6-2021

The Social Support Networks of Students Who Identify As Black and Latino/A/X in STEM and SBE Graduate Programs at Predominantly White Institutions

Kristi A. Tullis
Western Michigan University

THE SOCIAL SUPPORT NETWORKS OF STUDENTS WHO IDENTIFY AS BLACK AND LATINO/A/X IN STEM AND SBE GRADUATE PROGRAMS AT PREDOMINANTLY WHITE INSTITUTIONS

by

Kristi A. Tullis

A dissertation submitted to the Graduate College
in partial fulfillment of the requirements
for the degree of Doctor of Philosophy
Chemistry
Western Michigan University
June 2021

Doctoral Committee:

Megan Grunert Kowalske, Ph.D., Chair
Kelly Teske, Ph.D.
Andre Venter, Ph.D.
D. Eric Archer, Ph.D.

THE SOCIAL SUPPORT NETWORKS OF STUDENTS WHO IDENTIFY AS BLACK AND LATINO/A/X IN STEM AND SBE GRADUATE PROGRAMS AT PREDOMINANTLY WHITE INSTITUTIONS

Kristi A. Tullis, Ph.D.

Western Michigan University, 2021

Graduate students from historically underrepresented minority (URM) groups (those who identify as Black/African-American, Hispanic/Latino/a/x, Native American, Native Hawaiians/Pacific Islanders and/or Alaska Natives) encounter systemic and institutional hindrances to degree completion when enrolled in STEM doctoral programs at predominantly white institutions (Guiffrida & Douthit, 2010). Support networks have been identified as an important component for retention and success for graduate students from URM groups (Carlone & Johnson, 2007; Clewell, 1987; Johnson-Bailey, Valentine, Cervero, & Bowles, 2008; Joseph, 2012; Sweitzer, 2009). This study investigates the composition and structure of URM graduate students' support networks, where their support comes from, in what capacity, if URM women graduate students gravitate toward support systems that match their cultural/racial background or gender identity, and if URM students who complete degrees experience feelings of loneliness and isolation, which is a contributing factor to underrepresentation of students from these minority groups (Gloria, Robinson, Hamilton, & Willson, 1999).

Data for this study were collected through a longitudinal interview process combined with four social network surveys per individual as students progressed through their programs. Interview data allowed for longitudinal tracking of social support network members, which was

triangulated with the data from the social networking surveys and analyzed through the lenses of egocentric network analysis, constructivist grounded theory, and critical race theory. Many participants in this study needed and found a strong support network through student organizations that matched their cultural/ethnic/racial background. Countless students struggled with feelings of isolation and loneliness, yet finding support from campus groups helped fill this void. The final data collected after most of them had left graduate school showed significant discrepancy between their reported robust social network and their open-response data where they indicated a significantly reduced social network and the onset of feelings of loneliness. This dissertation, while focusing on social support networks for these URM graduate students at predominantly white institutions, has the potential to address social justice issues and equal opportunities for those identifying as Black/African American and Hispanic/Latino/a/x, encourage the importance of reaching a critical mass in higher education settings, work toward combatting systemic racism, add greater diversity and perspectives to the more elite careers that these degrees will lead to, and show the importance of having a social support network while pursuing a prestigious degree, the Ph.D.

ACKNOWLEDGMENTS

During the course of my Ph.D. degree, I have received a great deal of support and assistance, without which I would not have made it through this program.

First and foremost, I am extremely grateful to my advisor and mentor, Dr. Megan Grunert Kowalske. Megan, thank you for your priceless advice, continuous support, and patience during my Ph.D. study. Your expertise was invaluable in formulating research questions and methodology. Your guidance and insightful feedback pushed me to sharpen my thinking, bringing my work to a higher level. I will always treasure our relationship.

I would like to express my sincere gratitude to her and the National Science Foundation Grant No. 1309055 for the funding opportunity that supported my research. Many thanks to all participants that took part in the study and enabled this research to be possible.

My gratitude extends to my committee members, Dr. Kelly Teske, Dr. Andre Venter, and Dr. D. Eric Archer for their constant encouragement, time, genuine interest, and enthusiasm in my research and success.

I would like to extend my heartfelt thanks to the Chemistry Department at Western Michigan University for pushing me to expand my subject knowledge and chemistry applications. I am also grateful to the Kowalske research group for taking the time to review my work and for their honest feedback every week.

My success would not have been possible without the support and nurturing of my friends and family. My mom (Jackie), dad (Terry), Grandma Barb, and Papa Jack have been some of my biggest cheerleaders and provided unwavering love and support. I know you are

always there for me. I am so thankful for making this journey with a wonderful friend who I met in the program, Jennifer Ribble. Jenny, I am so thankful for being study buddies, lab partners, research groupmates, and for becoming confidants. Thank you for pushing me through the past five years, your encouragement, and for our deluxe grilled cheese and tomato soup dates. I cannot begin to express my thanks to so many other friends that provided enjoyable distractions to rest my mind outside of my research in the form of walks, runs, bike rides, beach time, or wine.

Lastly, I would like to thank my husband, Phil, and my two amazing children, Kyler and Tegan. I could not have completed this dissertation, passed my CUMEs, finished my program, and kept any form of sanity if you had not given me an incredible amount of love, support, and grace. I love you guys so much. Your encouragement, understanding, and support has been unrelenting as I decided I wanted to get my Chemistry Ph.D. while also trying to be a mom, wife, teacher, triathlete, and so many other things. Phil, I am so grateful that you accepted more of the financial burden, cooked more dinners, packed more lunches, and made me an office where I could escape to work. However, you do not get to quit your job and have me do all the work for the next five years, sorry!

