymes that degrade plastics, a research path that drives Joy’s passion in science. When we first met, Joy was still in her lab rotations, a process that helps students identify their thesis research labs. During our first meeting, she was interested in one specific lab, but still hadn’t made her final decision. Discussing the lab she was interested in at that time, she said about a lab at her current institution, “But he's working on like biodegradable plastics using algae oils, and I was like ‘Okay this is, I know this is where I want to be’”.

During our second interview, Joy went into more detail about how the science was a main factor in her decision-making process to join her current program.

> So that's where I started going more towards, "Okay, what can I do to create my own enzyme?". Because it is hard, you know, there's a lot of factors, you have to consider and that's when I realized, "Okay, I need to understand more the structure…", the more I learned about enzymes, the better chance I have of making my own, because I know what the key components are to create a stable protein. And then from there, a catalytic protein to do exactly what I want it to do. So, that's when I started looking at these different labs.

She also told me she had finally selected the lab she wanted to join. Although it was different from the lab she originally wanted to join, she felt that the lab she is in will allow her to grow her skills as an independent researcher, while also providing the support in science that she considered invaluable to developing her into the scientist she wanted to be.

> I feel like as a person who was transitioning from an undergraduate researcher to now a graduate researcher, I was still a little nervous and I didn't need my hand to be held, but I would like a little bit more assistance as I, you know, do my own science. Because I'm always scared of making a mistake, like, 'What if I slip up? What if I do something to completely mess up this experiment?'

She was also very happy to report that her current lab allowed her the opportunity to develop her own research. Joy stated, "I wanted to write my own proposal. So, I have an idea for a project and it will overlap with my PI's project so that I can do what I'd like."

Theme 1e: Institutional Mentorship

When selecting her institution, Joy knew that mentorship would be one major component to her being successful in her doctoral program. She recalls speaking to a mentor at her undergraduate institution and added, "You know, because I told him I was a little bit interested in industry he's like, 'Southern California is a very hot spot for like biotech industries or like bio scientific industries, so if you go there, you might find a mentor who has connections to that.' Which the mentor I'm interested in, he does." Having access to mentorship that could get Joy connected with industry was one factor that influenced her choice on the institution.

She recalled another conversation with her mentor at her undergraduate institution, saying it was one of the most valuable discussions she had in seeking advice on which institution to attend for her doctoral studies. Joy shared,

> And they said, 'Well, you know, you've seen our mentorship, if you did not have that mentorship where do you think you would have gone?' And they just kind of like let me sit and let that stew in my brain for a bit and they said, 'The end of the day, decisions up to you, but you want to make sure that you have a PI who's going to help you graduate and get to where you want to be. Because your project may be amazing and all that, but you're there just to learn.'

That discussion played a huge role in not only Joy's decision to join her current program of study but also when it came time to identify her current mentor/thesis advisor and join their lab. One last thing that Joy highlighted about having access to good mentorship was related to all students from underrepresented groups. Joy explained,

> I think most of them are underrepresented minorities and, even though our home dynamics are different, I think, one thing we do all have in common is we were paving our own way. And we don't really have many people to, other than our mentors, to guide us through getting whatever process in life we're going through.

Mentorship relationships will be discussed again in subsequent themes as they pertain to other aspects of the student's academic success. However, knowing that she could have access to high quality mentorship and mentors who were able to guide her future academic pursuits, were another top institutional and programmatic factor that Joy considered when deciding on joining her current program.

Theme 2: Academic Supports and Factors

Academic support plays a major role in the success of URM students in STEM fields. Throughout her educational experiences, Joy could point to instances where academic support helped advance her towards her goal of pursuing a PhD. The "whole-self" framework positions academic support as one of the main scaffolds to support URM graduate students in

STEM fields to degree completion (Ashley et al., 2017; Gandara & Maxwell-Jolly, 1999; Wilson et al., 2014). Being cognizant that education is a process and understanding the different factors that aided in Joy reaching the doctoral level of study is critical to understanding how best to support URM students in STEM.

Theme 2a: Prior Participation in Academic Success Programs for URM Students

As mentioned earlier, Joy's love of science started at a young age and was cultivated through her mother's lesson plans that prioritized science and math in her home-schooling curriculum. During our time together, Joy discussed her previous participation in an academic success program designed for underrepresented students during her undergraduate career. Joy was a scholar in the MARC (Maximizing Access to Research Careers) U*STAR (Undergraduate Student Training in Academic Research) program. This program focuses on developing diverse undergraduate students in biomedical research and also aids in their transition into higher education. The program aims to empower young scientists from underrepresented backgrounds through their participation in the MARC program. Joy explained to me that the MARC program really encourages their scholars to present their research at Academic Conferences, giving students access to authentic science communities and the ability to share their research findings. It also provided her with targeted mentorship (Ashley et al., 2017; Hernandez et al., 2013; Maton, et al., 2016).. Unbeknownst to Joy, her research mentor at the time was actually a Co-Director in the program and she was able to continue her research with this mentor through the MARC program. This relationship continues, and Joy stated that she still seeks advice from her research mentor. Other components of this program include dedicated research time in a lab which provides direct access to training opportunities, a financial stipend, partial tuition support,

opportunities to interact with researchers outside their institution through seminars and workshops, and training in preparing competitive applications for PhD programs.

Joy discussed her participation in a Summer Research Program at an out-of-state institution, as part of her MARC scholarship. Sadly, she was unable to physically attend the institution due to the COVID pandemic. She recalls, "I had originally been accepted to a research program for the summer, so I was going to go to, I think it was Kansas State University. I was going to go do my research there, but when COVID hit everything got canceled." Even though her plans were disrupted by the pandemic, she said that the program was able to pivot and provide students with academic support and engagement through a virtual setting. When asked what kinds of things were covered, Joy explained, "So, the way my professors adjusted is they had journal reviews. The way that the, our Professor, had us do it, it was, we had to dissect it. And in doing so, it just made it easier to read papers. Because I was able to say, 'Okay, this is where I understand. This is what I don't understand', and the Professor will help me out and it just helped me read papers even faster because I could just quickly take whatever information I needed." These journal reviews and journal clubs assisted Joy in honing her skills in reading scientific literature and in communicating science. This, she said, was especially useful as she was also in the process of submitting multiple fellowship applications at the time. This required Joy to write research proposals as part of her application. Although Joy's applications to competitive graduate level fellowships like the NSF GRFP (National Science Foundation, Graduate Research Fellowship Program), Ford, and Hertz, were not ultimately accepted, she remained positive and shared, "Unfortunately, I didn't get any of them, but I did get really good feedback. Especially, I think, the strongest feedback that I had was from the NSF and their main complaint was that I wasn't 'too sciencey', you know, it was like 'We

could tell that she is not like skilled in scientific writing'". Joy reported that these are skills she will continue to work to develop through graduate school and was happy to go through the process and receive the feedback as an undergraduate to help her continue to grow and develop as a researcher during her PhD.

Theme 2b: Current Academic Supports

Although Joy is only in her first year of her doctoral program, and not familiar with all the institution has to offer in terms of academic support, she indicated that her program staff was a good source of information on how to access academic support. Joy recalled an instance early in her second quarter, right before we met for our second interview, when she was feeling overwhelmed by a specific course. "There's this one class that I'm taking right now. It's a really interesting class, and I think it'll help me in terms of my enzymes project and interest. The only thing is, I was having a hard time with it. I don't think I was in the right mental space." She was concerned about not doing well in the course, but was also recovering from COVID and mourning her grandfather who had just recently passed. All of this was emotionally too much for Joy. Turning to a friend who was also struggling in the same course, they decided to reach out to their program staff to discuss changing the grading option on the course from letter-based grades to a "Pass" or "No Pass" option. She recounted,

> And I talked to her (her friend) and was like, 'You know what? We need to not worry about this class right now. So, let's just make it pass/no pass'. And we decided to discuss it with our advisor and with the Director of our program and they're like, "You know, we're so sorry you guys are going through these things. You know, just put in that application. Fortunately, at that time we were still able to, so we did it together, and it was just a weight off your shoulders.

Another academic support Joy mentioned was the option to obtain a Master's degree during her time in her doctoral program. This option requires students to complete 36 units

of prescribed coursework and pass a comprehensive exam. The prescribed coursework requires a certain number of units taken for letter grade, so working with her program staff, Joy received the academic support needed to keep her on track to receive her Master's degree.

> I think, with the whole pass/no pass option, I definitely felt more supported more by the program staff. I think they were my main source of communication, I think they were just really, really great support. Very helpful and they definitely showed me that there are alternatives, and what I can do to make sure that I don't fall behind in terms of getting my master's before I get my PhD. So, I did feel very supported.

Theme 2c: Participation in URM-Focused STEM Outreach Programs

Joy discussed the importance of outreach to other URM students during both of our meetings. Joy believed these outreach efforts helped with diversifying STEM in higher education. She had also been an attendee at such an outreach effort during her time at Community College. Joy recalled when a local institution came to her community college, "I know when I went to the Community college they had some people from a local institution come and talk about the different research programs, but I know that kind of really piqued my interest." She said that faculty members came and publicized about programs available to students and discussed their research. She ultimately ended up at that institution to complete her bachelor's degree, proof to her that these outreach efforts are effective in recruiting students into STEM.

Before arriving at her current institution, Joy mentioned that she participated in several panel discussions at her undergraduate institution with other URM students to get them interested in STEM and help improve the diversity of the discipline. She thought that people sharing their stories was valuable towards the goal of increasing diversity. Joy said,

> "I think it's really good for me to talk about my story, or for anyone to talk about their story. It's also nice because you get to hear about other people talk about their experiences and you're like, 'Wow! You had it even tougher than I did'. Or you know, 'Good on you, for working through those issues that you had'. So, I really do think that these kinds of panels are important, I think they're extremely important."

She also mentioned that her current program was working on doing outreach to local high schools. She added, "I think they're working on doing outreach for high schools, which is great, I think. I really do believe it starts in high school…where you can start gaining research experience or you can start looking at what schools to apply to." During our first interview, I asked her if she had been part of these types of efforts at her current institution, she shared she had not been asked yet, but would love to have the opportunity to do URM focused outreach. "I'm hoping to get on any committee that will allow me to because. I feel like my story is pretty complex, but at the same time, a lot of people can identify."

When I asked Joy if she had received any compensation for her participation in these URM outreach events, she noted that she had not received monetary compensation, and that she was okay with that. She said that receiving compensation would take away from her experience of giving her story to other students. She felt that "giving back" was more important than receiving monetary compensation for her participation. As mentioned above, a similar panel has helped Joy pick her undergraduate institution and supported her feeling integrated into her new campus. Attending a URM panel while at Community College, helped her establish a small network before arriving at her undergraduate institution. She explained the benefit of sharing her story was worth more than a monetary gift for her time.

> "I think I would say that maybe monetary compensation would kind of take away from the experience of 'I'm giving you my story'. Because I think it's really important for you to understand that other people have been in your shoes and if I could do it, you definitely can do it too. I think that's the biggest, I guess, reward.

> Hearing that you inspired someone or you changed someone's trajectory of life trajectory simply because if you told them, you told them your experience."

During our second interview, Joy had taken a big step towards providing outreach to other URM students in STEM at her current institution. She remarked that she and another member of her cohort are working on developing a club for Hispanic graduate students to reach out and support Hispanic undergraduate students, getting them interested in science. She also mentioned that they had identified a Hispanic faculty advisor, the only Hispanic faculty in her program to the best of her knowledge, to support their club. She said that they decided this was something they chose to do after coming to the realization that there weren't many Hispanic students at their current institution. She also mentioned that students from other underrepresented groups were even less present on campus. Joy presented their goals, including holding workshops for students' parents to explain to them career paths that are available to students who pursue higher education.

> "But yeah we basically noticed there's just so few (Hispanic students) so let's try to start and encourage them, 'Hey you know, you can do this'. We're thinking about maybe holding workshops, where we talked to the parents and explain, 'Hey look, they can actually get a good job by pursuing this higher education', because that's one thing that I know a lot of us have parents who worry about that, you know, 'I came to this new country, so my children would have an education and a stable job well. What is it that they're trying to do? It's not a doctor or an engineer or lawyer. What is this PhD?'.

Theme 2d: Academic Mentorship

Joy has had many mentors that influenced her academic trajectory from community college, to her undergraduate institution, and now at her current institution. These mentorship relationships have helped Joy build her sense of self-efficacy, improved her social integration, and provided her with a scientific community and network she can turn to for advice and academic support. As discussed earlier in the section describing institutional factors that were

top priority to Joy, mentorship is also a valuable component of academic support for her. Looking through the "whole-self" lens, we can begin to see how mentorship within each type of support can influence students' experiences and perceptions of support.

Mentorship has been a constant source of academic support for Joy. She explained that it was her mentor at community college that first explained to her what mentorship was. Coming from a homeschooled background, Joy was unfamiliar with the concept of mentorship. Joy recounted what her first mentor told her, "I'm going to take you under my wing. I'm going to be a mentor. I'm going to be your mentor for now, but I want you to find other mentors because they're going to take you even further than I ever could because I only have a limited level of experience." Joy explained to me that this really helped her understand that she would need mentorship. She said, "I knew I needed help if I was going to get to where I wanted to be. But when he started talking about mentorship that's what I was like, 'Oh that's what I need. That's exactly what I need.' This early mentorship relationship helped Joy identify multiple mentors through her time at community college and on into her undergraduate program.

She shared it was another mentor at her community college that helped her hone her interest in chemistry, explaining to Joy the different paths she could pursue to continue her growth as a scientist. It was this mentor that told Joy about graduate school and how she could continue to study and learn about enzymes, while also giving her academic advice on what she would need to pursue this path.. She described one conversation she had with this mentor,

> "she explained to me a little bit more about what getting a doctorate was like, and what the job field was like after you gained your doctorate, especially in what my interests were. And she encouraged me to apply to research programs, especially since I was still continuing my undergraduate education and I would be transferring soon."

Relying on the advice of her mentors, Joy reached out to faculty at the institution she was transferring to from her community college to help find someone who might be willing to support her as a student researcher. It was from that advice that she connected with yet another faculty member that encouraged her to apply to the MARC program described above and then became her faculty mentor as part of the MARC program. This faculty mentor's advice to apply for the MARC program and her subsequent participation as a MARC scholar gave Joy the opportunity to participate in authentic research, develop her identity as a scientist, improve her self-efficacy, and provide the resources to prepare for graduate school. This mentor also served as an invaluable source of advice and provided Joy with the academic support she needed to develop her skills as a researcher and be a competitive applicant to graduate school. Joy added,

> "it really gave me like a glimpse into what it was like to be a graduate student and what it was like to pursue the interests of going to graduate school. And then also having the opportunity to do research at my undergrad institution that was, that was awesome like I really got to know "okay is this what I really want to do?"

Joy's previous mentorship relationships also helped guide her selection of her current thesis advisor and faculty mentor and was a valuable part of her final decision making on which lab to join. She explained how she was really interested in the science being done by two different faculty members, but ultimately she decided to join her current lab because she believed she would get the academic mentorship she needed. She described that a previous mentor has shown her the kind of mentorship that worked well in supporting her academic and research goals and she was looking for the same in her current mentor. Joy said, "Someone who was always receptive to any of my comments or questions or anything. Was there in the lab to help me, and you know double check things for me and every once in a while, if I couldn't perform an experiment, he was there. So, he just really set the bar really high". She followed up by sharing that her current mentor is supporting her in creating her own research proposal, supporting her

research interests and helping her apply for funding. Joy described that conversation with her current mentor after joining the lab,

> "And after talking to her, I said, 'You know I have these ideas', and she said, 'Look, what you can do is, because we don't have funding for that project, is if you can write up a proposal and get funding for it, you can totally work on it'. And I think that was just even better. So, it definitely is mentorship."

As shown in Joy's experiences with mentorship, her mentors' academic support was a very big part of Joy achieving academic success and helped her move through her education to the doctoral level. Mentor relationships greatly impact the personal and professional development of graduate students and those with effective faculty-student mentor relationships can improve academic and career development outcomes (Johnson & Hume, 2002).

Theme 3: Psychosocial Factors- Social and Emotional Support

As discussed throughout this case, social and emotional support played a critical role in Joy's education. She accessed social and emotional support from different sources depending on the form of support she was seeking. During our interviews, Joy and I talked about many instances where social and emotional support were key factors to Joy's experiences and academic success as a doctoral student in STEM. These sources of support will be discussed in further detail below.

Theme 3a: Family Support

Joy's parents and family played a huge role in her academic success. As discussed earlier, Joy was home schooled for all of her K-12 education by her mother who tailored lesson plans and curriculum to support Joy's interest in science and math. Joy's parents also assisted her in the transition from homeschool high school to the local Community College. Although she mentioned that they were not able to academically support her by providing the scientific knowledge needed to assist her studies and assignments once she went to college, she added that

her parents, who both briefly attended Community College, were able to provide assistance when it came time for her to take placement exams and enroll in classes. Joy also disclosed that her siblings helped out a lot when it came time for her to focus on her school work and preparing for exams. She discussed how her siblings took on her chores, freeing her time up to study and work as a tutor.

Joy's parents were also actively involved in her day-to-day support when she was attending Community College and her undergraduate institution. During our second interview she disclosed,

> "They were also the ones who took care, they took over any of the finances, if I had to like bus pass, lunch money, if I had to have any. They were usually the ones driving me around if I needed to be, if I had to get up like at six, so if I had a class at like seven or eight in the morning. They were always making sure that I was well fed and I had all my books and I had a place to sleep."

Joy's ability to focus on her academic pursuits and goals was due in great part to her family taking care of many aspects of her day to day life. This helped alleviate stress and allowed Joy to put all her attention towards her academics. When discussing her academic pursuits and successes, Joy said of her family, "yeah they were very instrumental for that." Utilizing the "whole-self" lens, it is clear that Joy's familial support was a critical piece to her academic pursuits and successes. Layered with the other themes discussed earlier, such as choosing an institution in close proximity to her family, it can be understood that institutional factors influence social and emotional support and how she accesses support and from whom.

Theme 3b: Spousal Support

Joy said that her husband was someone she turned to throughout the process of selecting her institution and program. She shared that she and her husband were married shortly after she applied to graduate programs and that he was a constant source of support and helped her weigh

her options as discussed in previous themes. When asked who she turned to for social and emotional support, Joy added, “I think, without the support of my husband and my dad, that really helped me a lot of times. My husband, he's like, ‘Hey, if you ever need snacks or anything I got you’. Or yeah, if I needed to go somewhere he drives me.”

Joy described many instances where she used her husband as a sounding board, turning to her husband in the role of a trusted advisor. His input and their conversation were always highlighted by Joy when discussing which institution she picked and why, financial considerations, and even in her academic life. When discussing her process to select her current thesis research lab, she recounted discussing it with her husband. She went on, “And then later on, when I was talking to my husband, he said, ‘Remember, at the end of the day, you're just there to learn the tools and techniques to get you to become the best enzymologist you can be. But the mentorship is what's going to give you that direction.’” His support of Joy’s academic pursuits and goals helped her make her final decision and join her current lab. As with her family, her husband seemed to help reduce barriers and stress to allow Joy to focus her energy and attention on her degree progress and academic goals.

Theme 3c: Friends’ Support

In our discussions Joy highlighted the importance of her friends and cohort mates as a main source of social and emotional support. Joy described her friend relationships from her time in Community College and her undergraduate institution as the main source of social and emotional support for her. When I asked her who she turned to for social and emotional support, Joy said, “I would say the first people I go to are the best friends that I made in my Community college. Because they've been there through a lot of things. Second, I would say my best friends at <undergraduate institution> and then after that a kind of varies.”

I further asked what kinds of support they provide and Joy commented,

> I talk about my grades, though they'll definitely be like 'Okay well now gotta do better'. So, they're really good at like upping me. But in terms of like my best friends and they're even some best friends that are going to Grad school. So, actually, I have a best friend who's going to Grad school, I have another one who's doing a Post-Bach. One who's going to be applying to industry and just kind of talking about my experiences to them or ranting with them, I really feel understood and heard, which I think it's really important too.

Feeling heard and understood are important aspects of social connection. Joy also seems to have created a social network for herself that she can rely on for not only social and emotional support but also for academic support. The social and emotional support of her friends also plays a mediating factor in her sense of self-efficacy. As Joy elaborated above, her friends encourage and support her to do her best academically. She also shared, "Friendship support that was, those were pretty strong in terms of, if I needed to vent or I need someone to talk to where I know they would kind of understand, that would be them, that would definitely be my friends."