Kristi A. Tullis

TABLE OF CONTENTS

Table of Contents—Continued

Table of Contents—Continued

CHAPTER

Table of Contents—Continued

CHAPTER

Table of Contents—Continued

LIST OF TABLES

LIST OF FIGURES

List of Figures—Continued

CHAPTER I

INTRODUCTION

Background

Undergraduate students majoring in science, technology, engineering, and math (STEM) programs have less than a 40% degree-completion rate over the course of 6 years (President's Council of Advisors on Science and Technology, 2012). The retention and graduation rates for undergraduate women and students from historically underrepresented minority (URM) groups (defined as those who identify as Black/African-American, Latino/a/x or Hispanic, Native American, Native Hawaiians/Pacific Islanders and/or Alaska Natives) in STEM programs are even less, at fewer than 23% in 2009 (Hurtado, Eagan, & Chang, 2010), especially at predominantly white institutions (PWIs) (Huang, Taddese, & Walter, 2000). The large gaps in enrollment and degree attainment between URM students and non-URM students in higher educational settings, especially at the undergraduate level, are partially attributed to systemic racism, institutional inequities, and many other well documented factors (Allen, 1985, 1992; Brainard, 1998; D'Augelli & Hershberger, 1993; Gloria, Castellanos, Lopez, & Rosales, 2005; Moreira et al., 2019; Ong, Wright, Espinosa, & Orfield, 2011; Toven-Lindsey, Levis-Fitzgerald, Barber, & Hasson, 2015). One key barrier is the lack of faculty that match the student body. There are not enough women STEM faculty, STEM faculty of color, and scientists/professionals that represent the population. The way to alleviate this is to have more women and students of color going to graduate school, finishing their degrees, and becoming professors and

scientists/professionals. Therefore, the graduate student population is a pivotal area of study to address the shortage of diverse faculty.

According to the data from the National Center for Education Statistics (NCES, 2020), students from URM groups accounted for only 15% of doctoral degrees from all fields of study awarded in 2018, yet they account for 33.4% of the population in the United States (United States Census Bureau, 2019). URM students have the highest attrition in graduate school with over 66% of Black students not completing their programs at PWIs (Gloria, Robinson, et al., 1999). The participation of URM doctoral students is disproportionately low and has been identified as a growing national concern (Sowell, Allum, & Okahana, 2015) as we are quickly becoming the most racially and ethnically diverse nation in the world. By 2060, current minority groups will constitute about 56% of the United States population, yet their projected higher education enrollment is not expected to increase much (Cole & Espinoza, 2008; National Science Foundation, 2019; Smedley, Butler, & Bristow, 2004). With persistently low numbers of URM graduates completing higher education degrees, there is not an adequate representation of the U.S. population in the STEM workforce (Byars-Winston, Estrada, Howard, Davis, & Zalapa, 2010; National Science Board, 2008). Diversity in the workforce is necessary for many reasons, as it generates more creativity, brings forth a different set of experiences, increases productivity, provides a different point of view when problem solving, helps dissolve cultural biases, and helps provide fresh perspectives (Campbell, 2018; Hodapp & Brown, 2018; Powell, 2018). Diverse doctoral degree holders will allow for the United States to remain competitive on a global level (Autenrieth, Lewis, & Butler-Purry, 2017; Gibbs, McGready, Bennett, & Griffin, 2014). It is vital for the United States to embrace its increasing population diversity and support all students seeking advanced degrees to help meet an ever-increasing demand for STEM

professionals. The only way to meet this need and promote higher degree attainment is to discover what difficulties URM students are facing and how those students can best be supported in their degree programs.

PWIs are much more abundant in the United States compared to historically Black colleges and universities (HBCUs), yet even with diversity initiatives, they struggle with recruitment and retention of students from historically underrepresented groups (Hernandez & Lopez, 2004; McClain & Perry, 2017; Palmer, Maramba, & Dancy, 2011). Many studies have shown that URM students struggle significantly more than their non-URM peers at PWIs (Adair, 2001; Cole & Espinoza, 2008; D'Augelli & Hershberger, 1993; Espinosa, Turk, Taylor, & Chessman, 2019; Johnson-Bailey, Valentine, Cervero, & Bowles, 2016). The feelings of isolation, loneliness, cultural alienation, and unwantedness in their programs and the university at large have been difficult for many students from underrepresented groups (Gloria, Kurpius, Hamilton, & Willson, 1999; Gloria & Rodriguez, 2000). Allen (1992) suggested that minority students found it necessary to form their own social and cultural support networks within the white-oriented institution to help with these feelings and to fill the voids they were experiencing. This has been shown to help with URM student persistence (Carter, 2006; Pidgeon, 2008), and universities are trying to create programs to support URM students with limited success.

Social support networks are crucial for all doctoral students but are especially needed for students from underrepresented minority groups studying at PWIs (Allen, 1985, 1992). Scott (2017) said that social support networks provide "help, support, opportunities, and even a sense of well-being that would not otherwise be possible" (p. 2). Other studies have shown the importance of having a strong support network and how it can influence students' progress, persistence, and overall satisfaction in higher educational settings (Allen, 1992; Carlone &

Johnson, 2007; Clewell, 1987; Cole & Espinoza, 2008; Estrada, Burnett, Campbell, & Campbell, 2016; Joseph, 2012; Sweitzer, 2009). When looking for a support network, students often look for those around them experiencing similar things, and there is a strong desire for people with similar traits to befriend one another (McPherson, Smith-Lovin, & Cook, 2001). Seeking relationships with others that have similar attributes may or may not be purposeful, but it allows a feeling of belonging and helps to satisfy the need to feel safe and content (Kadushin, 2012; McPherson et al., 2001).

The Council of Graduate Students reported that 2,582 chemistry doctoral degrees were awarded by 619 graduate schools in 2017, but only 10.8% of those doctoral degrees were awarded to URM students (Okahana & Zhou, 2018). This equates to about 279 URM chemistry doctoral graduates total, or just less than one URM graduate student per two institutions. With the underrepresentation of minority students in graduate programs overall, conducting a research study focusing only on chemistry students would not provide enough viewpoints to draw any meaningful conclusions. However, underrepresentation in chemistry is not an isolated problem as the historical and institutional challenges for historically underrepresented groups are also present in other STEM and SBE (social, behavioral and economic sciences) fields. By looking at these systemic issues with a broader lens, we can provide insights into graduate programs in general, which then provides information that can be applied to chemistry programs.

Purpose of the Study

Social support networks are crucial for students from underrepresented minority groups while they are attending STEM and SBE graduate programs at PWIs. However, little is known about how those support networks are formed, if and how they change over the course of the graduate program, the composition of those networks, the perceptions of support received from

these networks, and the feelings of loneliness that occur without adequate support. Therefore, it is necessary to examine successful URM graduate students over the course of their programs at their respective PWIs to better understand their support networks.

Prior studies have not looked at the persistence and retention of students from URM groups from a social networking perspective. Therefore, this study utilized multiple data sources collected over a longitudinal timeframe to better understand the social support networks of students from underrepresented minority groups enrolled in doctoral programs at PWIs. Chapter II (article 1) in this dissertation lays out the methodological process that was developed to allow for multi-faceted analysis of the egocentric participant networks, including ways to visualize composition, turnover, and homophily. In the third chapter (article 2), we examine the composition of social support networks for study participants. In this article we explore the makeup of their networks and the roles the alters in their networks play, and combine survey data with interview data to understand the value of particular alters found within their support networks as well as in what areas within their support network participants felt they were lacking support. Chapter IV (article 3) explores homophily trends for Black/African American and Hispanic/Latina women with regard to both race and gender, utilizing the interview data to understand their feelings about their support networks. Finally, in Chapter V (article 4), we examine graduate students who completed their doctoral degrees to understand their perceived experiences of loneliness and isolation, the social support they sought while in graduate school, and how lack of a social network after graduation affects them.

Significance of the Research

This dissertation research is meant to help all concerned parties understand the social support networks of URM graduate students that are essential while attending PWIs. Lack of

minority enrollment and persistence in STEM and SBE programs at PWIs is well documented, but with this research, there is the potential to help future URM graduate students as they encounter shared experiences and feelings. This research aims to provide PWIs with an inside look at what experiences URM students are undergoing, and to allow them the opportunity to create spaces where they can find the support they need. Minority students might have a better experience if they are able to see the successes of URM graduate students, and hopefully it will increase URM recruitment and persistence rates, as well as continue to add to the diversity of the scientific community and workforce, which is critically needed.

Research Questions

Questions from Article 2 (Chapter III):

1. What do the social support networks of Black/African American- and Hispanic/Latino/a/x-identifying graduate students at PWIs look like?
2. What are the views and perceptions of support networks held by Black/African American- and Hispanic/Latino/a/x-identifying graduate students?

Questions from Article 3 (Chapter IV):

1. What do the social support networks of Black/African American and Hispanic/Latina women graduate students look like with regard to showing tendencies toward homophily on the attributes of race/ethnicity or gender?
2. How do Black/African American and Hispanic/Latina women graduate students express feelings about the support (or lack of support) they receive from their support network?

Questions from Article 4 (Chapter V):

1. How do Black and Latino/a/x graduate students at PWIs describe their social support networks?
2. What feelings of loneliness and isolation are they encountering in their graduate programs?
3. What changes in their social support networks do they describe over time?

Foundations and Frameworks

The foundation of this work is social support and social networks. Social support can be actual or perceived (Cohen, Gottleib, & Underwood, 2000) and is often reliant on personal, cultural, and environmental factors (Gottlieb & Bergen, 2010). Social networks vary constantly with life situation and location (Christakis & Fowler, 2010). Social support networks may consist of different types of support, such as from family, coworkers, friends, and bosses (Prell, 2012), and different people often fulfill different needs. Because URM graduate students have a greater likelihood for experiencing feelings of loneliness and isolation than non-URM students while attending PWIs, they have been identified as potentially having a greater need for robust social support networks. Having support networks, especially with those that share the same race or gender, has aided in the successes of URM students as it helps with persistence, motivation, and feelings of inclusion (Williams, Thakore, McGee, & Price, 2017).

Egocentric network analysis was specifically used as the methodological framework to explore each individual's support network. With this framework, we focus on the relational aspects of the listed alters and their attributes. It allows the researcher to see how many people are connected to the ego (participant), as well as the similarities and differences found in their support networks (S. Lee, Chung, & Park, 2018). The social network survey and interview data

together can create complete social network structures that are then able to be analyzed individually and can then be made into generalizations about larger populations (Perry, Pescosolido, & Borgatti, 2018). With egocentric research that is collected longitudinally, we are able to explore patterns based on network size, race/ethnicity, gender, role, and composition (Perry et al., 2018). This dissertation focuses solely on the ego, their reported social support network, and their perspectives.

Critical race theory (CRT) is another framework that guides this research as we explore the personal experiences of students from underrepresented minority populations. URM students experience issues within education that their non-URM counterparts are not impacted by, and it is imperative to center their voices and experiences to understand the structural and institutional racism that impacts their experiences in higher education. Dixson and Rousseau Anderson (2017) said that even after 20 years of applying critical race theory in education, we still use the voices of students from underrepresented groups to show the "importance of the personal and community experience of people of color as sources of knowledge" (p. 34). These voices need to be shared and their perspectives empowered in order to confront issues of power, privilege, racism, and other oppressions (Daftary, 2018). We use CRT as a lens to expose the inequity students from minority groups experience while creating and building their social support networks and pursuing their graduate degrees. This allows us to understand how they are/are not supported by their institution, their experiences with systemic racism, their perceptions of isolation and loneliness, and how their time spent in these graduate programs has affected their lives. Morris and Parker (2019) noted that "when viewed through the lens of CRT, the stories told carry the weight of liberation and fly in the face of marginalization and deficit representations of historically marginalized racial and ethnic groups" (p. 24). This dissertation

aims to capture and understand the perspectives of these marginalized groups studying at PWIs to critique the systems and structures that continue to pose barriers to their success in an effort to reform higher education.

Methodologically, the interview data collection and analysis portion of this work was guided by constructivist grounded theory (CGT) (Charmaz, 2006). Melvin and Ginsburg (2018) noted that CGT is a methodology "used to understand a social process or phenomenon inductively, where knowledge is constructed from participant experiences" (p. 4). This process is flexible and evolving, allowing models to be constructed as the researcher analyzes data. With CGT, participants are selected in order to be used as data to help "contribute to the understanding about a specific social phenomenon" (Melvin & Ginsburg, 2018). In the case of this dissertation, participants who are members of underrepresented minority populations attending graduate programs at predominantly white institutions were recruited to help us understand the challenges that traditional graduate education poses to students who do not identify as white cis-het men. Charmaz (2005) noted that any conclusions or theories generated from the data are merely suggestive and incomplete, while (Melvin & Ginsburg, 2018) noted that findings from the study should be discussed in terms of transferability, allowing the ability of "how" the findings from one study can be transferred to another context or situation. In this case, the voices and experiences shared by participants can be utilized to understand and illuminate racist and sexist structures that continue to exist in higher education as a way to bring about institutional and cultural change.