For Joy, having people who understood her and what she was going through served as a valuable resource throughout her education. When discussing the MARC program, she described her friendships,

> Also, it has helped me to create that kind of community, because there's a couple of friends that I met through the program that I still talk to, to this day. And it's just a really great way to kind of if I have anything that's on my mind, just kind of get it all out there, and just talk to them about it, and they'll do the same and just talking about our different experiences. So, that I would say just those are the main things, not just the intellectual, but also the community that I ended up gaining from that.

Although Joy relied heavily on friends and community from other parts of her educational background, she also brought up multiple instances where her current cohort has been a great source of support for her emotionally and socially. As a first-year student, Joy had not been with her cohort mates for very long, but it was clear that the relationships were of value

and aided Joy's sense of belonging and her self-efficacy. As discussed earlier, Joy described when she was struggling in one of her courses and she and her cohort mate sought help "together" and that really helped her in accessing support from her program. Joy also expressed that her cohort mates were a place where she could vent her frustrations or challenges with graduate school. She said,

> I think in terms of my cohort, they're really great for social and emotional support. A lot of times we start ranting to each other about something we didn't like in the class or a way that a student reacted. And I think it's a really great support system where we all know that we don't hate what's going on, but we just want to vent a little bit, and that's totally okay, it's like a place with no judgment.

This safe space to vent and access support helps build students' sense of belonging and social integration. She mentioned an instance, with another member of her cohort, when she and her husband were sick and quarantining,

> I had a one of the other members of my cohort, so, so, sweet. He brought us, brought my hubby and I, when we were in quarantine, brought us like a little baggie with like teas and medicine and cough drops and honey. It was just really sweet, and knowing that I had that kind of support group was just, it was so touching. It was amazing.

As described earlier, Joy also is working with a cohort mate to develop a club for Hispanic students on campus to help build a scientific community for other URM students to participate in too. All of these examples point to the value of strong relationships in accessing social and emotional support and how these relationships mediate other psychosocial aspects that contribute to URM student success and degree completion in higher education settings.

Joy's Story within the "Whole-Self" Framework:

The "whole-self" framework shows the interplay between different types of support and factors that can aid in the success of URM graduate students in STEM fields. Although individual support components were analyzed in this case study, it is important to show how

these factors are interconnected. Combining institutional factors and support, academic support, and social and emotional support, helps illuminate the factors that contribute to or inhibit Joy's sense of belonging, self-efficacy, and social integration. A strong and positive sense of belonging, self-efficacy, and social integration have been shown to positively influence URM students' academic success, especially in STEM fields (Bandura & Schunk, 1981; Bandura, 1986; Maton, et al., 2016; Strayhorn, 2008, 2018; Tinto, 1975, 1987; Tomasko et al., 2016). By centering the student and their lived experiences, the "whole-self" framework creates a lens through which Joy's experiences in graduate school can be viewed. It also helps show why certain factors may be prioritized or activated depending on the situation the student is facing.

Understanding the institutional factors that Joy considered helpful show how the "whole-self" framework supported Joy's decision-making process and was influenced by her previous experiences and social network. Institutional factors and support play a large role in how students will experience belonging at their institution and program of study, how they will socially integrate, and their sense of self efficacy. The importance of staying close to her social and emotional support network was a top priority for Joy and her academic success when choosing an institution and program of study. This shows how the connection between an institutional factor, like geographic location of an institution, is related to psychosocial factors such as family support. The student's belief that family support was a major component to her academic success influenced her decision to join her current program. The relationship between these factors help show how Joy's decision was shaped. Although each factor can be viewed in isolation, when combined, the contextual landscape in which the student finds themselves can be better illuminated.

Issues related to diversity can also impact a student's sense of belonging which has shown to be a mediating factor to their academic success, and acts as a strong predictor of retention in URM student populations (Quarterman, 2008; Strayhorn, 2008, 2018). As shown in the "whole-self" framework, the level of diversity at both the institution and program level are related to the students' perception of belonging and social integration. As reported by Joy, she did feel socially integrated and belonged in her program and on campus, but agreed that increasing diversity was one institutional factor that could be improved. Diversity, or lack of, can impact a student's sense of belonging and overall academic outcomes, such as retention and completion of degree, for URM students in STEM based doctoral programs.

Having access to affordable and consistent housing not only impacts Joy's sense of belonging at her institution, but also removes the stress related to navigating an expensive and unpredictable housing market off campus. Living on campus also allows for students to socially integrate with other members of the graduate student community at their institution. Social integration has been shown to contribute to URM student's persistence to degree in STEM fields (Tinto, 1975, 1987). The proximity of housing to the campus also contributed to her sense of self-efficacy and her belief in her ability to succeed academically. Joy confided in me that she does not know how to drive and relied heavily on her parents, and now husband, to get her to and from school, especially during the pandemic when public transportation was greatly impacted. Removing a barrier, like how she would get to campus, positively influenced Joy's academic success and provided another layer of support for the student.

Multi-tiered financial benefits such as access to student housing, food pantries, proximity to the campus, and the benefit of Joy's husband being able to find employment more easily created a reasonable financial package that Joy agreed was best for her and her husband and

ultimately, her success as a student. Access to stable financial support and other financially related institutional benefits, discussed above, helped Joy feel secure in her ability to focus on her studies and be successful in completing her degree. These factors positively influenced Joy's sense of self-efficacy, or her belief that she could accomplish her goals and be successful in her degree program.

Joy's identity as a scientist is also an important consideration when viewing her experiences through the "whole-self" framework. For Joy, working on research that was meaningful to her at an institution that would aid in her development as an independent researcher was another top priority when selecting her institution and program. This support for Joy to develop her identity as a scientist is a major factor impacting self-efficacy which has been shown to aid in the academic success of URM graduate students (Bandura & Schunk, 1981; Bandura, 1986; Carlone & Johnson, 2007; Chemers et al., 2011; Hernandez et al., 2013; Maton, et al., 2016; Rodriguez et al., 2019). She relied heavily on the advice of previous mentors from her earlier educational pursuits and her participation in academic success programs when identifying her current mentor. She considered the level of academic support and hands-on mentoring she needed before she selected her current research lab. As she discussed with me, having a mentor that was available, supportive, and knowledgeable was more important to her and her development as a scientist than working on a specific project. Mentorship relationships and a strong sense social integration are not only institutionally important for URM students, they can also provide academic support and social and emotional support, showing how the "whole-self" framework, and the interplay between these different types of support can be used to conceptualize how this student experiences and accesses support.

Mentorship relationships helped shape many of Joy's past and current educational experiences and serve as a main source of institutional, academic and social and emotional support for Joy. These relationships in addition to the friendships she developed through her past education and participation in academic success programs also help Joy feel like she has a strong social network and is part of a scientific community. Building a sense of scientific community helps socially integrate students and as discussed in previous chapters, this aids in students' persistence and retention in STEM fields (Carlone & Johnson, 2007; Gandara & Maxwell-Jolly, 1999; Hernandez et al., 2013; Maton, et al., 2016; Tinto, 1975, 1987; Wilson et al., 2014). Joy's participation in the MARC program, discussed earlier as a source of academic support, also served as the beginning of many of Joy's current best friendships. Joy relied heavily on these friendships as a source of positive social and emotional support. Her current cohort mates also served as a source of social and emotional support for Joy. She discussed that having others who understood what she was going through in her educational pursuits was a source of positive support. These friendships helped reinforce her beliefs that she could succeed academically and that she was not alone in the challenges she faced during her doctoral program. She also relied on friends for academic support, for example, when she and her friend chose to change a grading option, they did so "together". Joy's opportunity to create a scientific community and maintain friendships point to her success academically and her persistence to reach the doctoral level of study.

As shown above, sense of belonging, social integration, and self-efficacy, are some of the components included in the "whole-self" framework, that influence what kinds of supports students prioritize to achieve their academic goals, whether that be institutional or programmatic factors, academic support or social and emotional support. These factors have been shown to

positively influence URM student's perceptions of support and feeling connected, in addition to supporting their academic success (Bandura & Schunk, 1981; Bandura, 1986; Carlone & Johnson, 2007; Maton, et al., 2016; Strayhorn, 2008, 2018; Tinto, 1975, 1987; Tomasko et al., 2016). Understanding the full landscape in which a student presents themselves can help identify areas in which institutions and doctoral programs can provide interventions, resources, and additional support to URM students to positively impact their graduate school experiences and ultimately the path to degree completion.

Case 2: Stephanie- The Reserved Researcher

Stephanie is a first-generation Mexican American Graduate student who studies Cell and Molecular Biology. Stephanie is the second oldest of four children and the financial hardships and considerations of pursuing higher education were one of her top priorities, especially coming from a larger family. She was born and raised in Southern California and holds two undergraduate degrees and a master's degree from well-known Universities in the region. Stephanie's love of science developed at a young age. Starting in middle school she participated in the Mathematics, Engineering, Science, Achievement Program (MESA). Through her participation in this program, she not only made friends, she also got the opportunity to improve her math and science skills through weekend classes and tutoring, do experiments and also access information about college prep. She shared that when she got to high school the program was no longer available, stating that the program didn't have funding to continue their efforts. Stephanie exuded happiness when she spoke of her time in the MESA program.

Despite the financial barriers associated with pursuing higher education, Stephanie was determined to meet her educational goals. She received her first bachelor's degree in Biology

after completing high school at a competitive R1 institution in Southern California. She then went on to work at a middle school after-school program and started taking classes towards a second bachelor's degree in Chemistry. While working on her second bachelor's degree, Stephanie participated in the Hispanic Serving Institution Program (HSI Program), which is a program focused on improving STEM outcomes for Hispanic students. Through this program she had the opportunity to participate in extensive research which she explained encouraged her to pursue graduate school.

After finishing her second bachelor's degree, Stephanie took 6 years off from school to work and save money to go back to school. She informed me that during this time she did some work that was just for income, and later had the opportunity to work in STEM-based employment. This helped keep the fire and excitement for science burning inside her and when she was ready, she went back to school to pursue a masters in Biological Sciences. It was there that she really honed in on her research goals and interests. After completing her master's degree, Stephanie took another two years off from school and during that time she continued working and kept busy applying to PhD programs.

Currently, Stephanie is a fourth year PhD student who recently advanced to candidacy. She reported that she feels very supported and on track to finish her doctoral degree in the next two years. She is in a "Joint Doctoral Program" that straddles two Southern California campuses, with mentors and coursework at both. Her research focuses on studying skeletal muscle development using genetics and molecular biology to understand the transcription factors that regulate skeletal muscle specification and differentiation. She is also actively involved with cultural groups on campus such as SACNAS, serving in leadership positions at her local chapters.

Stephanie participates in outreach programs for other URM students with the goal of getting them interested and excited about science. She recounted using the story of Spiderman to communicate the science of genetic modification to younger students, helping these students relate to the higher-level concepts they were teaching. She pointed out another experiment she does with younger students using strawberries and toothpicks to extract DNA. As she explained this is an easy demonstration and experiment that can be done in classrooms and does not require being in a lab or using expensive equipment. Making science accessible and exciting for younger students was something that Stephanie said was important to her. She also expressed that this type of outreach also worked towards advancing the goal of increasing diversity in STEM fields.

Although Stephanie could be considered reserved in nature, nodding in response to questions, answering questions succinctly and with few words, she spoke of her experiences openly and honestly. Stephanie's smile shined brightly as she described her story of falling in love with science, her future goals, and the gift of sharing science with others. Stephanie is also an integral part of her doctoral cohort, helping organize social events and providing social and emotional support when needed. Stephanie enjoys playing board games, baking, spending time with her husband and playing with their dog.

Stephanie was interviewed twice, eight weeks apart, with each interview lasting a little over an hour. We discussed her background, how she came to love science, her past academic pursuits, how she decided on her current institution and other factors that have helped her get to where she is today. Stephanie revealed many insights during the interview that helped paint a picture of exemplary support academically, psychosocial factors that aided her academic pursuits, and institutional factors that helped her succeed in her studies. For the purpose of this

analysis, there are three major themes that will be presented along with sub themes that emerged through multiple iterations of data review and analysis. The themes include, institutional supports and factors, academic supports and factors, and psychosocial supports. Many of these themes interplay with each other and layer upon one another in support of the "whole-self" framework used to conceptualize this study. No one theme is independent of others and the connections between certain themes and theories will be described in further detail at the end of this case.

Theme 1: Institutional Supports and Factors

When interviewing Stephanie, it was clear that choosing her doctoral institution and program of study were decisions that were not taken lightly. Many factors played into her decision to join her current program and institution. She consulted with family, friends, and mentors from her undergraduate education and considered their advice when making her decision. Ultimately, four major sub-themes were ever present when we discussed anything having to do with her choice to attend the current program. The sub-themes described below, touch on areas relating to self-efficacy and sense of belonging, two important factors in URM student retention and persistence to degree completion (Bandura & Schunk, 1981; Bandura, 1986; Maton, et al., 2016; Strayhorn, 2008, 2018; Tinto, 1975, 1987; Tomasko et al., 2016).

Theme 1a: Campus Location, Climate, and Diversity

Stephanie was very open about how she came to her final decision on which program and institution she wanted to join. She shared that as a URM student, issues of racism and lack of diversity were big factors she considered when reviewing potential institutions she would apply to. One of her main reasons for selecting her current institution was the location. When asked about why she chose her current institution, Stephanie said "I really wanted to stay in Southern

California. And, especially because there's a lot of diversity",. She also said "Just because I was a little bit afraid of racism, because going through the program it's hard in itself, and I didn't want something else added on to that", when discussing potential programs in other parts of the country, based on advice from friends she spoke to who attended graduate programs in less diverse areas of the country. Staying in Southern California also allowed her to stay close to her family, which was another important point in her decision making. It was clear from her thoughts that a sense of belonging was significant to her and diversity was one way in which she could establish that sense of belonging. When asked if she believed the institution and program she attended supported diversity and represented a diverse mix of students, staff and faculty, she reported,

> I think since I've been there they're really trying to increase diversity in the program. I've definitely seen that, and so you know, that that keeps, that gets me motivated, it's like 'cool, like, you know, there's, there's more of me in there'.

Even though it was very important to Stephanie to attend a diverse and inclusive program and institution, she acknowledged that there is still work to be done. As she explained, seeing "herself", meaning others from underrepresented backgrounds, represented in her program of study was something that was of great importance for her. The literature supports increasing minority student populations on campuses as a method of recruiting racially diverse doctoral students (Hernandez et al., 2013; Whittaker & Montgomery, 2012). It has also been shown that when students see their own identities represented in their programs they feel a stronger sense of belonging and are better able to socially integrate themselves, whereas students from underrepresented backgrounds can feel like they don't belong in predominantly White institutions and programs of study. (Quarterman, 2008; Strayhorn, 2008, 2018). Even though

she overall felt supported and a part of her institution and program communities, she reported that it was a challenge for her being the only Mexican woman in her lab for some time.

> And yeah as a minority, because the lab I was in was very new, I think I was the only Mexican for about two years. Until we started getting some more diverse undergrads. Um, it was diverse, you know, there wasn't just Caucasians. There is like members from the Asian community and from India as well, so sort of like international. But just being like the only Mexican it's like well like 'I don't know if, like you know, if people understand me, like my culture and things like that', but it's definitely something that I noted and I am happy that now, we do have more Mexicans in there.

Theme 1b: Financial Support

Another important factor for Stephanie when deciding on a program and current institution was financial support. When we discussed financial support as an important consideration in her decision making, she said,

> I grew up in an immigrant family, so finances were definitely a burden in the family, just because there wasn't enough money. Especially with three other siblings who also went to college, and so I knew my parents weren't going to be able to financially provide for all of us, and so that is why that was like a main reason.

She highlighted that she selected her program and institution because of specific financial incentives they provided. Most importantly, coverage of tuition, benefits, and stipend, she said,

> Making sure that I received a basically full tuition and a stipend, just so that I can live off of because from my understanding, back then, was that Grad school takes a lot of your time and you can't necessarily work on the side.

Through our discussions, Stephanie mentioned various times during her education when she took breaks from school so she could work and support herself. Financially, graduate school can seem unattainable for many students and weighs heavily on their decisions. As Stephanie noted during our interviews,

> I really wanted to join a program where a stipend was provided and there's some programs that there's no money basically for PhD students. You're kind of on your own to support yourself.

This highlighted a concern that many first-generation students face when deciding on continuing in higher education.

Another financial consideration that was important to Stephanie was a program that supported her research goals financially. Stephanie was granted an external fellowship, which helps provide funding for her lab materials and supplies as well as travel funds to allow her to attend scientific conferences and present her findings in true scientific settings. This aids in her identity development as a "Scientist" and her self-efficacy as a scientist. "Yeah, I have access to travel funds through the department. And so, we can apply to that (...) priority is given to those like presenting at conferences and then just to those participating at conferences, depending on the budget." Stephanie recounted her travel to Costa Rica for a conference with a proud smile and sadly reported that another conference she was excited to attend was canceled due to COVID. It was clear that the travel funds provided by her program helped her, as a student, better manage the financial burden that is associated with attending academic conferences. Attending academic conferences allows students to develop relationships with other scientists and students, adding to their science and social networks which aids in their social integration. It also provides the opportunity to present their research to their peers and engage in authentic discussions regarding science, which can improve students' self-efficacy and identity as a scientist (Carlone & Johnson, 2007; Gandara & Maxwell-Jolly, 1999; Hernandez et al., 2013).

Although Stephanie reported overall satisfaction with the financial support package provided by her institution and program, she did mention that she and her cohort mates do wish it

was higher. She discussed that she hasn't felt the financial hurdles of being a student on a fixed stipend as much since she is married and her husband also has an income that they share. In our discussion she describes her current financial stipend, "Yeah it is pretty low compared to other campuses and <current institution>. Um and I know, like to live out here it's quite expensive, and so we, you know, myself and other students, we wish it was higher." Later in our interviews, she mentioned this again, "But I know that some of my classmates really struggle to make ends meet, and you know they constantly like to share that it's not enough money and yeah we all, we all wish it was more." As a student with a working spouse, Stephanie was aware that her personal situation eased some of the financial burdens that other students in her program faced, acknowledging that financial support provided by her program and institution does not adequately cover the needs of all graduate students.

She also recounted a programmatic financial incentive in which students' stipends are increased after Advancing to Candidacy, a major milestone of academic progress for doctoral students. Bureaucratic and unclear policy created confusion for Stephanie on when she could expect her "raise" in stipend. As it turned out, these raises in stipend took effect the semester following her successful advancement, causing Stephanie to wait for her raise to take effect from late summer through January of the following year, which was much later than expected. When asked if this created any financial hardships for her, Stephanie said, "I think it would have if I was single. Thankfully, you know, I have a husband who works full time so I'm not living, you know, paycheck to paycheck, thankfully."

Theme 1c: The Science

Another important factor for Stephanie when deciding on an institution and program of study was the types of science being done at that institution. Access to labs and mentors that

were doing research that aligned with her research goals played a role in her decision-making process. For Stephanie, choosing an institution that allowed her to do the science she was excited about was a major decision point. In our discussion regarding factors she considered when picking a program of study and institution, Stephanie disclosed, "that was one of the main ones (reasons why), because where I am attending, but they do have a couple of labs that specifically study like, either muscle diseases or cardiac muscle diseases and yeah."

She also discussed the importance of learning and growing as a scientist as one of the main goals of her doctoral studies and important to her decision to join her current program and institution.. She mentioned,

> Because in grad school you're learning various techniques that you can apply to learning even more techniques, later on, after you graduate and so, from what I was told is they're training you to be an independent thinker to know how to think, basically, as a scientist.

Stephanie's identity as a scientist and finding a place where she could grow and develop into an independent scientist was very important to her. "So, that's why I not only chose the program, because of what I was looking for in the sense of its diverse, it can financially contribute, you know, to my career, and then also it provided me with the great mentor."

Theme 1d: Institutional Mentorship

As mentioned in the previous theme, mentorship was an important factor for Stephanie in deciding on her current program of study. She shared that when exploring institutions and programs, access to high quality mentorship was important to her and was something she discussed with friends who were already in graduate school, seeking advice.

> Another important thing for me was mentorship. Having a faculty mentor that really understood me. And so, I would ask (her friends), 'What's more important?

> Is it the science that you're doing or is it the mentorship?' and I think about 100% of them said, 'it's the mentorship'.

Keeping mentorship high on her list of priorities when deciding on a program allowed Stephanie to identify a program where she felt that she would be supported and could gain the skills needed to be a successful student and scientist. Mentorship played an important role in Stephanie's past educational pursuits and her current program of study. Mentorship will also be highlighted as a sub-theme in subsequent sections regarding academic support and social and emotional support.