Definition of Terms

The following terms are defined to help the reader understand the context of each term in this study.

STEM: Science, Technology, Engineering and Mathematics

SBE: Social, Behavioral and Economic Sciences

Underrepresented Minority (URM): According to the National Science Foundation (2019), this term includes individuals identifying as Black/African American, Hispanic/Latino, American Indians, Alaska Natives, or Native Pacific Islanders/Native Hawaiians. These groups are "underrepresented minorities" because their representation with STEM/SBE is lower than their representation within the U.S. population. White and Asian groups are both identified as over-represented in STEM/SBE since their participation and degree attainment is higher than it is in the U.S. population. We are moving toward identifying individuals by their chosen racial/ethnic/cultural identity rather than lumping all individuals from these groups as one monolithic entity. For this study, we had students identifying only as Black/African American and Hispanic/Latino/a/x, so these group identities will be used when describing data and findings.

Black: For the purpose of this dissertation, Black will be used to identify all students that identify as Black or African American, as it is generally understood to be a more inclusive term.

Predominantly White Institution (PWI): Institutions of higher learning in which white students account for 50% or greater of the student enrollment.

Hispanic/Latino/a/x: For this study, Hispanic and Latino/a/x are often used interchangeably, though they actually mean several different things. Hispanic refers to people who speak Spanish and/or are descended from Spanish-speaking populations. Latino/a/x refers to men, women, or gender-neutral/nonbinary people who are from or descended from people from Latin America. Some students in this group do not like this larger grouping and would rather

identify as their specific origin (such as Mexican American). Others strongly oppose Latinx because it is inconsistent with Spanish language.

Assumptions and Limitations of the Study

An assumption in this study was that data on social support networks for the URM graduate student participants could be gathered from social networking surveys as well as from interviews to develop theory. This could be a limitation because we relied on participant report and participant recall when collecting data. We tried to alleviate the chance of this happening by asking about support networks during interviews and following up by email to clarify support network membership, but it is possible that someone could be left out, which could have drastically changed some participants' E-I indices that had smaller support networks. Another assumption was that all participants answered the questions honestly and completely during the interviews and surveys. It was important for the participants to feel comfortable during the interviews, which is why we had them choose the location on or off campus to have the interview conducted. We also wanted them to feel as though they could trust us with their experiences and reassured them that we would use pseudonyms to protect their anonymity. However, some participants may have still been uncomfortable sharing personal details or feared repercussions from their department or university if they were to be exposed due to being the only minority in their programs.

Another limitation of this study was the size of the participant pool. Despite multiple email invitations sent out and an incentivized structure to help make the pool bigger, we had 30 total participants. The participants were also all volunteers. However, they were compensated for their time and received Amazon gift cards for their willingness to participate, which was intended to entice more participation. We also did not have as many men as we did women that

participated. This hindered some aspects of the study as we could not look at the homophily tendencies of men since we had no Black men that completed all of the surveys. There was a wide age range amongst participants, which provided some challenges because they were in graduate school at different stages of their lives. Some were younger and had always been full-time students, while some had other life experience and were in their 30s and 40s. We did not take this age difference into consideration when comparing social support networks, even though older participants could potentially have a much larger and established support network.

The participants may not fully represent all URM graduate students at PWIs as we limited the study by sampling from only three PWIs in the Midwest United States. Midwestern states typically have a smaller population of students that identify as being Black or Latino/a/x compared to states that are considered majority-minority, such as Hawaii, New Mexico, California, Texas, and Nevada. Therefore, the representation of students that participated could potentially have different experiences than students in another part of the country. A larger and more diversified group from around the country may provide similarities and or differences to what we have encountered. Students that participated could have grown up in an area that was predominantly white, so their experiences at a predominantly white institution may seem normal to their prior life experiences. However, if a student is from another area of the country and moved to the Midwest to specifically attend one of these PWIs, they might have very different experiences. There could have been value in recruiting at historically Black colleges/universities (HBCUs) and Hispanic-serving institutions (HSIs). We would have been able to compare the networks of these students, what they felt was lacking or what was plentiful in their support network, as well as compare their feelings of loneliness and isolation to see how those relate to students at PWIs.

Another limitation of this study was that the data focused on the social support networks and experiences of URM graduate students in STEM or SBE programs. Social support networks and experiences may vary from one program to another. Findings may not be applicable to all URM graduate students at PWIs around the country. As a white female researcher that has worked in education for 15 years in predominantly white communities, there is likely some unconscious and conscious biases from prior workplace experiences; however, great care was used to avoid this by attending an implicit bias training and by using critical race theory as a lens for much of this study. There is no conflict of interest, however, throughout this study. Because constructivist grounded theory was used, emerging themes began to arise from the data (Charmaz, 2006), leading to the focus of loneliness and isolation with regard to social support. Therefore, additional literature review was done about URM students and their sense of loneliness to further investigate the resulting theory (Urquhart, 2013). Urquhart (2013) stated that while literature reviews are often done before the research, they are not necessarily comprehensive, allowing the data to guide the previous literature research, however taking care to not let literature review bias the study analysis.

Organization of the Study

Chapter II is a comprehensive review of the literature on social network analysis as well as the significance of social support for URM students. In Chapter II, "A Method for Conducting Egocentric Network Analysis for URM Graduate Students in a Longitudinal Study," the primary topic discussed is the method with which the study was originally based upon as a whole when designing an egocentric network analysis longitudinally. For subsequent papers, small modifications were made to the methods to better address research questions. It details the overall design of the study, while also discussing the different aspects that this egocentric

network data allows us to analyze. Examples include using VennMaker to visually see the ego's alters and their attributes, overall ethnic and gender homophily using E-I index calculations, how to see alter consistencies and network turnover comparisons in Excel, distribution of support network members, ethnic and gender composition and homophily within role analysis via E-I index, overall network turnover, and specific network turnover.