Theme 2: Academic Supports and Factors

Prior to joining her program and during her current doctoral program of study, academic support has played a huge role in Stephanie's success as a URM student in STEM. To better understand how Stephanie accessed academic support, it was important to not only discuss where Stephanie currently is in her doctoral studies but to understand different factors that contributed to her success in reaching the doctoral level of study. I will also review the current academic supports available to the student in their doctoral program in this section.

Theme 2a: Prior Participation in Academic Success Programs for URM Students

Stephanie's current love of science and academic goals began long before the start of her doctoral studies. Through our interviews, Stephanie mentioned different programs that she participated in through her education going back as far as her middle school days. In middle school and high school, Stephanie participated in the Mathematics, Engineering, Science, Achievement Program (MESA). According to their website, MESA "helps thousands of educationally disadvantaged students to become engineers, scientists and other math-based professionals." (https://mesadb.ucop.edu/) As she described it, she participated in extra classes on the weekends, providing support for students in subjects where students typically struggle,

while also participating in science-based activities. When recounting her time in the MESA program, she stated, “so that was like super fun” with a huge smile on her face further adding “I didn't really like that I had to spend extra time at school, but I really enjoyed being there with my friends, so I think that's what made it bearable, and the things that we're doing were exciting, you know, to me, and so, that’s why I kept going”. She also explained that MESA helped familiarize her with college, and that they provided support with writing personal statements as well as providing tutoring services, so the program was a great help to her.

In college, Stephanie participated in another URM targeted research program at her undergraduate institution. According to their website, The Hispanic Serving Institution Program (HSI Program), is a STEM-focused program to “foster Latino and low-income student success by providing culturally relevant enhanced learning opportunities and STEM specific academic support.” (https://web.csulb.edu/programs/hsi-stem/). Participation in this research-based program is what Stephanie states, “Propelled me to eventually go back to school, for grad school. Which I was already in school, but wanted to continue that education.” During her time in this program Stephanie remembers spending up to 40 hours a week in a lab setting over the course of the month focusing on learning different lab techniques. She also said that she really enjoyed participating in this program and that “I guess it made that little spark into a flame, to the point where I was like, ‘Oh, I need to apply to grad school!’”

Participation in academic transition programs and programs targeted at giving URM Students authentic research opportunities help combat issues of the leaky pipeline and help support the retention of URM students in STEM fields (Ashley et al., 2017; Hernandez et al., 2013; Maton, et al., 2016). Stephanie highlighted that her participation in these programs was integral to her continued academic success and pursuits. With their help she was able to be

better prepared for college and graduate school as well as building her confidence and identity as a scientist. They also provided Stephanie with a social network surrounding science and improved her sense of self-efficacy and agency. Another aspect of these programs is mentorship, which will be presented later as its own major theme.

Theme 2b: Current Academic Supports

Stephanie was aware of some academic supports that were available to her through her program and institution, however, she mentioned that she had not yet utilized them. She highlighted dissertation writing boot camps and writing workshops as something the institution provides to academically support doctoral students and that she planned to use them when she was further along in her studies and ready to utilize those resources. She also mentioned a "Graduate Resource Center" that she had never attended but knew it was there on campus. This underutilization of current campus academic supports could be explained by her prior participation in academic success programs which provided her with skills she needed to successfully navigate her doctoral academic needs. The data also highlights other supports that she turned to when seeking academic support. Stephanie seemed to rely heavily on her mentors for academic support and advice, for example, when choosing elective courses, finding ways to improve experiments, and general feedback on her research and scientific writing.

Theme 2c: Academic Mentorship

Stephanie identified her current PI (Principal Investigator/Advisor) as a major source of academic support. She explained how she relied on her PI for guidance on her research, coursework, and professional development. During our interviews, I tried to understand the level to which her current mentor was providing academic support. She explained that they meet

regularly to discuss her experiments and findings and that her mentor was readily available to her, keeping an open-door policy for any questions she might have. Stephanie stated,

> So, depending on what project I'm working on, if I'm expecting to see certain results and I don't see them…if I can't figure out why the reason is that I'm not seeing what I thought I was seeing then I'll go ask and say, 'Hey. This is what I'm doing. This is what, I, you know, hypothesized was going to happen, but it's not happening. I tried this approach, but I'm getting something else. Like I don't know if it's wrong because I'm getting like two different results here', and so we'll just brainstorm and see what other experiments I can do to validate what I'm seeing.

This open communication channel with her current mentor helped her stay on track with her progress to degree. Effective faculty-student mentor relationships can improve academic and career development (Johnson & Hume, 2002). When I asked if she felt academically supported by her PI, Stephanie responded positively, "For support and think it's an eight, probably eight out of 10. Yeah, yeah most of the time I received the support that I need."

Another form of academic support through mentorship that Stephanie talked about is a camping weekend/symposium that her current program also hosts where students and mentors come together to not only socialize, but more importantly to discuss their research. She described this trip in more detail and how she found the trip helpful to her academic and research goals,

> We recently had a camping trip, where there was a mini symposium incorporated in there, where students were able to present their most significant results in the lab. And the faculty were there too, and so they, anyone, was welcome to ask any questions, give any feedback. And so, I think that was really helpful for us, because we're trying to design our experiments and then trying to figure out what happens afterwards and so that was very helpful

As discussed in the literature review, access to a scientific community and feeling socially integrated are critical components in URM students' academic success and persistence

to degree. She confirmed that although being on a camping trip was a relaxed setting, it still felt like the focus was on science and brought together members of her scientific community in a fun and authentic way.

Stephanie also relied on previous mentors for academic support. Through her membership in SACNAS, she met a postdoctoral fellow, who now works at the NIH that she considers a mentor and who she keeps in touch with regularly. When looking for support in her academic writing, Stephanie reached out to this mentor to help her prepare, she told me,

> I came to her, because I was working on my research writing, and so I wanted her help in just going over my different aims. So, when you're ready to propose you physically write an NIH grant style paper to present. And so, I went to her to see if she can help me, and so we met a few times and she edited some of my drafts and in that way, I was better prepared to, you know, pitch my ideas to my PI.

Having multiple mentorship relationships have contributed to Stephanie's positive experiences in receiving academic support while also expanding her scientific network and positively influencing her social integration and self-efficacy. When students feel both academically and socially integrated, this integration can contribute to the retention and persistence of students in STEM fields (Tinto, 1975, 1987).

Theme 2d: Participation in URM-Focused STEM Outreach Programs

Stephanie participated in many opportunities to share her love of STEM with other URM students in an effort to "give back" and help increase diversity in STEM. She discussed working with middle school and high school students as well as college students considering graduate school. Stephanie beamed with pride as she discussed these efforts.

> "Yeah a lot of our outreach programs have been targeted at schools that have a big population of minority students, you know or disadvantaged, financially disadvantaged students, and so I really see myself in those students. That I was at one point, you know where they're at and I'm here now. And like, just helping them see and be hopeful that whatever career they choose to be, it is possible. It doesn't matter if you're, like, financially disadvantaged or don't have the same

> resources the other students have. It's like, if you keep…it's not if only if you keep working for it, but if all these other elements come together, like you're able to reach, whatever your goal is."

This included participating in panel discussions about being a URM in STEM, as well as outreach programs focused on science and preparation for college and graduate school. She worked with the Educational Opportunities program and the Graduate Students Association towards these efforts to help other URM students considering graduate school, stating, "so what they did was provide, um, workshops for graduate school admissions or graduate student life." When asked if she enjoyed participating in these programs she exclaimed that she felt honored, following up that it allowed her to "sit on the other side and talk about all of this" relating back to her opportunities in previous programs when she was sitting where these students are now, helping to engage them in a love of STEM and science.

Theme 3: Psychosocial Factors- Social and Emotional Support

In our interviews, there were many instances where social and emotional support played an integral part in Stephanie's experiences and persistence as a doctoral student in STEM. Social and emotional support came in many different forms, from many different sources. For this analysis, the supports will be listed by the source of support and give examples of the types of support utilized to explain Stephanie's experiences.

Theme 3a: Friends' Support

Friends and cohort mates came up frequently in our interviews. Stephanie relied heavily on advice and the experiences of other friends when applying to graduate school. This social network helped her in understanding what her life would look like as a doctoral student as well as providing her advice on things to be cautious of, such as lack of diversity and lack of financial support. When remembering who she looked to for advice on attending graduate school, she

said, “I did talk to a few friends that went to graduate school or were in graduate school. Just to get a feel for ‘okay, what's what's my life, going to be like once I, you know, I enter the PhD program?’” She also mentioned that as a minority student, friends' support was very important to her understanding of what a graduate school is. She specifically recounted, “You know (being a minority), it was definitely a challenge in the beginning, I didn't know what to expect, aside from you know the few friends that I did have in graduate school or that we're going through it.” and that she turned to them often for support.

Stephanie also mentioned her cohort as a huge support system, not only academically and relating to science, but socially and emotionally. Stephanie emphasized the importance of her social connections with her cohort, discussing different social events and activities she helped spearhead to build in some fun to her studies. She mentioned that in addition to “just supporting each other”, she also helps organize game nights, outings and time to just “chill” with her cohort mates. She discussed the closeness she felt with her cohort mates, and the camaraderie of experiencing something together, which was of particular importance to her as a first-generation graduate student.

> We're a very small cohort (laughter), there's only six of us. Yeah and so, we've kind of, like, basically took on this PhD and we've all at one point or another, you know, had a shoulder to cry on and support each other, and motivate each other, when it was needed. And so, that was very helpful to, you know, to myself, as a first-gen grad student.

The closeness with her cohort also aided in Stephanie’s social integration, sense of belonging, and creating a network that she can turn to for support in times of need. She further went on to describe her cohort, “they were all very friendly. Everyone helped each other out, which is great. It really helped me be, you know, be part of that <current institution> campus. I am very close with my cohort.” This social integration and strong sense of belonging to her

program and institution have helped Stephanie continue through her doctoral program. The relationships she has built will also continue to serve as a network of social support as she continues through her studies to degree completion.

Theme 3b: Spousal Support

Stephanie highlighted her spouse as a source of support for her both during her studies and when deciding on which institution and program to attend. She mentioned staying in Southern California, where she grew up as a key factor in her decision process. She also mentioned her husband as a main source of both financial support, in that he provides a second income, and as emotional support. As discussed in the financial support theme, Stephanie mentioned that having her husband's income relieved much of her Stephanie mentioned that her husband served as an important pillar of support for her every day. When talking about sources of social and emotional support Stephanie said about her husband, "He's someone that I can come home to every day and talk about research lab and anything that went on."

Theme 3c: Mentor Support

Mentorship played a critical role in all aspects of support for Stephanie. In discussing her mentorship relationship with her current PI, I asked her if she felt socially and emotionally supported by her PI, in addition to the institutional and academic support they provided for Stephanie. She stated that she hadn't had the need to reach out for that kind of support from her PI, but believed they would be a trusted option if she needed it, based on other's experiences in her lab. She asserted,

> Yeah, I can definitely see them helping me with, you know, any issue I would have or any question I would have or advice I would need outside of academia. And so, I think they'd be super open to that. And yeah, and I just know of lab mates who have, you know, have talked to my PI and people that have rotated in

> my lab, that come back and talk to my PI about things outside of academia, and so I know that they will be very helpful.

When meeting with Stephanie, she also made known that she is part of a diversity mentorship program that is supported by a large local biotech company. This mentorship program, she explained, was very open-ended providing those who are part of the diversity mentorship program with a list of scientists from underrepresented backgrounds who were open and available to provide mentorship in any capacity. The website lists the scientist with a short biography so that participants can identify the right person to go to with their questions. Based on what she shared with me there are roughly 20 scientists available to schedule time to talk with and she had already spoken to 4 of those mentors. I asked her what kinds of things she discussed with them and she replied,

> So, you're able to schedule a one on one meeting, and so you can ask whatever questions you want. I would typically ask how they either transition from graduate school to postdoc to scientists, or just directly from grad school to becoming a scientist. And how, for some of them, they change careers, a little bit, not so much a completely different career, but transfer from one position to another in the same company. So, I typically ask them, 'What skills do you need to be in certain positions? What should I be working on now?', just things like that.

Having access to support from other scientists from underrepresented backgrounds can help improve URM students' sense of belonging outside their programs of study and institutions and inside the larger scientific community. This also improves their social integration and building of their scientific networks.

Stephanie's Story within the "Whole-Self" Framework:

Stephanie's case was an example of how positive interactions with support at the institutional, academic, and social and emotional levels can yield positive experiences for URM students. Using the "whole-self" framework to understand Stephanie's experiences shows how

interactions between different types of support and factors can positively impact a student's sense of belonging, science identity and self-efficacy, and social integration. As shown in the literature review, these psychosocial factors are an integral component to URM students' academic success and persistence to degree, especially in STEM fields (Bandura & Schunk, 1981; Bandura, 1986; Carlone & Johnson, 2007; Maton, et al., 2016; Strayhorn, 2008, 2018; Tinto, 1975, 1987; Tomasko et al., 2016).

When reviewing Stephanie's case, it becomes clear that institutional factors such as campus location, campus climate, and diversity were important decision points for Stephanie. These institutional factors can be viewed individually, but as we spoke and I peeled back layers of Stephanie's story, we saw that these factors were also influenced heavily by her systems of social and emotional support as well as her desire to experience a sense of belonging. Students from underrepresented minority groups often do not feel they belong in predominantly White institutions which can create barriers to the retention and successful completion of degree. (Quarterman, 2008; Strayhorn, 2008, 2018). As Stephanie indicated in our interviews, she knew graduate school was going to be hard, and wanted to remove as many external barriers as possible. Selecting an institution she felt could support her and other diverse students was one way to protect against external factors like racism and feelings that she didn't belong in her program and study. Relying on advice from friends when looking at institutions further shows how a student with a strong social network can benefit from the collective knowledge of their friends and peers.

Other institutional factors such as financial support and access to the science Stephanie was interested in pursuing also played a critical role in her decision to join her current doctoral program. These institutional factors help support the student's development and identity as a

scientist, while also improving their self-efficacy, or the belief that they can accomplish their goal of completing their doctoral studies (Bandura & Schunk, 1981; Bandura, 1986). Science self-efficacy has been shown to relate to persistence, tenacity and achievement in educational settings (Bandura & Schunk, 1981; Bandura, 1986; Carlone & Johnson, 2007; Chemers et al., 2011; Hernandez et al., 2013; Maton, et al., 2016). Financial support helps alleviate some financial stressors and allows the student to pursue their academic goals without having to take on outside work to support themselves, creating an environment in which the students can focus on their academic and research goals. This combined with access to research that aligned with student goals, positively influenced the student's science self-efficacy providing her with a supportive institution to grow, learn and develop as a scientist. Academic support, like her prior participation in academic success programs, also helped positively influence her science self-efficacy, providing her with access to authentic research opportunities, the ability to improve her science and math skills, and also develop a science social network. This could be why, although she mentioned that she was familiar with campus level academic support resources available to graduate students, Stephanie did not access these types of support. Stephanie's confidence in her abilities and strong identity as a scientist also plays a role in her providing outreach to other URM students who might be interested in pursuing higher education and STEM fields. All of these factors combined create an environment where she is able to excel and achieve her scientific and academic goals.

For Stephanie, mentorship was an integral support system at the institutional level, academically, and for social and emotional support. Stephanie relied on her current mentor and past mentors for support in multiple ways including seeking an institution at which she could find a strong mentorship relationship, academic guidance and support, and future career

development. Strong mentors and effective faculty-student mentor relationships provide useful advice to students regarding educational planning and career development and can have a positive impact on the student's educational trajectory (Baker & Lattuca, 2010; Chemers et al., 2011; Johnson & Hume, 2002; Maton, et al., 2016; Robnett et al., 2018). Stephanie's relationships with her mentors and cohort mates helped her build a scientific community which is an important factor for students to feel socially integrated. Stephanie discussed how this social integration built her sense of scientific community through sharing her experiences, attending academic conferences, relying on her mentors for academic and career support, and attending her programs camping symposium. Although Stephanie did not explicitly state social integration and strengthening membership in her scientific community as goals of the examples we discussed, it was clear that these instances positively influenced her academic support experiences while also helping her feel socially and emotionally supported.

Social and emotional support, although explicitly defined in the three areas of support from friends and cohort mates, from her spouse, and from her mentor, was something that was interwoven throughout our conversations. Institutional factors she considered were weighed with her friends and spouse, showing that social and emotional support systems cannot be separated from institutional factors. Her spouse played an important role in her social and emotional support network, but also helped remove some of the financial struggles that her other classmates were experiencing. She also relied heavily on her cohort mates and their tight knit relationships for academic support and she turned to them when she needed someone who just "understood" what she was going through, meaning her graduate student experience. Her strong social network and integration with her cohort also allowed Stephanie to feel like she belonged in her program and at her institution. She explained that she not only looked to her cohort mates

for social and emotional support but also for academic support sharing instances when she needed supplies for her experiments or wasn't sure what direction to go in scientifically. Using Strayhorn's theories on the sense of belonging, which states college students' perceptions of support and feeling connected influences their persistence, retention, and completion of degrees, especially for URM students in STEM, the positive role these supports play in Stephanie's academic success are illuminated (Bandura & Schunk, 1981; Bandura, 1986; Maton, et al., 2016; Strayhorn, 2008, 2018; Tinto, 1975, 1987; Tomasko et al., 2016).

Stephanie expressed her overall satisfaction with her graduate school experience while also expressing that there is always more work to be done in terms of increasing diversity and some aspects of student support. Stephanie's case is an example of how institutional factors and supports, academic support, and social and emotional support can positively influence a students' academic persistence and success. Through the "whole-self" framework, we can see that positive interactions with different multi-tiered systems of support can add to a strong sense of belonging, science self-efficacy, and social integration through mentorship and personal relationships. Stephanie's experiences can serve as an exemplar of how positive interactions with the different types of support can help URM students in doctoral programs in STEM thrive and persist to degree completion. This case adds support to the value of the interconnectedness of the factors outlined in the "whole-self" framework.

Case 3: Dres- The Award-Winning Activist

Dres is a first-generation Mexican American graduate student from Fresno, California who studies Biology. Dres is the youngest of two children, and he expressed that his love of science began at a very young age. On a trip to the library with his mom at age 5, Dres discovered that his interest in bugs could lead to a career, and he was hooked. He recalled that

many people found it strange for a young Mexican boy to know what an entomologist was, but at the time he was set on pursuing a career in entomology from that day forward. Dres recalls that this was his first introduction to higher education and advanced science degrees. Dres is the first member of his immediate family and his entire lineage to obtain higher education and earn an advanced degree.

His father and mother had Dres' brother when they were a senior and junior in high school, respectively. Although both finished high school, neither pursued any education after that. Dres explained that his father continued on to become a correctional officer, taking some additional courses in criminology, but that there were no degrees earned after finishing high school. As Dres described, "they just did what they could to finish." Dres' told me that his older brother by 10 years, just recently completed his bachelor's degree.

From a young age, Dres was drawn to science, he explained that the drive to pursue science was all internal and could not recall a time when anyone around him was interested in science or tried to get him interested in science. Although his family was supportive of his love of science, they did not have access to the tools or resources to engage with him in his love of science. He emphasized that shows on Public Broadcasting, such as The Reading Rainbow and The Magic School Bus, helped expose him to more science, further stating that shows like these can help young kids learn about science. In the third or fourth grade, Dres participated in the Science Olympiad, an after-school activity at his elementary school. Dres described his elementary school as a school with many underrepresented minority students and a high number of students participating in the free and reduced lunch program. Dres' participation in his elementary school's Science Olympiad program really cemented his love for science. He recounted his disdain for playing soccer, among the other sports he participated in as a child,

having to wake up early and play in the cold temperatures in the mornings and the extreme heat of summer. He shared that after joining Science Olympiad, he opted to drop his other after-school activities. When discussing dropping his other activities to focus on the Science Olympiad, Dres described, "And so, with something like this (Science Olympiad), I'm like, 'I'm indoors. I get the AC, this is more my vibe. I get to use my brain. Okay, this is what I like.'".

After elementary school, Dres attended a magnet middle school. Although the school did not have a focus on STEM, it did provide expanded educational opportunities to Dres. During middle school, Dres was able to access more science and math courses that furthered his love and interest in science. Dres also confided that around this time, he developed a hate for the smell of fresh cut grass. One of his chores was helping his dad with keeping up the backyard, but this usually meant waking up in the early morning before the day got too hot and before his dad went to work, to mow the lawn. Dres elaborated that it was then when he decided he didn't want to do manual labor for the rest of his life. It was then he decided he wanted to continue his education, adding,

> Because my parents always pushed education, because they knew that was the way to get out, because of what they had to do. And you know, oftentimes, especially male Mexican people in California, end up having to do a lot of manual labor and I was not having that. I was getting out of that cycle any way I could.