Chapter III, "The Composition of Social Support Networks of URM Graduate Students at Predominantly White Institutions," is focused on the social networking survey data looking at the percentage distribution of support network data for Black and Hispanic students and the interview data where participants shared their thoughts and feelings about those support members and groups. Chapter IV, "Racial and Gender Homophily: Support Networks for Black and Hispanic/Latina Women Graduate Students at Predominantly White Institutions," utilized both the social network survey and interview data to explore the homophily of social support networks for women participants. Black and Hispanic women's E-I indexes were calculated by sub-categories within their support networks for ethnicity and gender and were compared. Their interview data about who they specifically sought support from was also analyzed. Chapter V, "URM Graduate Students' Experiences of Loneliness and Isolation at PWIs and the Transition to Feeling Support, Inclusion, and Validation," focuses on URM graduate students' feelings of loneliness and isolation and their social supports as they navigate through graduate school at a PWI. Chapter VI summarizes the overall findings from this study as well as discusses the implications of this research.

CHAPTER II

A METHOD FOR CONDUCTING EGOCENTRIC NETWORK ANALYSIS FOR URM GRADUATE STUDENTS IN A LONGITUDINAL STUDY

Introduction

Social network analysis (SNA) is an approach based on the study of interactions among individuals or groups embedded in "webs of connections" (Crossley et al., 2015; Freeman, 2004; Kadushin, 2012; Scott, 1988, 2017). Network analysts describe and explain the patterns, properties, and structures displayed in these social relationships and examine links among groups. Lumino, Ragozini, and Vitale (2016) noted how it is assumed that "networks have emergent properties, not explained by their constituent parts and not present in the parts which can be more adequately analyzed by seeing whole groups of parts and their interconnections as a whole" (p. 183). Social support studies investigate the value and the extent of an individual's social connections (K. P. Smith & Christakis, 2008). Perry et al. (2018) said that a substantially motivating issue for network researchers is to recognize "how patterns of relationships in personal networks influence the flow of resources to an individual" (p. 15). Additionally, Kadushin (2012) noted that network analysis "gives us powerful tools and concepts to unravel matters of concern" (p.11) as far as the lack of resources and support that an individual may need.

Two distinct research designs commonly studied are socio-centric (whole, complete, or full) networks and egocentric (ego or personal) networks. Socio-centric network analysis focuses on structural properties and patterns of relations, ties, and interactions between each pair of

nodes (human individuals) within whole groups as opposed to the individual relationships themselves (Borgatti, Everett, & Johnson, 2013; Crossley et al., 2015; Perry et al., 2018). Socio-centric network designs enable researchers to quantify relationships within defined groups such as residents of a town, the HR department in a company, or the senior class at a high school. With this design, it is imperative to have the entire network available to sample so relations can be collected for a whole population in order to connect each of the individuals within the group.

Egocentric network analysis focuses on the individual of interest (the ego) and their unique network of contacts (alters). These alters form around the centralized ego rather than whole groups with connections identified between all individuals within the group. This type of research involves all alters with whom an ego has a tie of a specific nature, such as including family members, book club friends, sports friends, emotional support, information sharing, etc. It also explores the nature of the ties connecting them, characteristics of these alters, and making generalizations about these ties (Borgatti et al., 2013; Crossley et al., 2015). When studying egocentric networks, the ties or the ways alters are connected are studied as well as information or attributes about those alters.

Scott (2017) writes that "a network of connections can provide help, support, opportunities, and even a sense of well-being that would not otherwise be possible" (p. 2). Building networks of peer support and other social support has been found to be especially important for underrepresented minority (URM) students throughout graduate school to help reduce isolation and low motivation that can form as a result from unsupportive environments (Carlone & Johnson, 2007; Clewell, 1987; Estrada et al., 2016; Joseph, 2012; Sweitzer, 2009). The social support system for URM students can greatly influence their progress and persistence through their graduate education (Joseph, 2012). There is much overlap between social support

and social networks, and social network analysis will allow us to examine any evident patterns in the social relationships and structure that these URM students form over time.

Studies have shown that Black and Hispanic students that attend predominantly white institutions (PWIs) encounter considerably more difficulties with assimilation than their white counterparts. Allen (1992) noted that

> Black students often find it necessary to create their own social and cultural networks in order to remedy their exclusion from the wider, white-oriented university community. Of all the problems faced by Black students on white campuses, those arising from isolation, alienation, and lack of support seem to be most serious. (p. 29)

Colleges and universities that graduate a larger percentage of URM students are cognizant to the social needs of these students, which has shown a direct relationship with the persistence of URM students in STEM (science, technology, engineering, and mathematics) graduate programs (Carter, 2006; Pidgeon, 2008). URM students face many challenges as they progress through graduate school as far as persistence and retention, as they have a higher probability of leaving their graduate programs than non-URM students (Carter, 2006). Having a support network is a critical variable for URM graduate students as they successfully persist to degree completion, especially at a PWI (Allen, 1992). Understanding how these support networks for URM graduate students function is necessary not only for the institution itself, but for society as it affects individuals' long-term social mobility, their career advancement, and ultimately their socio-economic status ("Holding a Four-Year College Degree Brings Blacks Close to Economic Parity With Whites," 2005; Pidgeon, 2008). Despite numerous programs around the country that offer student-centered supports for URM students, Medina (2015) noted that the enrollment and graduation rates in STEM fields still "do not generate enough growth to meet the demand or satisfy the need for a highly skilled and diverse workforce for professions designated as critical STEM industries" (p. 18).

While research has shown that strong social support networks are critical for URM students as they navigate doctoral programs, little is known about how they form, change, or are composed. Consequently, this study had multiple, emergent research questions. This study utilized social network analysis, specifically egocentric network analysis, to address multiple research questions:

- Are these URM graduate students seeking gender or racial homophily despite being surrounded by non-URM students?
- Does one ethnic/cultural group seek homophily more than another?
- Are URM students seeking support from certain people in certain roles?
- What does their support network look like?
- Do these people stay in their network over time, or is there a high turnover?
- Are these URM students having higher turnover rates of certain genders or ethnicities?
- Does their network composition change?
- How are their networks affecting them as they progress through graduate school?

These research questions were all asked initially, and as the project evolved, more research questions arose leading to further data manipulation and interpretation. What we share here are the methodological considerations and decisions starting from study design through data analysis. The goals of this chapter are to explain the research questions, methodology, design, visualization, analysis, and challenges of egocentric network analysis for a small population of graduate students over the course of 3 years.

Study Design

In this paper, we will first describe the timeline of the study, the participants involved, where they are from, and how they were identified and recruited. Then, the social networking survey design aspect of the study describing the social networking survey used will be described, followed by the qualitative design aspect and then how we integrated the two. There will then be a very detailed data analysis section explaining the many kinds of analysis that can be done and what can be learned through each. Finally, we will address challenges that were faced as well as conclusions made.

Participants

For this longitudinal study, the registrar for three Midwest PWIs sent out a survey (termed *pre-survey*) in the spring of 2015 to all non-white graduate students in their first or second year of a doctoral program or master's-to-doctoral program. More specifically, these graduate students included students enrolled in STEM or social, behavioral, and economic sciences (SBE) graduate programs. Asian students were then removed from the participant pool. Participants that took this pre-survey and were identified as being URM in these programs were considered to qualify for the study.

Those who took this pre-survey were compensated with a $25 Amazon gift card. At the completion of the pre-survey, they were prompted to leave contact information (this was separate from the survey to preserve anonymity) if they were interested in participating in the study and interview process. Everyone that noted interest in the interviewing process was emailed to schedule their first of six interviews for the spring of 2015. Not everyone that initially expressed interest in the pre-survey to participate in the full study responded to schedule interviews. Those participants that qualified, opted into the interview process, and completed interviews received

Amazon gift cards in the amount of $25 for the first two interviews, $50 for the third and fourth interviews, and $100 for the final two interviews (for a total of six interviews). A post-survey was also given at the completion of the study in the spring of 2018, and those participants that completed it received a $25 Amazon gift card.

Everyone that participated in the entire study was also included in the social networking study. Three social networking surveys were given at three different time frames to all participants (see Table 2.1) via a Qualtrics link embedded in an email, but no compensation was offered for the completion of them. Through the surveys and interviews, we were able to collect both social networking data as well as qualitative data.

Table 2.1

Timeline of the Study; The Pre/Post Surveys, Social Networking Surveys, and Interviews

	Spring 2015	Fall 2015	Spring 2016	Fall 2016	Spring 2017	Fall 2017	Spring 2018
Pre/Post Survey	■						■
Social Networking Survey			■		■		■
Interview	■	■	■	■	■	■	

Social Networking Design—Personal Network Research Design (PNRD)

A personal network research design involves sampling a collection of unrelated respondents (called egos) and asking about the people in their lives (called alters) (Halgin & Borgatti, 2012). The first step of the personal network research design is to have the ego generate an exhaustive list of alters from whom they seek support. This is the name generator. One

downfall to allowing infinite number of alters to be named is that it can be overwhelming for the ego by making them think that they need to fill in all of the blanks, or feel inferior that they do not have this many people in their network (Perry et al., 2018). For our study, a Qualtrics survey was created for the participants to complete online. There are advantages and disadvantages to online surveys. Some advantages include the low cost, quick data collection, and elimination of interviewer effects. Disadvantages of online surveys include not having someone to guide the participant through the task at hand; distractions in the environment the participant is in, which can cause errors and missing data; and survey fatigue leading to incompletion. Despite the disadvantages, online surveys have been deemed to produce reliable and valid network data (Perry et al., 2018).

The three surveys for this study included several name generators, which asked participants to name any family members, peers, friends (within or outside of the program), advisors, faculty members, GSA/campus organization group members, religious community members, or program society members to whom they felt they could turn for support or with whom they had a relationship. We used group prompts to help participants think of all the places and people they might get support from. All but one of the name generators had blanks for the participant to fill in alters. The one exception was for the advisor/faculty members section where the roster choice method was used. At the beginning of the survey, participants chose the program in which they were enrolled, and then they were able to choose from a drop-down list of faculty members that were in the department if they found them to be a support to them. This question required considerably more work to set up because it was necessary to go to the university's website and find out what professors to include for each program participants were enrolled in. One downfall we found to this method is that some university websites were not

current, so a few times a participant would email and tell us they could not find their advisor. This was a quick administrative fix, yet still inconvenient. Another downfall to the drop-down list in lieu of the blanks in this circumstance was that this question might trigger the ego to write down someone that is supportive outside of their department or someone with whom they have a mentoring or advising relationship that is not on the drop-down list and they would not be able to. Even though they could have mentioned them later in the survey, they might forget about them by the time they move on to that question. Participants could name up to 10 faculty members, 8 students in the program, 8 students outside of the program, up to 3 alters each for religious groups, campus organizations, societies, student government groups, and family members. A methodology alternative for future work would involve having the same number of alter slots in the survey for each question to not potentially limit any alters from being named while not overwhelming the ego.

For each name generator, there were also drop-down name interpreter questions that elicited additional information about the ego's perceptions of the attributes of each alter. Participants were asked to identify whether the alter would be considered either an underrepresented minority (URM) or non-underrepresented minority (non-URM). URM was defined as being Black/African American, Native American, Hawaiian/Pacific Islander, or Hispanic/Latinx, while non-URM was defined as being White/Caucasian or Asian. Participants then included their frequency of interaction with this individual (daily, weekly, bi-weekly, monthly, every 6 months), as well as gender (male or female). At the time the survey was administered, we used the terms *male* and *female*. However, based on current recommendations regarding gender and identity, the terms *man/men* and *woman/women* will be used for the

remainder of the study and for analysis purposes. See Figure 2.1 for one question from the survey as an example.