Dres claimed that he found solace in science, even though he didn't fit the stereotype of what many people expected a scientist to look like. After finishing high school, Dres attended a local public university for his undergraduate studies. During his time an undergraduate student, Dres was involved in many programs for historically excluded groups. He was a McNair and Louis Stokes Alliances for Minority Participation scholar. He also was part of the Geosciences METRO (Mentoring, Education, Teaching, Research, & Outreach) center at his institution which provides students with up to three years of financial support while they pursue research

opportunities. Dres took advantage of the opportunities available through these programs to further his access to research and help support himself financially through his undergraduate career. Dres also started a local chapter of SACNAS (Society for the Advancement of Chicanos/Hispanics and Native Americans in Science) at his undergraduate institution, helping connect other URM students on campus who were pursuing science. He graduated with a Bachelor of Science in Biology.

After receiving his B.S. in Biology, Dres was off to pursue a PhD in a biomedical sciences program in Texas. Unfortunately, during his time in Texas, both his mother and father fell ill, and Dres had to make the hard decision to discontinue his studies so he could be closer to home and his parents. He noted that financially, it was too challenging to travel back and forth and that his desire was to be with his family during this time. Once he returned to California, Dres focused his attention on finding a new PhD program which would align with his research interests and provide him with the opportunity to continue his PhD studies. Dres had previously advanced to candidacy while in his first PhD program, and actively and voraciously began researching different institutions and faculty that aligned with his academic goals. After identifying potential good fits, Dres traveled from institution to institution, all over the state, meeting potential future mentors and presenting his work, essentially interviewing labs and being interviewed himself, at the same time. After this process, Dres identified his current mentor and institution and began the process of being admitted as a transfer student, which is rather uncommon for PhD programs. Dres worked hard to meet the requirements of his new program while preparing to re-advance to candidacy, taking on multiple teaching assistantships, and getting his family settled in Southern California.

Dres is not one to shy away from the challenges faced when starting midstream at a new institution and continues to do exemplary research at his current institution. Dres' research uses single-cell biological approaches to understand metastasis, which is the spread of cancer cells from the place where they first formed to other parts of the body. He explained that this is an important problem since metastasis is responsible for the majority of cancer-related deaths. His goal is to help discover universal features of metastasis which will be critical for early detection and treatment decisions in the future. During his time at his current institution, Dres was selected as a Howard Hughes Medical Institute Gilliam Fellow, a National Academy of Sciences Ford Fellow, and an F31 Diversity Supplement fellow, in addition to a fellowship he brought with him from his institution in Texas. In addition to these prestigious fellowships, Dres is also a principal member of the Delta Alpha Pi (DAPi) Honor Society for students with disabilities and one of the inaugural speakers in the successful lecture series at his current institution, "Diversity and Science". Dres was the recipient of a Graduate Teaching Mentorship award and other awards given through his program. He also started a SACNAS chapter after arriving at his current institution.

Dres is married and has two kids under two, both born during his time at his current institution. In fact, his wife went into labor during our first scheduled interview, which was obviously rescheduled. With all of his responsibilities, Dres manages to be a supportive, engaged, and loving son, husband and father. Through our discussions it became very clear how important Dres' family is to him and to his success academically.

At the time of writing this, Dres has successfully completed his PhD and is moving on to an IRACDA (Institutional Research and Academic Career Development Awards) Post-Doctoral fellowship. The IRACDA program focuses on combining traditional mentored postdoctoral

research with opportunities to develop academic skills like teaching, which is one of Dres' future goals. Dres is known for his mentorship and is developing his skills as a URM STEM activist. He focuses his mentorship on supporting other students from underrepresented backgrounds and historically excluded students. He stressed that he works tirelessly to engage his community from middle school to community college. That engagement, combined with his time in the lab, inspires him to provide historically excluded students with the opportunity to perform quantitative biomedical research. Dres indicated that he hopes to become a professor so that students like him can see themselves in higher education.

Dres was interviewed twice, seven weeks apart. Dres and I spoke for over 3 hours, helping me understand his family history, educational background, his love of science and activism, his research goals, and what he found most important to his success as a student on the cusp of finishing their doctoral studies. Although Dres did not always have the most positive experiences during his doctoral studies, his love of science and his drive to improve diversity in STEM were always kept in the front of his mind. The following analysis will present the major themes and sub-themes that emerged through our discussions and through an iterative process of data review and analysis. Centering the "whole-self" framework in this analysis, each theme can be viewed independently, however the interconnectedness of the themes and sub-themes highlight the framework's strengths and can aid in developing policies and methods to better support URM students at the graduate level in STEM fields.

Theme 1: Institutional Supports and Factors

Even as a transfer student, Dres had many considerations when selecting his current institution and program of study. Dres had a strong sense of what he was looking for in his new institution and program, but still relied on the advice of his mentors and his family. Institutional

factors and supports greatly impact how URM students experience their time as doctoral students (Ashley et al., 2017). Whether it be the students' social integration, sense of belonging or their future career development, these factors cannot be overlooked. Using the "whole-self" framework, which helps illuminate the role of institutional support in how URM students experience graduate school, the following breakdown will describe in more detail each sub-theme that developed during my data analysis.

Theme 1a: Campus Location and Benefits

As a student transferring from another PhD program to his current institution, Dres had a very narrow set of criteria that he was looking to satisfy. Dres considered many institutional factors in his decision to join his current program which will be discussed in more depth in subsequent subthemes. Dres' top criteria was finding an institution in California so he could be closer to his family. After moving back to California, Dres spent his time out of school applying to different institutions in the state so he could continue his PhD studies. Dres said, "I knew I might have to start over, but I was like, 'Okay, <sigh> I've done it once, like you know, just do it again."".

Knowing that he might have to start over in a new program did not deter Dres. He continued forward trying to identify the right place for him to continue his PhD studies. During our interviews, Dres informed me that one institution he was considering was not the right fit due to the lack of diversity on that campus and the city the campus was in, which is predominantly white and conservative. The decision to not attend that campus was made clearer when he discovered housing would be challenging to secure as well.

Another important factor for Dres, was access to quality and affordable health insurance. Dres shared that at his previous PhD institution, the health insurance coverage worked on a

reimbursement system, where students had to pay for all expenses out of pocket then be reimbursed by the insurance. This, he explained, created financial challenges for him as a student who was living on a limited and fixed income. He was interested in finding a health insurance plan at a new institution that did not work on a reimbursement payment model. Dres recounted,

> I learned the hard way at <previous institution>, when they switched to the academic health plan, is that you have to pay everything up front, but they weren't offering any opportunities to get like a student loan to pay everything up front, but they didn't pay us enough to pay everything up front, so then they expected us just put it on credit card. So that was, like I learned that lesson.

Knowing he and his wife were planning to start their family combined with the fact that he has a chronic illness and disabilities, he knew from previous experience that access to easy to use and affordable health insurance was another top priority when selecting his current institution. He recalled a conversation with his current mentor before making his decision to join his current program of study.

> So, when I spoke with my PI (principal investigator/mentor), since I was a different stage graduate student coming to <current institution>, we had talked about, with my partner, that we could possibly end up starting a family. So, that was a consideration to have insurance, you know, 'How does this work? What are the family considerations? What is the insurance? How much is the insurance?'.

The previous challenges with health insurance helped Dres make a more informed decision when selecting his new program. This highlights the importance of institutional benefits to students when selecting their institutions and programs of study. The "whole-self" framework helps reinforce that students bring with them many experiences and identities which help inform what supports they rely on to achieve academic success.

Theme 1b: Financial Support

Speaking to Dres, as he prepared to complete his PhD program, he reflected on the financial support many times. Overall, Dres felt that graduate student financial support, especially for URM students, was inadequate and inequitable, at his current institution. Dres explained, the main difference between his previous institution and his current institution is that money stretches further in certain locations, as cost of living can vary dramatically depending on the city. This gave Dres the feeling that he was better financially supported at his previous institution, stating his current city has a very high cost of living. Although he mentioned considering financial support as a decision factor when selecting his current institution and program of study, Dres mostly discussed how he wished there was more financial support for graduate students, especially URM students.

Although Dres' prior participation in academic success programs for URM students will be discussed in more detail in a later section, Dres did mention how important the financial support provided by these programs aided him in achieving academic success. He recalled how his involvement in one program led to opening the door to other programs, because he needed to find ways to financially support himself through his undergraduate education.

> I'm competitive, but not in the sense of aggressive competitiveness, it's just I like to compete to get things because I needed money. And so, if there was an opportunity for me to get money, because I'm putting myself through undergrad, then that's what I needed to do. So, I would search these things out and it would be just like I talked to LSAMP, and I needed to find more money, I had to buy some stuff. They're like, "Have you heard about this program? Go apply". Okay cool. So, I went and did those things and I was there and I was able to get paid.

In the same vein, Dres applied to and was awarded many fellowships during his doctoral studies that helped support his research and studies. Dres shared that his current program of study provides students "bonuses" when they are awarded fellowships, and although he had

some administrative hurdles in accessing these bonus funds which will be discussed in a later subtheme, the extra financial support was a welcomed benefit to students who put in a tremendous amount of work into submitting competitive fellowship applications. When discussing his fellowships, Dres mentioned what he called the "diversity tax". I asked him to define this term so that his meaning could be reported in my findings. Dres defined the diversity tax as follows,

> Yes, so the diversity tax is... So, let's say in a university setting, in lab settings, so you get fellowships which will then pay for the graduate student and make them essentially free. And labs really like this, but to do so, you have to do outreach activities or oftentimes they want novel ideas for these granting agencies. So, then you have to do other things outside of research, and that's the tax. In order to get something that you want, that your lab wants, and ultimately, the university wants. Because it goes towards their (the university) goal of being more diverse and having them on their list of things that they have accomplished. They put it on the student. So that burden or tax is to do all these other activities and also be a stellar researcher, because if you don't and you slip, then you're just another minority that can handle it. That's the extra that we have to do.

In discussing ways that his current institution and program of study could better support URM students to degree completion, Dres offered many ideas for how institutions and programs can financially improve support for students from underrepresented backgrounds. He discussed specifically that his current institution is in the process of becoming a Hispanic Serving Institution, and although the institution provided the dollar amounts of money they are spending to achieve this goal, as a Hispanic student, Dres did not feel more supported or that he received any extra financial support from the monies allocated to this endeavor. Dres pointed out his view of these efforts,

> I mean, a big part of that is like what I've been trying to do with D.E.I. lately. I hear this rallying cry to be a Hispanic Serving Institution. And like, but what Hispanics are you serving? I'm someone that you're supposed to be serving and you're totally letting me slip through the cracks.

Dres, the activist, was ripe with knowledge of the challenges URM students face in higher education. He was aware that many URM students, like himself, come from financially disadvantaged backgrounds, creating barriers to pursuing higher education. He mentioned the graphic included below about equity to drive home his point that paying all students equally did not necessarily foster equity for all students.

> So, we talk about diversity, we talk about inclusion and everything, but wholeheartedly everybody forgets about equity, and we forget what equity means. What I think that <current institution> should be doing is, if you are a URM, you should pay me more for my stipend, if that's true equity. Because you (the institution) are saying, "Well I'm putting more weight into you (URM students) and I'm going to invest into you more because I really want to increase that (diversity)". And it's the same box, I'm still disadvantaged, man. (showing two box heights side by side) It's not, it's not, you're not helping me, and you want to make it equal for everybody else. Pay me $12,000 more, and then, if you have a family, pay me more too.

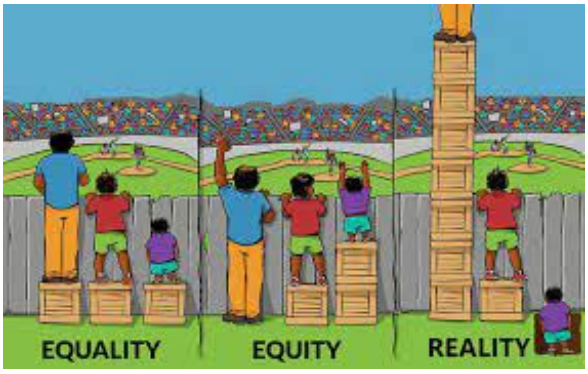

Figure 4.1: Graphic Depicting Equity

During our discussions, Dres also mentioned that he wished his current institution provided financial support for childcare since he is a parenting student. He mentioned that his current program provided a childcare reimbursement to parenting students to attend the program's annual retreat but that he was unaware of other financial resources for parenting students.

Through my discussions with Dres, it was clear to me that financial stability is one factor that he felt would strongly impact URM students' success through doctoral programs.

Theme 1c: Housing

Tying into the sub-theme of financial support, discussed above, access to affordable housing in close proximity to campus was another factor that was prioritized by Dres when selecting his current institution. As mentioned earlier, in his search for the right institution, one of the factors that influenced his decision on attending another California institution was that he did not believe he could secure affordable housing near campus. When considering his current institution, he looked at what the options were for student housing. He recalls speaking to his current advisor and mentor prior to deciding,

> So, the city was a factor. Like I had some interviews and possible positions at <other California institution> but I couldn't find housing that I wanted. And then, so the next important thing was, what is their student housing like? So, when I spoke with my PI, he was saying that, "You have the option and I can help you get on the priority list for student housing". I knew <current city> is a very expensive city, I need help.

Even with the promise from his advisor to help him with priority housing, Dres felt that his current program failed to inform him of a program at his current institution that serves as a recruitment tool and provides priority over waitlists and guaranteed graduate student housing for five years for students. It wasn't until he was two years into his program, when he was doing recruitment outreach for his current program at a SACNAS conference, that he learned about this housing benefit and he described feeling frustrated that this was not shared with him when he was accepting his offer of admissions.

> And I learned that I missed out when I started doing these things for SACNAS, with the department at <current institution>. And then I found out what they were advertising, I was like, "Hold on here. Why wasn't I offered this? Like I asked people about this, and no one told me that I would get priority for housing on

> campus". Like I lost thousands of, 10s of thousands of dollars, and I had to put out and I had to take out loans, just to be able to make ends meet and you're gonna tell me, two years after?

Dres also remarked that due to the scientific needs of his research, living further away from campus in a more affordable neighborhood was not an option. He needed to be close by so he could make progress on his studies and his research. Dres explained that he and his wife had one car because financially that was all they could afford, and although his current institution provided access to free public transportation, it required a lot of planning to ensure he was able to arrive on time to campus and his lab. He explained the following scenario in our discussions about housing, as an example of why he needed to live in close proximity to campus.

> And then, but like a timing thing was there because, like it's different when you have classes, because you can plan your day, but when, you know, someone cancels their microscope time, I don't have an hour. I can't live an hour away or 40 minutes away to get there, because then I missed that slot. And so that's an issue, so I needed to find something that was close, which meant more expensive, which meant like 90% of my stipend was going to a one-bedroom apartment just so that way I can walk a mile to the bus and have access to getting to <current institution> a lot quicker.

Dres also pointed out that one of the things that would have made him feel more supported through his time at his current institution and program of study would have been access to housing. He further went on to describe how access to affordable housing helped him greatly in his previous PhD program. He offered techniques used by his previous institution as a potential solution for all institutions looking to improve student support and outcomes. He described how the other institution worked with housing developers to provide affordable housing in the area, removing the competition and time-limits for affordable on-campus housing between students.

> I was well supported, I had enough, I mean I didn't even need to live on campus housing, because there was affordable housing that was around the university, because they (previous institution) worked with people, like the developers and everything.

Theme 1d: The Science

Another factor Dres considered was access to the type of science he was working on and his research goals when considering which programs to apply to. His goal was to identify either a Biology or Biomedical Sciences PhD program to join, where he could also do the type of science and research he was interested in. Dres was looking for the right fit in a program, lab, and institution. Although he had narrowed his choices to California institutions, he considered large R1 institutions and programs all over the state. Dres recounted his process,

> All I did was Google single cell biology and I was looking at the different <Public R1 Institutions in California>. And now it helped me find the labs. So, then I would be like any mention of single cell biology? So, then, I would go down, 'So who's doing cancer?', because I'm interested in cancer, specifically metastases. And so, I wanted to see who was doing stuff around there.

Dres could have chosen to pursue a different research goal when changing programs, but he chose to stay true to his research interests when selecting a new program and institution. Dres utilized an iterative process, to identify labs and then dove deeper into specific labs and faculty members to understand if their research goals aligned with his. Some campuses offered programs in Biology or Biomedical Sciences, but did not provide access to the type of research he was looking to do. "Fit" was very important to Dres and he ultimately landed on his current institution. He mentioned how he spoke to multiple mentors from his past research experiences and how their guidance also helped him in his decision. They all provided him with similar advice which was choosing a place where he could do research that he really liked and was invested in. He also mentioned two different instances when faculty mentors at other institutions

offered him the opportunity to complete his PhD studies in their labs, but also mentioned that they knew their research did not exactly align with Dres' research interests. They both told him to follow what was in his heart. He shared, "So, I talked with him about it. I didn't want to join his lab and he knew that, he knew my heart wasn't in it, he's like, 'You can get your PhD in two years, but, what do you like? Is this something you really want to do?'"

Since Dres had disclosed that both of his parents had been diagnosed with metastatic cancer prompting him to leave his previous program and find a new program in California to be closer to his sick parents, I inquired if his personal life drove his research interests in cancer metastasis. He told me that the two were unrelated, and that it was important for a researcher to detach from the personal aspect of what they study so that they aren't "driven down by the stress and weight of what has to be done." When I further probed into his research interests and why finding the right fit in a lab at a new institution was so important to him, he answered,

> Metastatic cancer is one of the last frontiers of cancer treatment, that's the reason 90% of the people who died from cancer is because of the metastatic disease. We have no idea what makes it, you know metastatic, and we have no drugs that target the metastatic disease stage. So that's why. It's one of the hardest problems in cancer. And I like to work on hard problems.

Dres also explained that these same mentors who told him to follow his heart, told him to consider what shared resources there were between the institution he selected and other institutions in the area. One major factor in selecting his current institution and program of study were the collaborations that were happening scientifically across multiple campuses and institutions. This factor helped give Dres access to cutting-edge technologies and techniques to further advance his research goals. He said, "So that's how I set on the program, I found a lab. What are their affiliations? What other programs are they tied to? That's the one I have to apply for."

Finding the right "fit" scientifically in his selection of his current program shows how institutional factors, mentor advice, and access to scientific resources and technologies overlay and help support students.

Theme 1e: Institutional Mentorship

When selecting his current institution, access to science was important but so was mentorship. As previously discussed, Dres used the science to identify potential advisors in new programs of study. Dres describes finding his current PI (advisor), who he considers a very good mentor both academically and personally.

> I found my current PI, and he does cancer research, but in a different way, and that is my niche, doing cancer research in a quantitative computational single cell way. When I did my interview with the PI I am currently with at <current institution>, I brought my poster, brought it out, went, met the lab, did everything. And then went from there. And so that was the process to find the current position.

Although it was very important for Dres to find the right fit scientifically when selecting his current institution and program, as discussed above, he later divulged that mentorship is the most important factor for success as a student and future independent scientist. He contended, "The mentor is always the most critical thing. Like who cares about the science? It's about the mentor, in order to teach you to be a scientist."

Theme 1f: Staff/Administrative Support

Although Dres was able to find a great lab and mentor, he also faced some challenges with administrative staff and programmatic support when joining his current program of study. As a student transferring from another program, Dres was admitted to the program with an edited set of curricular requirements and timeline to complete degree requirements. Since Dres had already completed the PhD course requirements at his previous institution, some but

not all of the courses in his current program were waived. This also accelerated his time to complete his program. When admitted to his new program, the new program expected Dres to complete the remaining curricular requirements, establish and make progress on his thesis research project, while also completing the program's 3 required teaching assistantships within the first 2 years of study. Students in Dres' program typically complete their 3 teaching assistantships over years 2-5 in the program, Dres was expected to complete this requirement in two years. Dres recalls that this created issues for him,

> they (program staff/administrators) were not helping and allowing flexibility when I had to do these courses, because they expected me to teach. So, the goal was that you graduate in two years, you get your PhD in two, you have to advance to candidacy, then you're done after the next year. And so that's what the push was. So, I had to do three years of teaching in two years, and then I had to get these classes done, and they were not budging at all.

Dres explained that his PI had to reach out to the program on his behalf to advocate for more flexibility and support, Dres retells that his PI told program administrators, "we're making it unreasonable for him. How is he supposed to do all of this?".