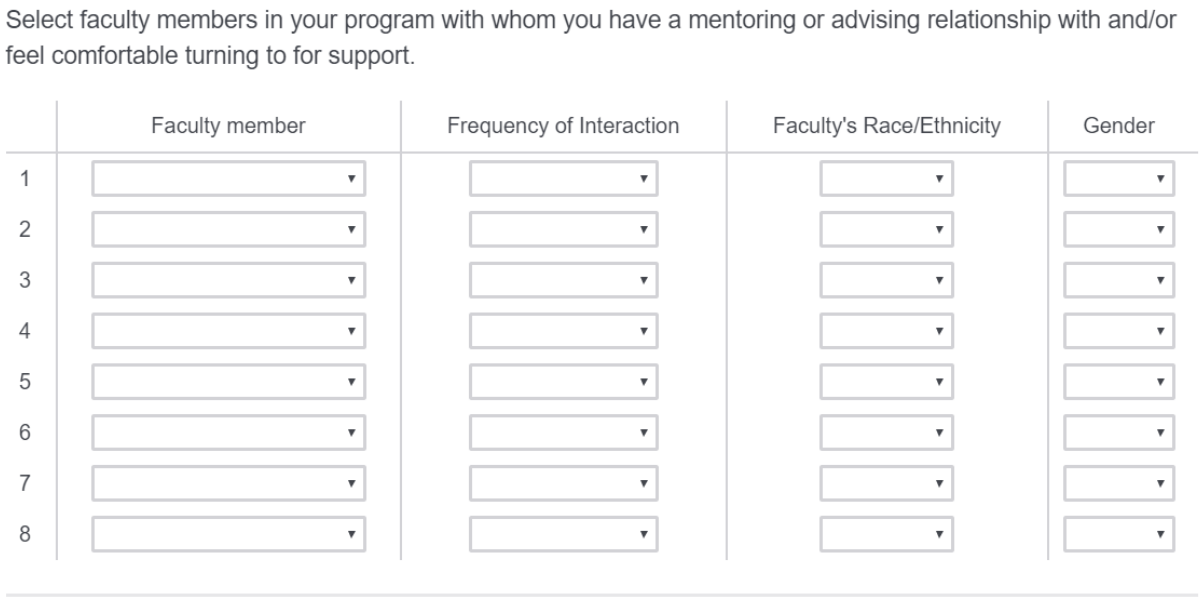

Figure 2.1. One question from the Qualtrics survey to exhibit the types of name generator and name interpreter questions asked on the social networking surveys.

Once these whole ego networks were compiled, we were then able to further study the whole support network and analyze the distribution of alters that the egos were seeking support from, what network trends existed, and whether they were seeking gender or racial homophily, meaning support from others similar to themselves. It should be noted that with personal networks, we see the world only through the ego's eyes, so we do not know who the ego chooses not to connect with. The personal network approach does not allow us to determine whether the respondent consciously chooses to avoid a particular race or gender or if they live in a community with a highly unbalanced race or gender ratio and therefore have limited opportunities to nominate men, women, URM, or non-URM alters (Halgin & Borgatti, 2012).

When this study began, we did not have the Qualtrics survey ready for the Spring 2016 send-out date (from Table 2.1). Therefore, in May 2017, two personal network surveys were sent to participants. One survey was written in past tense and asked about people who were in their support network when they first started graduate school, while the second survey asked the respondents about people in their support network currently. One challenge to this method was that there was confusion with participants who did not read the directions in the email that explained that they were sent two links; the first link would lead to the survey for when they "started" graduate school, and the second link would lead to the survey for who was "currently" in their support network. Another challenge to this was the possibility that they forgot who may have been in their network at the beginning of graduate school.

In March 2018, a third and final social networking survey was sent to participants to be completed. This survey was identical to the second survey that asked who was currently included in their support network. All surveys were the same format. The largest challenge with this study was lack of participation. This may have been due to their busy schedules or the fact that gift cards were not offered for those that completed the social networking surveys. Despite many emails asking participants in the full study to complete the surveys, some just did not complete all three surveys. Only complete data sets were included in this analysis and participants with incomplete data sets were excluded.

Qualitative Study Design

Conducting one-on-one interviews in an intimate, confidential setting is less of a challenge for the respondent as it is "less cognitively challenging for the respondent than telephone or self-administered surveys, easing the burden of egocentric data collection on respondents" (Perry et al., 2018, p. 46). In this study, we had much better compliance with

interviews compared to surveys. While the online surveys were extremely beneficial, having the interview data proved to be a great tool, as the participant was in a controlled environment, had fewer possible distractions, and were only required to use basic verbal and listening skills.

In this study, five members of the research team conducted 194 interviews over six unique semi-structured interview sessions. These were conducted biannually: spring of 2015, fall 2015, spring 2016, fall 2016, spring 2017, and fall 2018 (see above Table 2.1). Interviews were conducted on or near the campus that the participants attended, at a location of the participants' choosing to facilitate comfort and confidentiality. Thirty participants completed all six interviews and were given pseudonyms to protect participant anonymity. All interviews were audio recorded and then professionally transcribed.

The interviews focused on a variety of topics related to participants' graduate school experiences, with a subset focused on support networks. Some interview questions prompted students to note any relationship changes with their advisor, committee members, and research members. They were asked whom they turned to for help with academics, research, teaching, or coursework. Another interview question asked participants what difficulties they had recently faced, what coping strategies they used when they were having a difficult time, and who they turned to when this occurred. They were asked for an update on their relationships with their cohort and peers in their graduate program. In the interview protocol, there was also a specific support networks section that asked participants to identify who supported them, if there have been any significant changes in their support network, if they have turned to new people, and why. Specifically, they were asked which individuals in their life were the most supportive of them being a graduate student at that moment. They were then asked about any updates about the

support they obtained from their family and/or significant other. Lastly, they were asked what groups they belonged to and if these groups helped them adjust to their graduate program.

Validity and reliability were ensured as transcribed interviews were read in their entirety and coded as social support whenever they referenced supportive relationships. These data were then connected to the survey data to see if any additional alters were mentioned during that same time frame as the interviews that were not mentioned in the surveys. Any alters of support that were mentioned in the first two interviews but were not included in the social networking survey were temporarily added to the first survey's data, interview 3 and 4's alters to survey 2, and the final two interviews to the last survey's data. We had multiple interviewers, a large research team, and I did member checking on their social networks. Trustworthiness and credibility were established as intercoder agreement was reached with another researcher in the group as well as countless discussions took place to talk through the data analysis process.

Combining Social Networking Survey Data and Qualitative Data

An Excel spreadsheet was made to compile each participant's data from the three social network surveys. Individuals that were consistent across all three surveys were aligned in blue, those that appeared only in the first and second surveys were identified in yellow, those that were named only in the second and third surveys were identified in red, and those that were mentioned only in one survey were identified in black (see Figure 2.2). The purpose of compiling and color-coding these data was to be able to have an initial visual and more easily see how many and which alters were consistent versus which were more temporary.