In addition to the tight and inflexible academic timeline provided to Dres, he also received resistance from the program when trying to access financial support available to all students in the program. He explained to me that students in his current program receive a "financial bonus" when they are awarded a fellowship. When transferring to his new program, Dres brought with him the fellowships and their attached funding from his previous institution. He described that when he inquired about the potential for him to receive these bonuses for the two fellowships he brought with him, the program responded negatively to him.

Theme 1g: Racial Profiling and Harassment

One of the most personal and challenging experiences for Dres was his experience at a neighboring institution that collaborates closely with his current institution where he was attending a monthly student run-seminar as part of his program's academic requirements. Dres explained that on three different instances attending this neighboring institution to attend his required course, he was met with hostility and harassment from the security at the neighboring institution. Over these three instances Dres faced what he best described as racial profiling and harassment. On different occasions he was asked for ID, asked to prove he was there for a class, asked to leave the property of the institution and return within 10 minutes of his course, was detained by the security, was unable to use the restroom without being escorted, and was asked to pay an entry fee that was different and higher than the published rate for public visitors to the institution. He also explained that in one instance, the security that detained him, was talking loudly to another security guard all while looking at Dres, about another person they had detained. Dres recounted,

> And they were like, "No you can't go in. You actually have to sit right here", so they made me sit on a bench and there was three of them there. And then they were talking about like, "Yeah, you know, we saw some guy and he was just walking around, so we tackled him down, we got on him. I held him down on his back and everything".

Dres retold the story of another instance with the security at this neighboring institution,

> The next month comes around, and so, I go in and I asked like, "Okay", you know, "I'm here for this so and so class and everything", and they're like "No, you're here too early for the class". I was like, "It's you know 15 minutes early, it's not like that early. And they're like, "No you can't be here. And you have to wait outside of the premises". So, they actually asked me to go on to the sidewalk that was not on the institution's sidewalk. And then, in the parking lot, there was a security guard following me until I exited. Exited, but really it was just stepping from one piece of sidewalk to another that technically put me on public property. And so, I waited there until it was like three minutes till the hour and then I went back, and I was like, "Can I come in now?". And they're like, "Oh yeah, what are

> you here for?", like they've never seen me before and made me go through the whole thing and they're like, "Okay, yeah you can go down", and then it was just like flippant about it.

Dres further explained that on his second visit he kept his parents on the phone with him as he was concerned he would be harassed again. He described his anxiety and fear and was visibly pained when retelling the story to me.

> So, I walk in, and that was the second time where they say, "No, you need to get off the premises", and my parents were there with me on the phone and I was talking to them. And then my dad works in law enforcement, and so he was like, "Why are they talking to you like that?" and I was like, "I don't know, he told me I can't come in, it's 15 minutes too early". And my dad asks, "Isn't that your class, though?", and I was like, "Yes.". Now again the guys watching me, and my dad says, "well stay on the phone and everything, so that way, you know we know where you're at", and stuff like that. My mom was on the phone so they heard them talk to me, they heard all of it going on, and they were concerned. They're like, "What's going on? Haven't you been here before?", and I was like, "Yes". So, then, the third time, definitely I was, I was anxious, I was worried about getting there.

Dres third visit was no different than his first two, he was asked for proof of enrollment in the course, was told he couldn't use their restrooms without an escort, and was asked to pay an entry fee, even though he had explained that he was there for a required course hosted at the institution. When he was finally let into the building, he asked his classmates, the majority of which were white, if they had ever experienced similar issues with the security and they all said no and were confused by the treatment Dres received. The pattern seemed clear to Dres, that his appearance as a Mexican man with a beard did not fit the security guards' ideas of what a doctoral student looked like and treated him like a security threat to the institution.

Following this terrible experience, Dres decided to report this to his institution through the office that handles harassment and discrimination. He was told that since the instances described occurred at a different institution, they were unable to take any action, even though he was there to attend a course that was an academic requirement for his program. He was referred

to the neighboring institution's HR department to file a complaint. Dres felt it was very important that this case be documented, so he took the required steps to file a formal complaint with the HR department.

> So, I had to meet with HR for an hour and a half, and again, take time away from my newborn, in the morning, super tired, because I'm on paternity leave, and I have to do this. And I want to get it done, because then it's going to fall by the wayside, so I do this. I meet them and everything, I then have the hour and half meeting, they take all these notes, they say they're going to get back to me, and a week later, the pandemic hits. And so, then they had said, "yeah, they need a more of investigation," stuff like that. They can't do it themselves, so the HR department at this institution cannot do it themselves, they need it give it to a third party. This third party is a law group.

As Dres described, he felt the case being handed over to a third-party law group was another form of intimidation and his experiences with the law firm only solidified his view. What Dres went on to discuss was his conversations with the lawyers appointed to investigate his claims. Dres words below re-tell a story that he explained further traumatized him and made him feel profiled.

> So, I was like okay I'm ready to do this. So, we go, he's going through, I tell them the whole thing. I wrote everything out, right, because you have to have a timeline, you have to show a pattern. I showed the pattern over multiple times I had to get dates, I had to say who I was on the phone with, where I moved to. I put it on a map to show my spacing, where I was going, and where the other person was. The whole shebang, all for this. And then during the conversation, he asked me, "What were you wearing?", and I was like, "What was I wearing?" and he says, "Yeah, what were you wearing?", so I respond, "I was wearing a button up, just the same thing I told you before". And he was like, "Okay, well, you know, you weren't wearing what you're wearing now?" and I was like, "What I'm wearing now? I'm wearing a NASA T shirt". And he was like, "Well your beards pretty big", and I was like, "So you're saying that it's okay? Is that what you're saying? That based on someone's looks that...", the lawyer says, "Well, no that's not exactly what I mean", and I was like, "That's what you're hinting at. I know you're not saying it, because you're a lawyer and you know how to get out of it, but you as a person, know what you're hinting at" and I was like, "So, no, I was not wearing anything…", the lawyer responds, "Well did you have baggy pants?".

Ultimately, the law firm found no harm done by the security guards and the institution reported that they were acting within the bounds of what the security guards were trained to do. Dres expressed frustration but also stated that he knew this would be the outcome. He remarked that he reported the claim knowing it might not lead to resolution saying,

> But someone has to do it, it's now logged, it's now become an official complaint. Someone complained. So, that way, when it happens to someone else and, hopefully, they can complain, now they have two and three, and they show a pattern over the years of this type of thing.

Dres felt that his institution should have done more to protect him and support him. He addressed his frustration stating the institution should be obliged to support students attending academic requirements on outside institutions campuses, so that students are able to participate in their programmatic requirements without fears for their safety or being subjected to harassment. Over the course of our discussions, Dres mentioned many times "someone has to do it", conveying that he felt responsible to report these instances to help his larger community and other URM students down the road.

Theme 2: Academic Supports and Factors

Academic support available to students plays a critical role in students' self-efficacy and development of their science identities. In education, self-efficacy plays a large role in students' perceptions of their own abilities and has been shown to have a mediating effect on perseverance, academic achievement, and self-regulated learning (Bandura & Schunk, 1981; Bandura, 1986; Hernandez et al., 2013; Maton, et al., 2016; Strayhorn, 2008, 2018; Tomasko et al., 2016; Trujillo & Tanner, 2014). Reviewing the different factors that helped Dres arrive at his current institution and program of study through past educational experiences can help illuminate how URM students in STEM fields experience academic support.

Theme 2a: Prior Participation in Academic Success Programs for URM Students

As discussed earlier, Dres has loved science since he was a young child hoping to become an entomologist and study bugs. Throughout his education, he was drawn to activities that allowed him to focus on science, like the Science Olympiad. Dres was also very active in academic success programs during his undergraduate studies for students from historically excluded groups.

The McNair scholars' program is for qualified junior and senior undergraduate students who are interested in pursuing graduate studies leading to PhD degrees in STEM. As a McNair scholar, Dres was part of a tight-knit community who was given access to research opportunities and support in applying to graduate school. This prestigious program, named for Black astronaut Ronald McNair, the second African American to fly in space. The goal of the program is to encourage low-income and first-generation college students and underrepresented minority students to expand their educational opportunities through enrolling in PhD programs with the ultimate goal of pursuing academic careers. The opportunity for students to engage in an authentic research setting, communicate with other scientists regarding scientific problems, use technical scientific language helps improve students' self-efficacy, as has been shown through reviews of many academic success and summer bridge programs like the McNair. (Bandura & Schunk, 1981; Bandura, 1986; Carlone & Johnson, 2007; Hernandez et al., 2013; Maton, et al., 2016; Stryker & Burke, 2000; Tomasko et al., 2016; Wilson et al., 2014). As mentioned earlier, Dres hopes to be a college professor one day, and he explained that his participation in this program helped him when applying to graduate school.

Dres' participation in the Louis Stokes Alliances for Minority Participation scholar, or LSAMP, and the METRO center also helped him prepare for graduate school. In addition to the

graduate school preparation support, the LSAMP program and METRO center provided Dres with financial support to pursue his undergraduate research, attend conferences and enhance his education. It also provided Dres with a network of other underrepresented minority undergraduate scholars and mentors in STEM with the goal of improving academic outcomes and achievements for the students who are identified as scholars. This program helped with his social integration and building of a science network and community, components which have been shown to positively impact URM students' academic achievement (Baker & Lattuca, 2010; Robnett et al., 2018; Stryker & Burke, 2000).

Theme 2b: Current Academic Supports

In our first interview, Dres rattled off a short list of academic supports he was aware of that were available to graduate students on campus. He mentioned that there was a writing center that holds workshops and supports students in their thesis writing. He mentioned that he felt accessing these writing supports were rather easy and reported no major barriers to his utilization of this resource. Dres was able to easily access this support via Zoom during the pandemic and he felt that it was a useful resource for him at the late stage of his doctoral program.

When asked if he was aware of other academic support available to students, Dres mentioned another negative interaction with a staff member in a campus office for graduate studies. When he first arrived at his current institution, he wanted to get caught up on the requirements for his dissertation and research, so he could better prepare himself for what was ahead in his academics. He shared that the staff person who had the answers to the questions he was asking dismissed his inquiries because they felt the student was asking too early. Dres tried explaining that he wanted to be prepared so that he wouldn't fall behind or need to request

exceptions to policies or additional accommodations and was met with a perceived lack of interest in helping him. Dres mentioned that as a minority student he feels the urge to be overly prepared so that his lack of understanding of certain processes and procedures aren't viewed as failures because he is a minority student, similar to the idea of "diversity tax" discussed in an earlier section. He explained,

> And part of like why I, you know, if you reflect on that, or the reason why I'm doing that is because I don't want to be the minority that's waiting for the last minute that you already have this impression of, and then, "Ahhh! Of course, he didn't have his stuff together". So, I overcompensate for that, by trying to get it well ahead. That way that impression, that prejudice isn't even there. But then when you dismiss (it) and now you're like, "Well you're trying too hard, you don't need to worry", but I do need to worry because you're blind to what the ethnic and cultural differences and racial differences are and you don't have to deal with that.

Overall the perceived dismissiveness of the office staff, left Dres feeling unsupported and like he could not ask them questions in the future. He mentioned that he would copy his faculty mentor (PI) on emails when asking questions from certain staff members in his program and at his institution as a layer of protection and assurance that he would be treated equally as other students and not judged by his URM status. These difficulties accessing this type of academic support isolated Dres from helpful information that would support his academic goals and also turned him away from reaching out for support after his negative experiences. This example sheds light on how students' experiences with academic support, both positive and negative, can impact a student's self-view and their sense of belonging, self-efficacy, and social integration on campus and how they choose to interact with other supports.

Theme 2c: Participation in URM-Focused STEM Outreach Programs

Through his participation in the academic success programs discussed previously, Dres met and started his first campus chapter of the Society for Advancement of Chicanos/Hispanics

& Native Americans in Science (SACNAS) at his undergraduate institution. After attending the SACNAS conference, he described feeling excited to be in a room with other people who looked like him and were doing amazing things in STEM fields and talking with his friends about how they wanted to have that feeling all the time. With help from his LSAMP peers they went back to their undergraduate institution and started a chapter. Dres exuded pride and happiness any time we discussed SACNAS, and his role in bringing chapters to all the institutions of higher education he attended. As a student leader in SACNAS, Dres felt it was important to create chapters of SACNAS to help develop a community of historically excluded groups in the sciences.

Dres is also a graduate student mentor and participates in URM outreach and recruitment events for his current program of study through annual conferences like SACNAS and the Annual Biomedical Research Conference for Minoritized Scientists (ABRCMS). Dres is an outspoken member of Diversity, Equity, and Inclusion initiatives on campus, including starting a lecture series through his program of study, and draws on his own experiences as a URM student with the goal of improving experiences of URM students who will come after him. This sense of responsibility to his community of URM students was something that Dres found valuable, even though he best described many of his experiences in his graduate program and at his current institution as “othering”, “isolating”, and “lone-wolfing”.

Theme 2d: Academic Mentorship

Dres stated that his PI, principal investigator, played a huge role in his academic success. As mentioned earlier, Dres relied on copying his PI on emails to campus offices that are designed to offer students’ academic support. This “back-up” made Dres feel like he would get

better support than when he just reached out on his own. Beyond serving as back up for Dres, his PI, or official mentor, also helped Dres with his sense of imposter syndrome. Dres described,

> And he was so transparent when I asked him for honest reflection, so I can be better, he gave me honest answers. And I'd fix the things I needed to fix and then, when I… everything was good, and he would tell me, "Everything's good, you're doing great!", I believed him. And then I was able to lower and deal with my imposter syndrome a lot better. And so, you know it was kind of just a mixture of someone really putting their time and giving the honest feedback and then celebrating me. And, and then advocating for me.

Having the academic support of his mentor greatly impacted how Dres experienced his doctoral program, although he had many negative experiences, he felt fully supported by his mentor. Opportunities for URM students to interact with and develop quality mentor relationships with STEM faculty and professionals can not only improve students sense of STEM identity and satisfaction with their academic performance, but also help build social capital and a strong STEM network (Baker & Lattuca, 2010; Carlone & Johnson, 2007; Robnett et al., 2018; Stryker & Burke, 2000).

Theme 3: Psychosocial Factors- Social and Emotional Support

As has been alluded to throughout the presentation of the previous themes and subthemes, social and emotional support played an important role in Dres' academic success and education. Dres relied on his different systems of social and emotional support as he moved through his doctoral program. He described this support as being instrumental to help him continue pushing forward even through emotionally challenging situations like the instance described earlier of racial profiling. These sources of support will be discussed in more detail below.

Theme 3a: Family Support and Spousal Support

Dres' family and wife provided him with the most social and emotional support. He mentioned multiple times how his family helped support his interest in science growing up, even though they did not have the resources or knowledge to engage with him scientifically. They also served as a social and emotional support system to him while he was going through the situation described earlier at the neighboring institution. He described how his parents or wife were always on the phone with him as he approached the security to ensure that he was safe.

> They had a security guard escort me to the bathroom and wait outside of the restroom. And so, I use the restroom. I am texting, you know my wife and my parents and everything. And my dad's like, you know, "Just cooperate with them. There's been other people that they found suspicious and they tackled him and used force. You want to avoid all this".

When I asked him who he turned to for support after this incident, Dres answered,

> It's overwhelming, it's overwhelming. It's just a rush of emotions. And you know, I'm emotional, I get emotional about it. For multiple times, every time I had to interact with that lawyer, interact with them or after the resolution, when I brought it up again, it's overwhelming. I cried. It's overwhelming and you get anxiety from that. You get anxiety from having to go there. I was getting anxiety from having to do that class. And I was so relieved that there was a global pandemic that I didn't have to go in person anymore, because I was like I really want to go to this class and I don't want to have to be nervous and scared every time. And so, the people I turned to are my family and my partner.

In our first interview, Dres also disclosed that he thought that many URM students relied on their families support or the support of their spouses based on his experiences with other URM students in STEM fields. He told me,

> We always talk about, especially with my mom and dad and my partner, that we're all going through this together, and everything and so we're all doing this together, and it's all of our PhDs because it puts stress on everybody and everything. And so, they see it, you know and but THAT, that's where a lot of it comes from. And that's not uncommon for a lot of first-gen and URMs and everything.

Theme 3b: Friends' Support

Dres also relied on his friends as a source of social and emotional support through his entire education. His strong relationships with other URM students through his participation in academic success programs and SACNAS gave Dres a space where he could talk about his experiences with friends that acutely understood how he felt. He described attending his first SACNAS conference,

> I went to a SACNAS meeting in 2013 in Seattle with my friend, and we're like, "This is awesome! I've never felt anything like this before", "Did you know stuff like this happened?". "No, I didn't". And so, it was just like close friends, that were not all in biology, everybody was kind of everywhere, and then we started that and that was in 2013.

Being a transfer student created a challenge of socially integrating with his cohort. Dres commented that he felt very isolated the first two years in his program, because the students he entered the program with were at a very different stage of their studies. He also talked about how he felt like the "other" and was treated differently than his other classmates, which made it difficult to reach out to his classmates and feel like he belonged in his doctoral program. He articulated this further,

> To get equal, like being seen and heard equally, is not the same as my non URM peers. And when I say non- URM, what I would classify it as just based on what I've seen. Caucasian, Asian and yeah. And so, I've seen my peers that would be treated differently and it's really frustrated me.

Even with the struggles to socially integrate in his new doctoral program, Dres did mention that his lab mates served as a system of social and emotional support too after some work on all their parts,

> Yeah I have some lab mates and everything, it's taken a while to cultivate that relationship, again it's this issue of the "other", but then…it's the culture was not being set correctly. And then we got to a point of like, "Why? Why are we all

> doing this? And so, let's all work together to break that down in order for us to survive and us to get along better and do better things". And so, as lab mates, we've gotten there. It's taken three years but we've gotten there.

Theme 3c: Mentor Support

Dres mentioned that he can turn to his current PI for social and emotional support, especially when he was struggling with the incident described earlier. He discussed the aftermath of the incident and how it impacted him with his PI. This genuine care shown by his PI was something that made Dres feel very supported. Even though Dres mentioned his PI didn't always know the right thing to say or do, he listened and did his best to support his student through a challenging time.

> I do have to say that my PI, he didn't understand what to do. So, like one of his things, he was so taken aback. I think I am, I am his first URM student. And, and he's like, "I don't know what to do", and I was like, "I know", and he's like, "Anything you need, anything. Whatever it is, just tell me what you need. I don't know what to do". And so, I took some time off after, in between all this, because I was getting frustrated. It was just like, "Go. Take your time, so that way you feel like you're able to cope with it. And I can't help you, but I can, the best thing I can do is just give you time with no hassle and don't worry about anything". And so that's the best thing, because you don't need everybody to know how to cope with that, but you do need people to have empathy and ask you, "What do you need?" and then give you that, with no strings.

That time and space away from the lab without interruption in his progress or his pay allowed Dres to take some time off to focus on healing from a traumatic experience and made him feel that his mentor not only supported him financially and academically but also emotionally.

Another instance where Dres felt socially and emotionally supported was when he was discussing his experiences with being racially profiled with his program's diversity committee. Dres discussed how a faculty member of color heard his story and then shared his own experience being racially profiled in a room that was predominately white. The faculty

member sharing their vulnerability and letting Dres know that he understood his feelings and experience helped validate Dres experience. He recalls the interaction,

> I've interacted with (names Black Professor) but not in any official capacity. And it was just like, I was talking about getting detained at <neighboring institution>, and he was like, "Bro, I was, you know police rolled up on me and my old house and everything". Like that thing, that moment, that five minutes, where we talked about it, that was huge.

Dres went on to describe this relationship as a "momentary mentor", someone who was there in the moment and helped him feel supported and that he could turn to them for advice. He said that throughout his education, there have been momentary mentors when he needed them, although he didn't have a strong or lasting relationship with them.

Dres' Story within the "Whole-Self" Framework:

Dres' case presents a story of a student who excelled academically against all odds. He encountered treatment that was less than desirable but continued to persevere. His case helps frame negative experiences within the "whole-self" framework and how his experiences were impacted by the ways in which Dres activated or refrained from certain types of support. Viewing Dres' suggestions and experiences through the lens of the "whole-self" framework, shows that although institutional support and factors, academic support, and social and emotional support can be viewed separately and acted on individually, viewing these factors together and how they interact can better frame the true experience of the student and allow for better systems of support to be identified by institutions and programs and where resources can be best allocated to better support URM students.

Institutional factors such as campus location and benefits were closely tied to financial support, something that Dres felt was very important to removing barriers in the way of his academic success. Having health insurance that was accessible and access to affordable housing,

combined with equitable financial support do not individually equate to academic success, however when viewed through the "whole-self" framework, access to affordable and conveniently located housing and health insurance are important institutional factors that also play a role in students feeling financially supported. Access to housing also helps with psychosocial factors such as a sense of belonging, allowing students to be active members of their on-campus community, and self-efficacy, by removing external barriers to academic success, like living far from campus.

For Dres, being close to his family, his main source of social and emotional support was another major factor when choosing an institution and continue his doctoral studies. This was also tied to the financial burdens associated with travel from his previous institution to be with his parents when they were diagnosed with cancer. Through the "whole-self" framework, Dres' desire to be close to his network of social and emotional support and have some sense of financial stability influenced how he selected his program of study.

Access to the type of science and research Dres was interested in pursuing as well as access to good mentorship show that these factors overlap and cannot easily be separated. Although Dres had multiple negative experiences accessing support through his program and campus staff, having the support of his mentor helped Dres continue and persist to degree completion. Dres not only relied on his mentor for academic support, he also turned to his mentor for social and emotional support when he was faced with a challenging situation. The continued support and open dialogue with his PI helped Dres feel supported and able to continue his goal of completing his PhD. Mentor relationships allow students the opportunity to discuss important factors like educational planning and career development, as well as challenges they are facing (Baker & Lattuca, 2010; Chemers et al., 2011; Maton, et al., 2016; Robnett et al.,

2018). Tinto offers that when students feel both academically and socially integrated, this integration can contribute to the retention and persistence of students in STEM fields (Tinto, 1975, 1987). For Dres much of his social and academic integration was obtained through his mentor relationship. These psychosocial support components help URM students build their STEM identity and increase feelings of belonging in graduate level STEM programs (Carlone & Johnson, 2007; Rodriguez et al., 2019).

Although Dres had a strong mentor relationship with his PI, he was not fully socially integrated with his cohort as a transfer student. This lack of social integration meant that Dres was not accessing support from his classmates academically or socially, but he still built himself a community and strong social network through his participation in SACNAS and other campus and program level groups. Using the "whole-self" framework to understand Dres' desire for community, you can see that his past participation in academic success programs introduced him to SACNAS, which provides the opportunity for URM scientists to connect and network. Dres' experience attending the SACNAS conference as part of his participation in the LSAMP program led to him starting a chapter at his current institution. This not only added to Dres' sense of belonging on his campus but also added to his science network. As previously discussed, underrepresented minority students often do not have a strong sense of belonging at predominantly White institutions which impacts their retention and successful completion of degree (Quarterman, 2008; Strayhorn, 2008, 2018). As shown in Dres' case, although he did not feel a strong sense of belonging at the larger institutional and programmatic levels, his participation in focused URM outreach and cultural groups positively impacted his persistence to completing his doctorate (Davis et al., 2019; Strayhorn, 2008, 2018). Mentoring and community building are an important component of psychosocial support for URM students

pursuing STEM fields. (Ashley et al., 2017; Baker & Lattuca, 2010; Maton, et al., 2016; Robnett et al., 2018; Wilson et al., 2014). Psychosocial supports help build students' self-efficacy, membership in the STEM community, networking with other members of the science community and identifying mentors and how to build mentor-mentee relationships. This layered onto academic supports such as access to authentic research opportunities and foundational knowledge that Dres accessed through the academic success programs during his undergraduate program also help increase self-efficacy. Science self-efficacy and STEM identity development have been shown to relate to persistence, tenacity and achievement in educational settings (Bandura & Schunk, 1981; Bandura, 1986; Carlone & Johnson, 2007; Chemers et al., 2011; Hernandez et al., 2013; Maton, et al., 2016).

Psychosocial supports help build students' self-efficacy, membership in the STEM community, networking with other members of the science community and identifying mentors and how to build mentor-mentee relationships. Dres' prior participation in academic success programs helped develop his self-efficacy and he strongly believed that he was capable of completing his degree, even after transferring. This could explain why Dres did not need to access the academic support from his institution or program after his negative experiences. His prior positive experiences helped fortify his sense of science self-efficacy.

Dres experiences through his education and during graduate school influenced Dres' future career goals. He accepted a postdoctoral position that focused on teaching and mentoring as well as its focus on independent research. When I asked Dres about his desire to become a professor he shared,

> The first thing that came to mind when you asked that was, someone has to do it. And I see a lot of URMs, where we start out in our graduate career wanting to do it, and, by the end of it we're like, "We don't want to do it anymore". The diversity

> tax is extremely taxing. To be able to do those things, to be competitive, to get awards, to be two-times better than your non-URM counterparts, breaks a lot of people. And in fact, it broke me. And so, if it wasn't for, you know, support to keep doing that, and then seeing how it affects people, I would just stop. I'm not going to do this. And also, a lot of us deal with generational wealth development, so they'll go into industry or other things that quickly pay more.

Looking back on his experiences when sharing his future goals, Dres revisited the challenges and choices he faced as a URM student. He reflects on financial considerations and challenges faced by diverse students and how those may impact future career decisions. Dres' statement also may help illuminate barriers to diversifying the professoriate. The "whole-self" framework helps support Dres' experience by showing the interconnectedness of financial considerations, sense of belonging, diversity, and future career goals even beyond the student's time in a doctoral program.

The above discussion shows how sense of belonging, self-efficacy, and social integration relate to institutional factors and support, academic support, and social and emotional support. When students have positive interactions and perceptions of support, they also feel connected and feel supported in their academic success (Bandura & Schunk, 1981; Bandura, 1986; Maton, et al., 2016; Strayhorn, 2008, 2018; Tinto, 1975, 1987; Tomasko et al., 2016). Dres' negative experiences influenced how and why Dres would interact with different institutional and academic support systems available to him. Using the "whole-self" framework to understand Dres' experiences we can see that past positive educational experiences which enhanced his self-efficacy, access to quality mentorship relationships which helped him feel connected to a science community, and a solid social and emotional support network which helped with his sense of belonging all contributed to Dres' persistence to degree completion, despite his negative experiences in other levels of the framework.

What I learned through the "Whole-Self" Framework

Utilizing the "whole-self" framework to review the findings of each case, I discovered that there were many commonalities between each case, but also differences in how each student experiences their graduate program and institution as it pertains to different types of support. In this next section, I attempt to answer the research questions posed in this study using the data provided by the participants. Using the students' experiences to answer these questions will also guide the discussion of how programs and institutions are successfully supporting URM doctoral students in STEM based programs and areas where more attention and resources can be focused which will be discussed in the following chapter.

Findings for Question 1: In what ways do URM students experience and perceive support from their program and institution during doctoral training?

This study revealed that URM students do not always experience and perceive support from their program and institution the same ways. Although two participants, Joy and Stephanie reported that they overall felt supported by their programs and institutions, Dres reported an alternative experience of feeling isolated and unsupported both by his program and institution. To better understand the differences and commonalities between participants, it is important to discuss findings as they pertain to each sub-question that together help answer the main question defined above. Overall, the findings to question 1 and its sub-questions demonstrate the interconnectedness of many of the major themes supporting the "whole-self" framework and its strengths in identifying how URM students experience and perceive support during their doctoral training.

Question 1a: Strategies Used by URM Students to Access Resources. When examining the strategies used to access resources and opportunities (for example, academic,

financial, and health and well-being related), it appears that URM students relied on past mentors and participation in academic success programs, reaching out to program staff and administration, relying on the guidance and advice of their mentors, relying on the collective knowledge of their classmates and friends, and also identifying resources on their own.

All three participants in this study were part of academic success programs designed specifically for URM students either in their K-12 years or during their undergraduate education. These academic success programs served as a valuable source of information for URM students about navigating higher education and helped students develop skills and strategies that seemed to improve their experiences as graduate students. Similar to summer bridge programs, described in the literature review, these academic success programs combine academic and psychosocial supports with institutional goals to help aid in the retention of URM students in STEM fields to graduate school and to degree completion (Ashley et al., 2017; Gandara & Maxwell-Jolly, 1999; Hernandez et al., 2013; Maton, et al., 2016; Wilson et al., 2014). Joy, Stephanie, and Dres all shared this finding in common, and shared the ways in which these programs helped them be better prepared for their doctoral programs. These programs provided the three participants with opportunities to improve their core STEM knowledge, through academic support, which helped with their STEM persistence. More importantly, participants Joy and Dres were able to engage in authentic scientific research through their participation in these programs. This not only aided in the development and strengthening of their science identities, scientific skills, and science self-efficacy, this also provided them with access to mentorship from other scientists.

Another commonality was that all three participants were aware of academic support programs available to them through their institutions and programs but chose not to utilize

them. This could be that their prior participation in academic success programs helped develop skills and the ability to identify alternate sources of academic support, such as mentors and program faculty and staff.

Mentorship from both past mentors and current mentors in their PhD programs, referred to as PIs (principal investigators) were a major source of guidance in identifying opportunities and resources. All three participants mentioned multiple times that they go to their PIs for academic support, financial support, and even emotional support when asked where they turn to for support in each of those areas. PIs play a critical role in the academic development of PhD students, advising on coursework, helping them develop their research goals, supporting their academic pursuits financially, and offering advice on a multitude of factors. PIs also were a trusted source of information for all three participants, helping connect the student with either program staff or campus resources that could help them if the PI was unable to support them. All three participants reported strong and supportive mentorship relationships with their current PIs.

Question 1b: URM Students' Participation in E.D.I.. Joy, Stephanie and Dres all participated in events that contribute to equity, diversity and inclusion efforts through their program and their institution. All three of them reflected the importance of these types of activities not only on their own trajectory as students, but as a way to encourage other URM students to pursue STEM based fields. Joy and Stephanie reported that they felt honored when asked to participate in diversity efforts. This reflected a strong sense of pride in their own accomplishments and the strength of their experiences as ways to help other URM students. All three participants also claimed that their participation in these efforts were important as it created a space for other URM students to believe they too can be successful in STEM fields and in

pursuing graduate education. This indicated that the participants felt that their role in diversity efforts played a critical role in building other URM students' sense of belonging and self-efficacy. Dres and Joy also reported that their participation in diversity efforts afforded them the opportunity to serve as mentors to younger students which also assists in building other URM students science networks and aids in their social integration.

All three participants also shared that they participated in campus based cultural organizations which serve as hubs for efforts towards diversity, equity, and inclusion. Through their participation in groups such as SACNAS, Dres, Joy, and Stephanie were able to act locally with other URM students on their campuses as well as join other URM students nationally through conferences and presentations. The cultural groups served as a positive source of social integration and allowed the participants to expand their science networks. These groups also created a space for them to experience belonging and give back to their institutions and programs by acting on and helping to improve circumstances for URM students.

Joy and Stephanie both agreed that their institutions and programs cared about diversity, but that there was still more work needed to help increase diversity and more equitable and inclusive spaces for URM students. They felt more positive about their institution and programs commitment to these efforts while acknowledging that further efforts could be made. Although Joy and Stephanie both had positive feelings towards their institution and program's commitment to diversity, equity, and inclusion, Dres' experiences left him feeling like there was little to no commitment towards those efforts. Dres expressed a strong personal commitment to improving diversity in higher education but reported instances of racial discrimination, feeling like an outsider, and having to work twice as hard as his non-URM counterparts to prove that he belonged in his program and at his institution. These differences between the students'

perceptions of their institution and programs' commitment to equity, diversity, and inclusion highlight the importance of understanding the student's experiences and how those experiences shape their feelings of belonging and social integration on predominantly white campuses. It also shows how these experiences influence how the student interacts with the different types of support and how they are accessed as described in the "whole-self" framework.

Question 1c: Social and Emotional Support Provided to URM Students. Mentorship support emerged as the most important kind of social and emotional support created by their institution and programs. All three participants reported that they felt comfortable reaching out to their mentors for social and emotional support if they needed it. This strong relationship and trust placed by the participants in their mentors shows that high quality mentorship can not only help students at the institutional and academic levels, but also provide social and emotional support when needed.

Joy and Stephanie reported that their program administrators and staff also provided them with guidance and resources available for social and emotional support. They believed that they could turn to program administrators and staff if they were struggling and would receive positive social and emotional support. Dres shared that he struggled to find social and emotional support through his program's administrators and staff as he had many negative interactions during his doctoral program. He also shared that there were some staffing changes that improved his situation and that he felt positive about reaching out to certain staff members for help and support. Once again this calls attention to the importance of student's experiences and from who and how they access support.

Joy and Stephanie shared the value of their cohort mates and colleagues as sources of social and emotional support as they were experiencing their doctoral programs together. Dres,

Joy, and Stephanie also shared that their participation in cultural organizations also provided them with a space to receive social and emotional support. Being able to rely on and turn to other URM students who shared similar experiences and backgrounds with the participants created a safe space for the participants to go to when facing social and emotional challenges. Although not a support provided by the institution or program, another commonality for all the participants was the importance of family and friends as main sources of social and emotional support. All three participants stated that choosing institutions close to their families and friends was high on their list of priorities, which shows how access to social and emotional support systems influenced the student's choice of institution. This social network created through family, friends and classmates is another example of how students perceive and experience their institution and programs in supporting them socially and emotionally. The social network also reflects the need for URM students to have access to at least one source of social and emotional support, noting that it would be detrimental to the students' progress and successful degree completion to have no access to any sources of social and emotional support. Sources of support can include institutions, mentors, program, cohort mates, friends, cultural organizations, family and so on. Although not all URM students will access the same sources of support, students who may be lacking in support from certain sources can seek support from alternate sources that serve to counterbalance the lack of support from other sources, as was shown in Dres' case.

Findings for Question 2: How do URM students' lived experiences and perceptions of their institution, program and other sources of support contribute or inhibit their persistence in the doctoral program?

Stephanie and Joy in general reported strong and positive experiences which they felt contributed to their success in their academic programs. They both mentioned areas in which

they could have more support, such as financially, but did not feel that it inhibited their persistence to degree completion in their doctoral programs. Their positive experiences reflect positive interactions with institutional level, academic, and social and emotional support available to them.

Dres' experiences and perceptions of his institution and program were not as positive as those shared by the other participants. Although overall he felt unsupported by his institution and program, he relied heavily on the support of his PI to help navigate his academic experiences. He also relied on the support of his family to help him through his doctoral program even stating that this degree was earned by his whole family. Dres utilized the support of his PI and family as well as his own personal drive to persist through his doctoral program. He felt that if he was able to persist to degree completion, it would allow him to pursue a future career in academia as a professor. He expressed that this goal was driven by his desire to improve diversity and give URM students examples of themselves in academia to turn to for support. His dedication to improving diversity efforts towards more equitable and inclusive programs in STEM was the driving factor behind completing his degree.

Chapter Five: Discussion and Conclusion

This final chapter will review the purpose of this study and discuss the implications this study has on the areas of practice and policy and areas for future research in understanding the factors that contribute to the retention of URM students' in doctoral programs, specifically in STEM fields, to degree completion. Through the lens of the "whole-self" framework, it is clear that the interplay between multiple levels and types of support influence how URM students experience their STEM doctoral programs. As shown in the three cases, multiple threads including institutional support, academic support and social and emotional support come together to knit a tapestry that depicts how URM students experience their doctoral programs and institutions. It also will show how a student's level of self-efficacy, sense of belonging, and social integration can explain how student's access different systems of support through their programs and institutions. For the purpose of this discussion, I will offer areas of focus for policy and practice in which institutions and doctoral programs have influence. In the concluding section, I will explain how using the "whole-self" framework can help institutions and STEM-based doctoral programs support URM students and guide future inquiries.

Overview of the Study and Problem

The purpose of this study was to understand the factors that contribute to the retention of URM students' in doctoral programs, specifically in STEM fields, to degree completion, directly from the students' perspectives. Retention of URM students is the most important factor to expanding both the STEM workforce and diversifying the professoriate. To best understand the factors leading to retention and degree completion in URM students, it was valuable to understand their lived experiences and how those experiences shape their perceptions of support. Current research has not focused on the lived experiences of racially diverse URM students once

they enter their doctoral programs in STEM fields and how their experiences compare to those of their white counterparts. More importantly, we must understand if these experiences have any impact on the retention, persistence and successful degree completion of the racially diverse student.

Through the interviews with the three research participants I was able to identify major themes and data to support the "whole-self" framework created to help frame the students' experiences with different types of support at their current institutions and doctoral programs. Each case provided valuable insight into the unique experiences of the students as well as highlighting the similarities and differences between them. The data collected from these interviews will add to the body of knowledge surrounding the URM student experience in STEM based doctoral programs.

Areas for Focus

The cases presented in the previous chapter represent the experiences of three individual URM students in STEM doctoral programs but provide key insights into possible areas of focus for institutions and doctoral programs who aim to improve the experiences of their URM student population. Three major areas of focus that were most prevalent across all three cases include mentorship coupled with the recruitment of more URM faculty, financial support, and access to academic success programs. Institutions and programs who prioritize the support of URM students and all students can have the biggest impact by addressing students' needs using the "whole-self" framework. Although the areas of focus can each be acted on separately, institutions and programs will have limited impact on supporting the "whole student" if efforts and resources are only concentrated in one area. Programs and institutions will have the greatest impact in improving how URM students experience their doctoral program by acting in all the

areas of focus, recognizing that these three areas are interconnected. For example, access to quality mentorship can result in better access to financial resources and opportunities and access to academic success programs can result in better access to engaged mentors. Focusing efforts in each area can not only influence how students experience their doctoral programs and institutions but also provide the opportunity for more positive interactions with each area of focus.

Mentorship

Mentorship was a theme that appeared throughout each student's prior experiences and current experiences as graduate students. Opportunities for URM students to interact with and develop quality mentor relationships with STEM faculty and professionals can not only improve the students' sense of STEM identity and satisfaction with their academic performance, but also help build social capital and a strong STEM network (Baker & Lattuca, 2010; Robnett et al., 2018; Stryker & Burke, 2000). The data collected showed that the participants turned to their mentors for institutional, academic and social support throughout their education and these relationships helped increase the student's self-efficacy, sense of belonging and social integration. Access to many different high-quality mentors was shown to positively impact the student's experiences throughout their education serving as sources of academic advice, professional advice, scientific advice, and career development. The mentorship relationships described by the participants were varied and diverse, some only serving as mentors in one area of focus, some serving as continuing mentors, some as official mentors and advisors, and while others served as "momentary mentors", providing support to the students in passing.

One area that is important to note is the benefits to URM students who have URM mentors. Access to mentors who are from similar backgrounds, who may physically present as or

represent the student's racial identities, and may share similar experiences is paramount to URM students' success academically as well as their persistence to degree completion and overall feelings of support. Institutions and programs can center recruitment of URM faculty in their diversity efforts as well as working on improving the career development of URM students to help best prepare them for academic careers after degree completion.

Institutions and programs can also focus their efforts on cultivating mentorship relationships between students, faculty, staff, and outside entities. This can be done through workshops explaining mentor-mentee relationship types to students and can also include a networking component that helps students get connected to mentor opportunities outside of their institution. Targeted comprehensive mentorship training opportunities for faculty and staff would also benefit the students and improve the quality of mentorship provided to the students. Another opportunity for improvement is setting clear mentorship expectations and norms for all official faculty and student mentor relationships through informal agreements about the norms and culture of mentoring between the student and their mentor at the time they join their labs. This can be done through regular and continuing conversations between the student and the mentor and coming back to the initial agreements made when entering into the lab. Free and open discussions between students and their mentors should be ongoing and address changing needs of the relationship.

Students should also feel empowered and encouraged to reach out to other members of their academic community including program staff, campus officials and other faculty members for support and mentorship. This diversity of mentorship can help provide students with access to varied areas of expertise and expand their access to different support resources. Furthermore, students should also be encouraged and supported in providing mentorship to their peers and

other students. This creates a stronger sense of community and aids in fostering strong social integration on campuses and in programs.

Financial Support

The data collected in this study show that URM students consider financial support as a critical component to their academic success. Stipend support, cost of living, and fellowship opportunities are two major areas in which programs and institutions can focus resources to better support their URM student population. All three participants mentioned financial instability in their families and lack of generational wealth to support their academic pursuits as part of their considerations in choosing their current programs of study. Institutions and programs can help better support URM students by providing extra monthly financial stipends based on need. Doctoral programs and their hosting institutions can use a technique of assessing financial need similar to that of needs-based student loans. Using family income or personal income to identify a student's financial need, programs and institutions that offer full financial support packages to their students with a base stipend for all students, then adjust additional financial support based on need level. This would help provide more equitable financial support to URM students who are experiencing a financial disadvantage. Providing better financial support for childcare expenses and improving access to affordable childcare for parenting students is another area in which institutions and programs can redirect financial resources and better help support all students, but specifically URM students.

Assisting URM students and providing guidance on ways in which they can access affordable and on-campus housing is another important component of financial support that institutions can redirect resources towards. Students who are able to live in close proximity to

their campuses and have access to affordable housing options can focus their energy and efforts towards their academic pursuits. Removing transportation barriers and high living expenses in off campus options also helps reduce financial stress on the student. Institutions and programs can work on building more on-campus options for graduate students and can work with local developers in the nearby communities to acquire more housing options for their students. Large R-1 institutions can leverage their reputations and consistent increases in enrollments and access to financial resources to provide access to affordable housing options for their students.

Lastly, institutions and programs can use advancement and diversity funding to create fellowship opportunities for URM students that would directly provide additional financial support to the student. In most instances, if a student is awarded an internal or external fellowship that covers living expenses and/or tuition and fees, that money is simply redirected to the programs and institutions to replace the funding package offered to the student at admissions. This disincentivizes students working hard to apply for these fellowships as they get minimal additional financial support from their efforts. Although this may appear to be an unequal use of institutional and programmatic financial resources from the perspective of non-URM students, this does point more to equity between students who have access to different resources. Providing opportunities for URM students to apply for additional financial support in the form of fellowships can help provide a more equitable funding model for URM doctoral students.

Access to Academic Success Programs

In all three cases presented in this study, the students participated in some kind of academic success program prior to attending their doctoral program of study. The students indicated that these academic success programs helped them gain valuable scientific experiences

in lab settings, develop mentorship relationships and friendships with other URM students in STEM, and improve math and science course outcomes. Institutions can focus diversity efforts on developing their undergraduate URM students in STEM through increased access to these programs. Normalizing the focus on academic success for URM students in STEM at the undergraduate level can help stop the "leak" in the STEM pipeline discussed in earlier chapters. This would also help improve the post-graduation outcomes of undergraduate URM students and help make the institution's undergraduate students more competitive when applying to graduate programs or outside careers. Institutions could also concentrate efforts on creating academic success programming with local high schools and community colleges to help increase interest in STEM fields and support the academic development of URM students in their own community. This will also help combat the historical challenges URM students face associated with access to competitive math and science curriculum in their early education.

Doctoral programs could offer one-year academic success programs with an offer of admission to the PhD program contingent on successful completion of the academic success program. This will help URM students who may not be as competitive as their White and Asian counterparts to be better prepared to tackle their doctoral programs and be more likely to complete their degrees when they start a program. This would also help orient the student with campus and program resources, develop mentorship relationships prior to starting their doctoral programs, and can help improve the student's self-efficacy as well as positively influencing their sense of belonging and social integration at their institution and in their program of study.

Limitations and Positionality

As previously discussed, there are inherent limitations to this study design. Due to the limited availability of the student participants, third interviews were not conducted. I feel that

having one more opportunity to discuss certain experiences would have provided richer data and more insight into the student's lived experiences. Another limitation was the original interview questions designed for the study. Through the process of the six interviews and data analysis, it became clear that the questions asked could have been more targeted to understand specific areas that arose as major themes. My skill and comfort as an interviewer were also a limitation in this study. As the interviews progressed, I found ways to improve my interviewing skills and probe further, however, at points it was challenging to keep the participants focused on the question asked and to extract information from the more reserved participant.

Another limitation was the document review process. Although I hoped these documents would help construct the context in which the student's experiences are made, they provided very little insight to the students' experiences. Through the review of these documents, little to no evidence that supported or conflicted with the experiences the students shared was discovered. Further, these documents added little to no context to the understanding of the services available to the students through their programs and campuses or the spaces in which the students experienced their doctoral programs. They were mostly listings of initiatives and dollar amounts dedicated to diversity efforts with little to no information about the specifics of the initiatives, their activities, or the outcomes of the diversity efforts in place. These documents included things such as campus and departmental vision and mission statements, diversity statements, statements on current social and political climates, resources available to students, student organizations and mentorship programs available. These documents provided little context to the environment in which the student's experiences are made and did not provide much insight into potential mediating factors found during the interviews.

As mentioned earlier, my position as a STEM PhD program coordinator at a large R-1 institution was helpful in establishing good rapport with the participants in the study. There were some instances during the interviews where the participants shared their personal situations and struggles. As an academic advising professional with knowledge of resources and support available to the students, I chose to speak to the participants "off the record" about specific areas of support available to graduate students such as grief counseling and access to childcare reimbursements when they mentioned their specific challenges. Although this interaction during the interviews may also highlight the importance of informal mentoring opportunities that can arise in any situation. Connecting the students with these resources did not impact their participation in the study nor did this information incentivize their participation. As a member of their community with knowledge of resources it was appropriate to provide the information to the participants as a professional courtesy.

Although only specific theories were highlighted in the development of the "whole-self" framework, there are many other theories and considerations that could have been included to enhance and perhaps improve the understanding the framework helps create. The choice to use three main theories was intentional to keep the core analysis of the students experiences clear and concise. The basis of the framework in these three-core educational and psychological theories allows for related theories and ideas to be added and interchanged to gain further insights and deeper understanding of the students' experiences and is an area for future research.

Conclusion

This study and its findings add to the understanding of how URM students in STEM doctoral programs experience their programs of study and institutions. It provides further insight into how URM students access or don't access different types of support and the sources of that

support. The "whole-self" framework can be used as a method to identify areas in which programs and institutions can better serve their students and which areas are underutilized and why. This can also aid in the reimagining of how support is provided to URM students in STEM doctoral programs and by whom. This reimagining can help guide resource allocation, programming goals and development of program faculty and staff skills to best serve the needs of URM students in STEM doctoral programs. Although this study only touched on the experiences of three URM students in one geographic region, it illuminated many areas in which URM student's experiences have influenced their academic success and persistence to degree. As a community, higher education institutions and doctoral programs can focus their attention on working together with students and learning from their experiences to better serve the needs of all students, but specifically URM students. The "whole-self" framework can be used as one method to help increase the persistence and retention of URM students in STEM based doctoral programs by providing a way to assess and evaluate efforts in place to support students. Understanding the previous educational experiences of the URM student, who they turn to for different types of support and their experiences with those different types of support adds to the understanding of the student's "whole-self". Centering the student as a unique individual can assist in identifying areas of support that would best help the student in their academic success and persistence to degree completion. An area for future research includes using the "whole-self" framework as a method of evaluating the individual needs of URM students and their experiences as they enter their doctoral programs. This evaluation can be used to help identify which supports would be most beneficial to the student and their academic success. It can also help guide programs and institutions to evaluate their current efforts of providing support to students and if those efforts would be better allocated in other areas.

Appendix A

Survey Questions

Demographic Information:

Multiple choice/fill in the blank

Age

Race

Gender Identity

Sexual Identity

Annual Household Income

Highest Education of Parents/Guardians

Previous Institutions attended and Degree level

Military Status

Current Institution Information:

Fill in the blank

Name

Location

Degree Name

What year in doctoral program are you in?

What is the average time to completion of your doctoral program?

Have you previously participated in an academic transition or summer bridge program? If so, please list the name of the program.

Factors Influencing Graduate Program Selection:

Likert Scale (strongly agree- strongly disagree)

The admissions process was clear.

The admissions process was cost prohibitive.

The admissions requirements were clearly spelled out.

I was able to get answers to my questions during the application process.

The application was clear and accessible.

Yes/No

I was invited for an in-person interview.

I was invited for a phone interview.

I participated in an on-campus recruitment.

I was offered a financial support package.

The financial support package included tuition and fees.

The financial support package included a monthly stipend.

I selected my institution because of the financial support package.

I identify as a member of the scientific community.

Factors Impacting Campus Climate, Sense of Belonging, Self-Efficacy:

Likert Scale (strongly agree- strongly disagree)

Personally:

I feel empowered to learn here.

I believe in my potential to succeed academically.

I see other students that represent my race on campus.

Faculty:

Faculty empowers me to learn here.

Faculty believes in my potential to succeed academically.

There are Faculty that represent my race on campus.

Staff:

Staff empower me to learn here.

Staff believe in my potential to succeed academically.

There are staff that represent my race on campus.

Departmental Leadership:

Department Leaders empower me to learn here.

Department Leaders believe in my potential to succeed academically.

There are Department Leaders that represent my race on campus.

Racial Climate:

I have been a victim of harassment/violence on campus because of my race.

I have been treated badly/negatively on campus because of my race.

I feel that I am a member of campus.

I feel safe on campus.

I feel a sense of belonging on campus.

I am encouraged to get involved in campus activities.

I feel that my cultural background is represented on campus.

I feel that my academic achievements are impacted by my race.

Self-efficacy:

I believe in my ability to practice science.

I believe I am a scientist.

I feel empowered to practice the science I am interested in.

I feel empowered to make decisions regarding my research.

Supports and Social Integration:

Yes/No

I have a faculty mentor.

I have a staff mentor.

I have a mentor outside of the campus.

My mentor is from a similar racial background as me.

I am aware of academic supports available to me through my program or institution. (things like tutoring, study groups, campus programs that help with academic support).

I have utilized academic support during my doctoral program.

I am aware of social and emotional supports available to me through my program or institution. (things like health and well-being programs, campus counseling, cultural or racial identity centers on campus or within your program).

I have utilized social and emotional support during my doctoral program.

I am aware of financial support available to me through my program or institution. (things like fellowships, scholarships, employment opportunities)

I have utilized financial support during my doctoral program.

I feel supported by other students in my program.

I have other students who I can rely on for support.

I have personal support outside of the program or institution.

Open-ended/short answer:

If you have used or received any types of support listed above, can you please describe the type of support and briefly your experience with accessing and utilizing the support.

How satisfied were you with the support you received?

Are there other types of support from your program or institution that you have utilized during your doctoral program not listed above? If yes, please briefly explain the type of support and your experience with the support.

Are there other types of support outside of your program and institution that you have utilized during your doctoral program that are not listed above? If yes, please briefly explain the type of support and your experience with the support.

Appendix B

Interview Questions

Research Question	Researcher Question	Interview Question
Background	Who is this student? Why are they here? What is their motivation? Does this student exhibit a strong sense of science self-efficacy?	Can you tell me a little bit about why you are pursuing a doctorate?
		Tell me about why you chose this program and institution.
		Were there factors that were important to you when selecting your doctoral program?
		Tell me about how you decided on joining this program/ campus?
		Were there people you looked to for advice? If so, can you please tell me a little bit about who they are and why their advice was valuable to you?
Question 1: In what ways do URM students experience and perceive support from their programs and institution during doctoral training?	How does this student describe support? What knowledge of resources does this student have?	Overall, do you feel supported by your program and institution?
		Can you describe the ways in which you feel supported or unsupported by your program and institution?
		Are you aware of resources available to

		you as a student? Can you describe or name those resources?
Question 1a: What are URM students' experiences on campus with respect to accessing resources and opportunities (for example, academic, financial, and health and well-being related)?	What knowledge of academic resources/supports does this student have?	Are you aware of any academic supports available to you as a student, either from the campus or your program exclusively?
	How does this student experience academic resources/supports?	Can you describe your experiences with accessing academic support on campus or in your program?
		Follow up: In your opinion, was the academic support easy to access? Follow up: What were the barriers to accessing academic support?
	What knowledge of financial resources/supports does this student have?	Are you aware of any financial supports available to you as a student, either from the campus or your program exclusively?
	How does this student experience financial resources/supports?	Can you describe your experiences with accessing financial support on campus or in your program?
		Follow up: In your opinion, was the financial support easy to access? Follow up: What were the barriers to accessing financial support?

Question 1b: In what ways do URM students connect their experiences with support to a commitment (or lack of) for diversity, equity, and inclusion.	Does the student have a strong sense of belonging? Does the student feel socially integrated?	Do you feel part of or that you belong to the larger campus community?
		Do you feel part of or that you belong in your program?
		Do you feel the campus has a commitment to diversity, equity and inclusion?
		Do you feel your program has a commitment to diversity, equity and inclusion?
		Follow up: can you describe a little bit about why you feel that way?
		Follow up: can you think of opportunities for the campus or program to enhance their commitment to diversity, equity and inclusion? Follow up: can you discuss those opportunities in more detail?
		Has your program or institution asked you to participate in programming or panels about being an underrepresented minority student in a doctoral program.

		Follow up: How did you feel about the request? Follow up: If you participated, were you compensated for time and energy?
		Do you feel part of or that you belong to the larger campus community?
		Do you feel part of or that you belong in your program?
		Do you feel the campus has a commitment to diversity, equity and inclusion?
		Do you feel your program has a commitment to diversity, equity and inclusion?
		Follow up: can you describe a little bit about why you feel that way?
		Follow up: can you think of opportunities for the campus or program to enhance their commitment to diversity, equity and inclusion? Follow up: can you discuss those opportunities in more detail?
		Has your program or institution asked you to

		participate in programming or panels about being an underrepresented minority student in a doctoral program.
		Follow up: How did you feel about the request? Follow up: If you participated, were you compensated for time and energy?
Question 1c: How do URM students perceive the social and emotional support provided by their institution and doctoral program?	Does the student have a strong sense of belonging? Does the student feel socially integrated?	In your opinion, do you have access to social and emotional support? If yes, where do you access this support and from who?
		Have you ever utilized campus or program specific supports or resources? Can you describe your experiences with those resources?
	Does the student feel socially integrated?	Do you have an official or unofficial mentorship relationship with someone in your program or on campus?
		Do you have an official or unofficial mentorship relationship with someone off of campus? If yes, how did this relationship come to be?
Question 2: How do URM students' lived experiences and perceptions of	Does the student have a strong sense of belonging?	Can you describe a time you felt supported

their institution, program and other sources of support contribute or inhibit their persistence in the doctoral program?	Does the student feel socially integrated?	or unsupported by your program or institution?
	Does this student exhibit a strong sense of science self-efficacy?	In your opinion, what supports (available or not) help you feel successful and able to focus on your educational pursuits?
		In your opinion, what barriers inhibit you from feeling successful and able to focus on your educational pursuits?
	Does the student feel socially integrated?	Can you describe a time you felt supported during your doctoral program, either by the program, faculty, or campus?
		Can you describe a time you did not feel supported? What, if anything, could have changed that experience?
	How is the student experiencing their doctoral training program and institution?	Is there anything you would like to add about your experience as an underrepresented minority student in a doctoral program?
		Are there things we have not discussed that have impacted your perceptions of your program and institution?
		Are there things we have not discussed that

		have impacted feeling supported or unsupported by your doctoral program and/or institution?

Appendix C

Follow- Up Interview Questions

Joy Myrtle:

1. You discussed the U star MARC program and the impact that program had on your research trajectory, can you talk to me a little more about that?
2. You mentioned medical school being expensive, and that a good stipend was important to you. How would you rank financial considerations in your decision to attend the program you're in now?
3. You mentioned that your family was an important part of your education over different points of our conversation. Can you explain to me a bit more about their role in your academic success?
4. Do you think homeschooling provided you a different experience than your peers?
5. Do you think it made you think of what educational support looked like in a different way from your peers?
6. You mentioned giving advice to your siblings and you said "I think I'm becoming what I wish I had". Can you describe what you wish you had more in depth?
7. Is there a personal reason you are interested in the enzymes and in particular the ones that degrade plastics?
8. Last time we spoke you were wrapping up your first quarter, we are no more than half way through your second quarter, how are you feeling and experiencing things.
9. Is your cohort still tightknit?
10. Do you feel like your SHORE offer will help with your educational success? Does it relieve any stress or financial burden, knowing you have 5 years guaranteed housing?
11. Do you feel like you would have gotten the SHORE offer if you hadn't been so persistent?
12. How does UCSD measure up in comparison to other institutions you were considering? You mentioned Scripps, did you compare UCSD to other institutions too?
13. How important is teaching to you? Why?
14. How are you feeling in terms of support this quarter (from program or institution)?
15. Have you participated in any support-based activities, you had previously mentioned the program for students with ADHD and CalFresh? Have you been able to access those or other resources?
16. How is the search for a PI and rotations going for you?
17. Do you feel like you have mentors at UCSD at this point who can help you with questions and advice?
18. Can you talk to me a bit more about the hierarchy you mentioned between undergrads, grads, stuff, faculty etc. and how that makes you feel as a part of the campus community?
19. Do you feel like you have seen any representation now in faculty and administrators that represent diverse backgrounds?
20. You mentioned you identify as Latina, Jewish, and Middle Eastern. Can you talk to me more about that? How do you manage your identities and how they might intersect?

21. Since joining your program have you been asked to participate in any panels or programming about being a URM student in STEM?
22. Is your cohort still a main source of support? Have you reached out to your program or needed any additional support from them since last we spoke?
23. Have you started to identify any mentors either staff, faculty or more advanced students at UCSD?
24. What kinds of support help you feel successful and able to focus on your education?
25. You mentioned at the end of our interview, that "it was tough, it was a pretty rocky road." and that you were happy you were able to find mentorship because you wouldn't have known what to do. Can you dive a little deeper into that?
26. Can you offer some words of advice for a student who might be where you are one day?
27. Is there anything else you would like to share?

Stephanie:

1. You discussed finances and racism as reasons why you chose this program. Can you explain more why those were important to you?
2. You mentioned your friends you sought advice from when you were trying to pick where you wanted to attend. What kinds of questions did you ask them? What did they share?
3. You mentioned you worked between undergrad and masters and PhD, can you tell me more about the type of work you were doing and did that also influence you in going back to school for the PhD?
4. You mentioned the writing workshops; do you plan to utilize those when you are closer to your dissertation writing process?
5. You mentioned that if you needed some kind of academic support you would just go to your PI? Can you explain a little more about the types of help you get from your PI?
6. You mentioned you have an external grant; can you tell me a bit more about what that helps support? Do you get any extra funds for travel or conferences? Are you able to get some stipend from the grant?
7. You mentioned that more funding would be nice, but do you feel like the current funding you receive is a barrier to studying and completing your degree? Does it create financial burdens?
8. You mentioned that your cohort was a large part of your support system, can you talk more about that?
9. Is your cohort diverse?
10. Can you tell me more about the outreach you did with SACNAS? Did that make you feel like you were connected with students like yourself? What was the impact of those events?
11. Can you tell me a little more about the MESA program you participated in?
12. Did you feel you wanted to participate in outreach because it had a personal impact on you as you went through your education? Can you tell me more about that?
13. Can you tell me a little more about the diversity mentorship program through Genentech? Have you benefited? If so, how?
14. Do you plan to reach out to your mentors for non-academic things as you move further through your program? You mentioned that you currently hadn't reached out for things like that.

15. You mentioned it sometimes felt like everyone is on their own island? Does that feel isolating? How do you cope with that?
16. You mentioned the beginning of your program was challenging, can you tell me a bit more about that?
17. You mentioned that you were the only Mexican in your lab for a while, was that challenging for you to adjust to?
18. Do you feel that COVID has impacted your course of study or progress? Has it created any challenges that weren't there before it happened?

Dres:

1. You had mentioned in our previous interview that your love of science started at a young age and that you wanted to be a professor. Can you tell me a little bit more about that and are you still interested in teaching in higher education?
2. You mentioned many groups you were involved in for historically underrepresented and excluded groups. Did you select those specifically because of they were for URMs?
3. Have you participated in any program not specifically for URMs?
4. You mentioned your family being a really big support system and that you "roped your cousin into everything you did". Does your cousin come to you for support?
5. If so, can you describe the type of support that is sought from your cousin?
6. You mentioned that you had changed programs due to family reasons, and that you were very specific in what your goals and intentions were. What prepared you to make these decisions regarding changing programs and what to look for or not look for?
7. You mentioned that you felt isolated during your first two years in your current program. How did you cope with those feelings? What kind, if any, support did you seek out?
8. You mentioned that you didn't feel supported by your current institution the way you did at your past institution; can you talk to me a bit more about that? How it feels different or what the other institution did well that is lacking at your current institution?
9. You mentioned that 60% of the time what you were experiencing was the same as any student on campus, is that good or bad experiences? For example, is the institution serving or not serving all students in certain ways? Can you talk more about that?
10. We had discussed your involvement in activism and that it was a big part of your identity, can you talk to me more about how your activism supports you?
11. How does your activism help your community?
12. We talked about how you sometimes felt you had to overcompensate because of your identity as a URM student. Is this due to instances of bias you have experienced?
13. How does the code-switching make you feel?
14. You mentioned that over your time at the current institution you spent about 60% of your time presenting in a way to work around bias you experience. How does that make you feel?
15. Do you feel your identities are respected by your program and institution?
16. You said that you felt that some of the barriers you were experiencing with program staff trickled down to subgroups of students as well. How were the students aware of your situation with fellowships etc.? Why would they know these things?

17. You mentioned that your current institution was working to be an HSI (Hispanic serving institution) but that you didn't feel they were serving you. Can you talk to me a bit more about that?
18. What things could the campus do to help build a better sense of community with all students?
19. You mentioned that sometimes you "just have to lone-wolf it". How many people like you do you think are lone-wolfing it? Do you have ideas for ways to gather the lone wolves into a pack?
20. We talked a bit about how after the death of George Floyd, people you interacted with were now seeming to show interest in your well-being and you mentioned that annoyed you. Can we unpack that a bit more?
21. You also mentioned how administrators talk a lot about how much financial resources they put into efforts, and how that was a bit offensive to you. Do you think that money could be better spent? If so, how?
22. You mentioned you liked doing panels because there is the opportunity to be vulnerable and reach people. Can you talk a bit more about that and what you get back from it?
23. You talked about "momentary mentors" can you explain to me the value you get from these relationships? Do you feel like you have been in that role for others?
24. You mentioned mentorship training being really important and offered some insight into how you felt these trainings were best utilized. What are 3 key take aways you want mentors to have after these trainings? What is most important to you as a URM student?
25. Let's end this on a note of hope. What is your hope for a student who identifies like you maybe just starting the program?
26. Anything else you would like to add?

Appendix D

Participant Recruitment Email

Hello,

My name is Melody Bazyar and I am a doctoral student in the Joint Doctoral Program in Educational Leadership at the University of California, San Diego and California State University, San Marcos. I am reaching out to seek assistance with my dissertation study.

I am interested in finding out more about how underrepresented minority students in STEM based doctoral programs experience graduate school, specifically looking at different types of support.

For this study, I am looking for participants who meet the following criteria:

• Are at least 18 years of age

• Identify as an Underrepresented minority (African American/Black, American Indians/Alaska Natives, and/or Latino)

• Are currently enrolled in a STEM based Doctoral Program at an R-1 Institution

• Have advanced to candidacy

Would you be able to assist me in distributing this call to your constituents? If you know someone who may qualify for this study, I would greatly appreciate it if you could share this information.

Students who are interested in participating, can do so by participating in the survey at the link below.

All information submitted for this study will be kept confidential and secure. Only pseudonyms will be used in the data collection and publication of my dissertation.

Survey Link: https://ucsd.co1.qualtrics.com/jfe/form/SV_86PXU16tLLpSbvE

Specifically, I plan on having two phases for this study. Phase 1 asks participants to complete an online survey that will take approximately 15-20 minutes and will collect information on which factors were influential in selecting their graduate program, how the student views the climate on campus, and questions that help with understanding the student's science self-efficacy, sense of belonging, and level of social integration. This online survey will also serve to recruit participants for further individual interviews. Submissions may be deemed incomplete if unusual responses are provided (e.g., irregular timing or unusual responses).

If participants self- select to be contacted to take part in Phase 2 of this study, they will do one 60 to 90-minute video conference or in-person interview (dependent on safety considerations) to share their experiences at their current institution and their educational experiences in their doctoral programs as they relate to different types and systems of support. The interviews will also attempt to collect a brief history on the student's previous educational experiences and how they decided on their current program. These interviews will allow for the interviewees to

address what they find valuable about their experiences in graduate education as diverse students as well.

After completion of the interview, participants will receive a $20.00 Amazon e-gift card.

For questions about this study, please call me at 858-414-9873 or email mebazyar@ucsd.edu . You may also contact my research advisor, Dr. Christopher Halter at chalter@ucsd.edu.

I greatly appreciate your support!

With gratitude,

Melody Bazyar, MPH
Pronouns: she/her/hers

Doctoral Student - Cohort 15
Joint Doctoral Program - Educational Leadership
University of California, San Diego
California State University, San Marcos

Appendix E

Participant Recruitment Flyer

Participants needed for a study about support of underrepresented minority (URM) students in STEM Doctoral Programs.

WHO CAN PARTICIPATE?

- Are at least 18 years of age
- Identify as a URM (African American/ Black, American Indians/Alaska Natives, and/or Latino)
- Are currently enrolled in a STEM-based doctoral program at an R-1 Institution
- Have advanced to candidacy
- Willing to take a short 15 – 20 minute survey about your experience

After the survey, there is an opportunity to participate in an in-depth 60 – 90 minute interview about your experiences with different types and systems of support.

WHAT IS THIS STUDY?

Support matters. This study seeks to understand how URM students in STEM-based Doctoral Programs experience graduate school — specifically different types of support from retention to degree completion — from the student's perspective.

TAKE THE SURVEY

IRB #800014 | Melody Bazyar (Researcher) mebazyar@ucsd.edu | Dr. Christopher Halter (Advisor) chalter@ucsd.edu

References

Allen, B. M., & Zepeda, Y. (2007). From baccalaureate to the professoriate: Cooperating to increase access to graduate education. *New Directions for Higher Education,138*, 75-82.

Allen-Ramdial, S.A. & Campbell A.D. (2014) Reimagining the pipeline: Advancing STEM diversity, persistence, and success, *BioScience, 64* (7), 612–618.

American Association for the Advancement of Science. (2011). *Vision and change in undergraduate biology education: A call to action.* Washington, DC.

Ampaw, F., & Jaeger, A. (2011). Understanding the Factors Affecting Degree Completion of Doctoral Women in the Science and Engineering Fields. *New Directions for Institutional Research., (152),* 59.

Ancis, J.R., Sedlacek, W.E., & Mohr, J.J. (2000) Students perception of campus cultural climates by race. *Journal of Counseling and Development*, *78*, 180-185.

Ashley, M., Cooper, K.M., Cala, J.M., & Brownell, S.E. (2017). Building better bridges into STEM: A synthesis of 25 years of literature on STEM summer bridge programs. *CBE-Life Sciences Education, 16,* 1-18.

Baker, V.L., & Lattuca, L.R. (2010). Developmental networks and learning: Toward an interdisciplinary perspective on identity development during doctoral study. *Studies in Higher Education, 35*(7), 807-827.

Bandura, A., & Schunk, D.H. (1981). Cultivating competence, self-efficacy, and intrinsic interest through proximal self-motivation. *Journal of Personality and Social Psychology, 41*(3), 586-598.

Bandura, A. (1986). The explanatory and predictive scope of self-efficacy theory. *Journal of Clinical and Social Psychology, 4*, 359-373.

Bernal, D.D., & Villalpando, O. (2002). An apartheid of knowledge in academia: The struggle over the "legitimate" knowledge of faculty of color. *Equity and Excellence in Education, 35*(2). 169-180.

Bersola, S. H., Stolzenberg, E. B., Fosnacht, K., & Love, J. (2014). Understanding admitted doctoral students' institutional choices: Student experiences versus faculty and staff perceptions. *American Journal of Education, 120*(4), 515-543.

Boske, C., & Elue, C. (2017). Are you qualified to be a member of this "elite group"? A school leadership preparation program examines the extent "diverse" candidates are admitted to graduate school. *Journal of Cases in Educational Leadership, 20*(2), 145-162.

Boud, D., & Tennant, M. (2006). Putting doctoral education to work: Challenges to academic practice. *Higher Education Research & Development, 25*(3), 293.

Brownstein, R. (2010, July). The gray and the brown: The generational mismatch. **The National Journal.** P.14-22.

Cabrera, A.F. & Nora, A. (1994). College students' perceptions of prejudice and discrimination and their feelings of alienation: A construct validation approach. *Review of Education, Pedagogy, and Cultural Studies, 16,* 387-409.

Carlone, H.B., & Johnson, A. (2007). Understanding the science experiences of successful women of color: Science identity as an analytic lens. *Journal of Research in Science Teaching, 44*, 1187-1218.

Carnegie Classifications of Institutions of Higher Education. (2018). Basic Classification Description. Retrieved from http://carnegieclassifications.iu.edu

Castellanos, J., & Gloria, A.M. (2007). Research considertaions and theoretical application for best practices in higher education: Latina/os acheiveing success. *Journal of Hispanic Higher Education, 6*(4), 378-396.

Chandler, T. (1993). Incorporating diversity into the professoriate. *New Directions for Teaching and Learning,* (54), 91.

Chemers, M.M., Zurbriggen, E.L., Syed, M., Goza, B.K., & Bearman, S. (2011). The role of efficacy and identity in science career commitment among underrepresented minority students. *Journal of Social Issues, 67*(3), 469-491.

Cherwitz, R. A. (2005). Diversifying graduate education: The promise of intellectual entrepreneurship. *Journal of Hispanic Higher Education, 4*(1), 19-33.

Davis, G.M., Hanzsek-Brill, M.B., Petzold, M.C., & Robinson, D.H. (2019). Students' sense of belonging: The development of a predictive retention model. *Journal of the Scholarship of Teaching and Learning, 19*(1), 117-127.

Delpit, L. (2012). *Multiplication is for white people: Raising expectations for other people's children.* The New Press.

DiAngelo, R. (2011). White fragility. *International Journal of Critical Pedagogy, 3*(3), 54-70.

Eubanks-Turner, C., Beaulieu, P., & Pal, N. (2018). Smooth transition for advancement to graduate education (STAGE) for underrepresented groups in the mathematical sciences pilot project: Broadening participation through mentoring. *Primus, 28*(2), 97-117.

Fleming, J. (1984). "Blacks in college: A comparative of students' success in black and in white institutions". San Francisco, CA: Jossey-Bass.

Frey, W. H. (2015). Diversity explosion: How new racial demographics are remaking America. Washington, D.C.: Brookings Institution Press.

Gandara, P., Maxwell-Jolly, J. (1999). *Priming the pump: Strategies for increasing achievement of underrepresented minority undergraduates.* The College Board Publications.

Garces, L. M., and U. M. Jayakumar. (2014). Dynamic diversity: Toward a contextual understanding of critical mass. *Educational Researcher 43*(3): 115–24.

Given, L.M. (2008). *The SAGE Encyclopedia of Qualitative Research Methods* (Volume 2). SAGE Publications, Inc.

Griffin, K. A., & Muniz, M. M. (2011). The strategies and struggles of graduate diversity officers in the recruitment of doctoral students of color. *Equity & Excellence in Education, 44*(1), 57-76.

Hall, J.D., O'Connell, A.B., & Cook, J.G. (2017). Predictors of student productivity in biomedical graduate school applications. *PLOS ONE, 12*(1).

Harper, S.R. (2010). An anti-deficit achievement framework for research on students of color in STEM. *New Directions for Institutional Research,* 4, 63-74.

Hernandez, P.R., Schultz, P.W., Estrada, M., Woodcock, A., & Chance, R.C. (2013). Sustaining optimal motivation: A longitudinal analysis of interventions to broaden participation of underrepresented students in STEM. *Journal of Educational Psychology, 105*(1), 89-107.

Iverson, Susan V. (2007). Camouflaging Power and Privilege: A Critical Race Analysis of University Diversity Policies. *Educational Administration Quarterly, 43*(5), 586-611.

Kumashiro, K.K. (2000). Toward a theory of anti-oppressive education. *Review of Educational Research, 70*(1), 25-53.

Ladson-Billings, G. (2014). Culturally relevant pedagogy 2.0: aka the remix. *Harvard Educational Review, 84*(1), 74-84.

Laursen, S. L., & Weston, T. J. (2014). Trends in Ph.D. productivity and diversity in top-50 U.S. chemistry departments: An institutional analysis. *Journal of Chemical Education, 91*(11), 1762-1776.

Leonardo, Z. (2004). The Color of Supremacy: Beyond the discourse of 'white privilege'. *Educational Philosophy and Theory, 36*(2), 137-152.

Lindsey, R. (2016). *The cultural proficiency manifesto: Finding clarity amidst the noise.*

A manual for school leaders. Corwin Press.

Lipschutz, S. S. (1993). Enhancing success in doctoral education: From policy to practice. New *Directions for Institutional Research, 1993*(80), 69-80.

Maton, K.I., Beason, T.S., Godsay, S., Sto. Domingo, M.R., Bailey, T.C., Sun, S., & Hrabowski III, F.A. (2016). Outcomes and processes in the Meyerhoff scholars' program: STEM

PhD completion, sense of community, perceived program benefit, science identity, and research self-efficacy. *CBE- Life Science Education*, 15, 1-11.

Maxwell, J.A. (2013). *Qualitative research design: An interactive approach*. Sage.

McIntosh, P. (1989) White Privilege: Unpacking the Invisible Knapsack. *Peace and Freedom Magazine,* 10-12.

Merriam, S.B., & Tisdell, E.J. (2016). *Qualitative research: A guide to design and implementation.* Jossey-Bass.

Moneta-Koehler, L., Brown, A.M., Petrie, K.A., Evans, B.J. & Chalkley R (2017) The limitations of the GRE in predicting success in biomedical graduate school. *PLOS ONE, 12*(1).

Monroe, K. R., & Chiu, W. F. (2010). Gender equality in the academy: The pipeline problem. *PS: Political Science and Politics, 43*(2), 303-308.

Munoz-Dunbar, R., & Stanton, A. L. (1999). Ethnic diversity in clinical psychology: Recruitment and admission practices among doctoral programs. *Teaching of Psychology, 26*(4), 259-263.

National Academy of Sciences, National Academy of Engineering, and Institute of Medicine. (2010). *Rising above the gathering storm, revisited: Rapidly approaching category 5.* Washington, DC: National Academies Press.

National Center for Education Statistics, U.S. Department of Education. (2012). Degrees conferred by degree-granting institutions, by level of degree and sex of student: Selected years, 1869-70 through 2021-22. In Digest of education statistics. Retrieved April 21, 2019, from the National Center for Education Statistics Website: https://nces.ed.gov/programs/digest/d12/tables/dt12_310.asp

National Center for Education Statistics, U.S. Department of Education. (2016). Status and Trends in the Education of Racial and Ethnic Groups 2016. Retrieved October 21, 2019, from the National Center for Education Statistics Website: https://nces.ed.gov/pubs2016/2016007.pdf

National Center for Education Statistics, U.S. Department of Education. (2015). The National Assessment of Educational Progress (NAEP). The nation's report card, 2015. Retrieved April 21, 2019, from the National Center for Education Statistics Website: http://nces.ed.gov/nationsreportcard/pdf/studies/2011462.pdf

National Science Foundation. (2014). NSF approved STEM fields. Retrieved from https://www.btaa.org/docs/default-source/diversity/nsf-approved-fields-of-study.pdf?sfvrsn=1bc446f3_2

Pacheco, W. I., Noel, R. J., Jr., Porter, J. T., & Appleyard, C. B. (2015). Beyond the GRE: Using a composite score to predict the success of Puerto Rican students in a biomedical PhD program. *CBE - Life Sciences Education, 14*(2), 1-7.

Payne, E. C., & Smith, M. J. (2018). Refusing Relevance: School Administrator Resistance to Offering Professional Development Addressing LGBTQ Issues in Schools. *Educational Administration Quarterly, 54*(2), 183-215.

Programme for International Student Assessment (PISA), (2015). Key findings from PISA 2015 for the United States Retrieved October 21, 2019 from the OECD website: https://www.oecd.org/pisa/PISA-2015-United-States.pdf

Poock, M.C. (2007). A shifting paradigm in the recruitment and retention of underrepresented graduate students. *Journal of College Student Retention, 9*(2), 169-181.

Posselt, J.R. (2014) Toward inclusive excellence in graduate education: Constructing merit and diversity in PhD admissions. *American Journal of Education*, 120, 481-513.

Posselt, J. R. (2018). Trust networks: A new perspective on pedigree and the ambiguities of admissions. *The Review of Higher Education, 41*(4), 497-521.

Potvin, G., Chari, D., & Hodapp, T. (2017). Investigating approaches to diversity in a national survey of physics doctoral degree programs: The graduate admissions landscape. *Physical Review Physics Education Research, 13*(2), 020142-1-020142-13.

President's Council of Advisors on Science and Technology. (2012). *Engage to excel: Producing one million additional college graduates with degrees in science, technology, engineering, and mathematics.* Washington, DC: U.S. Government Office of Science and Technology.

Quarterman, J. (2008). An assessment of barriers and strategies for recruitment and retention of a diverse graduate student population. *College Student Journal, 42*(4), 947.

Quinn, D.M., & Cooc, N. (2015). Science achievement gaps by gender and race/ethnicity in elementary and middle school: Trends and predictors. *Educational Researcher, 40*(6), 336-346.

Ramirez, E. (2016). Unequal socialization: Interrogating the Chicano/Latino(a) doctoral education experience. *Journal of Diversity in Higher Education, 10*(1), 25-38.

Robnett, R.D., Nelson, P.A., Zurbriggen, E.L., Crosby, F.J., & Chemers, M.M. (2018). Research mentoring and scientist identity: Insights from undergraduates and their mentors. *International Journal of STEM Education, 5*(41).

Rodriguez, S., Cunningham, K., & Jordan, A. STEM identity development for Latinas: The role of self- and outside recognition. *Journal of Hispanic Higher Education, 18*(3), 254-272.

Solorzano, D., Ceja, M., & Yosso, T. (2000). Critical race theory, racial microaggressions, and campus racial climate: The experiences of african american college students. *The Journal of Negro Education, 69*(1/2), 60-73.

Strayhorn, T.L. (2008) Fittin' in: Do diverse interactions with peers affect sense of belonging for Black men at predominantly White institutions?. *NASPA Journal, 45*(4), 501-527.

Strayhorn, T.L. (2018). *College students' sense of belonging; A key to educational success for all students.* New York: Routledge.

Stryker, S., & Burke, P.J. (2000). The past, present and future of an identity theory. Social *Psychology Quarterly, 63*(4), 284-297.

Sue, D. W., Nadal, K. L., Capodilupo, C. M., Lin, A. I., Torino, G. C., & Rivera, D. P. (2008). Racial microaggressions against black Americans: Implications for counseling. *Journal of Counseling & Development, 86*(3), 330-338.

Tinto, V. (1975). Dropouts from higher education: A theoretical synthesis of recent literature. *A Review of Educational Research, 45*(1), 89-125.

Tinto, V. (1987). *Leaving college: Rethinking the causes and cures of student attrition.* University of Chicago Press.

Tomasko, D.L., Ridgway, J.S., Waller, R.J., & Olesik, S.V. (2016). Association of summer bridge program outcomes with STEM retention of targeted demographic groups. *Journal of College Science Teaching, 45*(4), 90-99.

Trujillo, G., & Tanner, K.D. (2014). Considering the role of affect in learning: Monitoring students' self-efficacy, sense of belonging, and science identity. *CBE- Life Sciences Education*, 13, 6-15.

Tyson W., Lee R., Borman K.M., & Hanson M.A. (2007). Science, technology, engineering and mathematics (STEM) pathways: High school science and math coursework and postsecondary degree attainment. *Journal of Education for Students Placed at Risk, 12*(3), 243–270.

U.S. Census Bureau (2018, March 13). Older People Projected to Outnumber Children for First Time in U.S. History. (Report No. CB18-41). Retrieved from https://www.census.gov/newsroom/press-releases/2018/cb18-41-population-projections.html

U.S. Census Bureau (2018, March). Demographic Turning Points for the United States: Population Projections for 2020 to 2060. (Report No. P25-1144). Retrieved from https://www.census.gov/content/dam/Census/library/publications/2018/demo/P25_1144.pdf

Valenzuela, A. (2010). *Subtractive schooling: US-Mexican youth and the politics of caring.* Suny Press.

Wang X. (2013). Why students choose STEM majors: Motivation, high school learning, and postsecondary context of support. *American Educational Research Journal, 50*(5), 1081–1121.

Whittaker, J.A., & Montgomery, B.L. (2010). Cultivating diversity and competency in STEM: Challenges and remedies for removing virtual barriers to constructing diverse higher education. *The Journal of Undergraduate Neuroscience Education, 11*(1), A44-A51.

Wilson, M., DePass, A., & Bean, A. (2018). Institutional interventions that remove barriers to recruit and retain diverse biomedical PhD students. *CBE - Life Sciences Education, 17*(2), 1-14.

Wilson, Z.S., McGuire, S.Y., Limbach, P.A., Doyle, M.P., Marzilli, L.G., & Warner, I.M. (2014). Diversifying science, technology, engineering, and mathematics (STEM): An inquiry into successful approaches in chemistry. *Journal of Chemical Education*, 91, 1860-1866.

Winkle-Wagner, R., & McCoy, D. L. (2016). Entering the (postgraduate) field: Underrepresented students' acquisition of cultural and social capital in graduate school preparation programs. *Journal of Higher Education, 87*(2).179-205.

Winkleby, M.A., Ned, J., Ahn, D., Koehler, A. & Kennedy, J.D. (2009). Increasing diversity in science and health professions: A 21-year longitudinal study documenting college and career success. *Journal of Science Education and Technology*, 18, 535-545.

Zamudio, M., Russell, C., Rios, F.A., Bridgeman, J.L. (2011). *Critical race theory matters: Education and ideology.* New York, NY: Routledge.