1						2						3				
Names	Role	Frequency	URM	Gender		Names	Role	Frequency	URM	Gender		Names	Role	Frequency	URM	Gender
	Faculty Member	Bi-weekly	URM	Female			Faculty Member	Bi-weekly	URM	Female			Faculty Member	Monthly	URM	Female
	Faculty Member	Monthly	URM	Female			Faculty Member	Monthly	URM	Female			Faculty Member	Every 6 months	URM	Female
	Friend	Weekly	URM	Male			Friend	Weekly	URM	Male			Peer/Friend	Monthly	URM	Male
	Friend	Weekly	URM	Female			Friend	Weekly	URM	Female			Peer/Friend	Monthly	URM	Female
	Friend	Weekly	URM	Female			Friend	Biweekly	URM	Female			Friend	Weekly	URM	Female
	Mother	Weekly	URM	Female			Mother	Weekly	URM	Female			Mother	Weekly	URM	Female
	Father	Weekly	URM	Male			Father	Weekly	URM	Male			Father	Weekly	URM	Male
	Friend	Weekly	URM	Female			Friend	Weekly	URM	Female			Friend	Weekly	URM	Female
	Friend	Bi-Weekly	URM	Female			Friend	Weekly	URM	Female			Friend	Weekly	URM	Female
	Friend	Weekly	URM	Female			Friend	Weekly	URM	Female						
	Friend	Weekly	URM	Female			Faculty Member	Monthly	URM	Female			Faculty Member	Monthly	URM	Female
	Friend	Daily	URM	Male			Faculty Member	Bi-weekly	URM	Female			Faculty Member	Bi-weekly	URM	Female
							Faculty Member	Monthly	URM	Male			Faculty Member	Monthly	URM	Male
							Faculty Member	Monthly	URM	Female			Faculty Member	Monthly	URM	Female
							Friend	Weekly	URM	Female			Peer/Friend	Biweekly	URM	Female
							Friend	Weekly	Non-URM	Male			Peer/Friend	Biweekly	Non-URM	Male
							Friend	Monthly	URM	Female			Friend	Weekly	URM	Female
							Friend	Monthly	URM	Female			Faculty Member	Every 6 months	Non-URM	Male
							Friend	Monthly	URM	Female			Faculty Member	Every 6 months	Non-URM	Female
							Peer	Weekly	URM	Female			Counselor	Bi-weekly	URM	Female
							Peer	Weekly	URM	Female						

Figure 2.2. Excel document with combined data from the three social networking surveys with the alter names removed for anonymity.

After the above Excel spreadsheets were compiled from strictly survey data, the alters from interview data were tentatively added to the Cxcel spreadsheet in a different color at the bottom. The spreadsheets were sent to each participant to have them check for accuracy and whether the added alters from corresponding interview data indeed belonged and were a source of support at that time. If they responded no, those temporarily added names were removed. If they said that yes, that they needed to be added, participants were then asked to fill in their frequency of interaction with them, identify if the alter was URM/non-URM, and identify gender to the best of their recollection.

In the same email, participants were asked to explain if an alter was dropped from one survey to the next on purpose, or if they were accidently left off by means of distraction, survey fatigue, or other reason. They were also asked to explain the appearance of new alters that were added in later surveys. In two situations, a parent was listed in only two of the three surveys, but the participants noted that they must have accidently left them out and to add them to the third survey as they were a constant form of support. Many times an alter was in the first two surveys as they were an older graduate student that was a close support, but after they graduated from the program, they were not available for the participant's final support survey. Similarly, alters that might not have been mentioned in the first survey but were in the second and third surveys were often identified as peers that they did not know well at first, but became friends and part of their support network as they got to know them better throughout the program.

After revisions (if any), a final Excel sheet was created with all alters and their attributes for the three surveys. Combining interview and survey data has given us the best representation of the participant's whole support network over time. Some might argue of biases with this method of incorporating alters mentioned in interviews because they were not specifically mentioned on the actual survey. However, because of potential distractions and/or burnout associated with survey data, combining the two data collection means worked best to give a complete picture of the participants' whole support network. Additionally, some participants did not have the same interviewer consistently for all six interviews, so some participants might not have been as open, or some interviewers might not have asked for clarifying answers and names of specific support members. To maintain consistency across data collection methods and interviewers, it was necessary to member-check the social network data for clarity and

completion by email after the conclusion of data collection. This allowed participants to visualize their complete support network over time and verify accuracy.

Analysis

Sixteen participants completed all three surveys (7 Black participants, all women, and 9 Hispanic participants, 4 women and 5 men; see Figure 2.3).

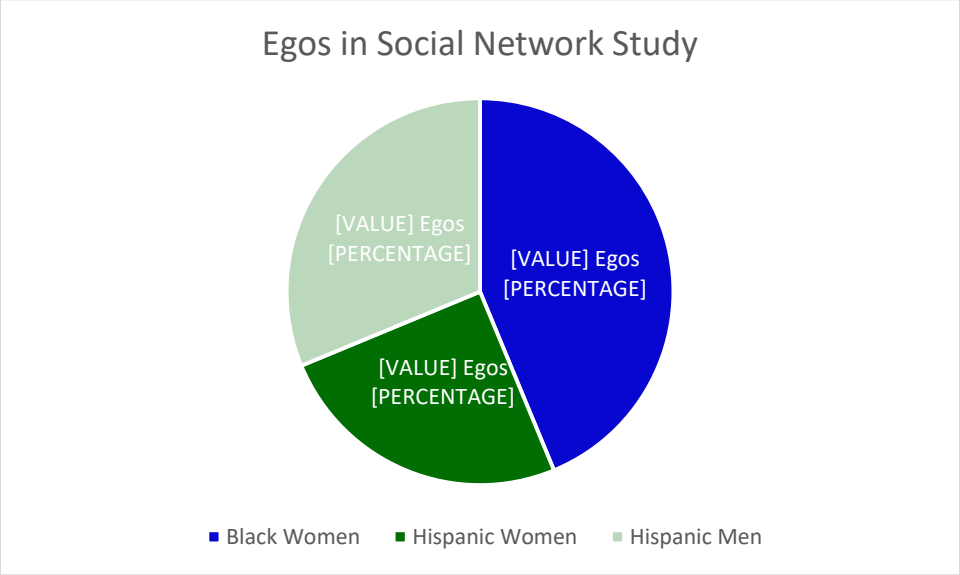

Figure 2.3. Ethnic and racial distribution of the 16 participants of which detailed analysis was completed for this study.

Numerous emails were sent to the remaining participants asking them to complete the surveys; however, 14 people did not complete at least one of the three surveys and were not included in analysis. Analysis has been completed only for the 16 participants that completed all three surveys in order to ensure continuity and generalize findings. At first, knowing where to start was challenging because there was an excessive amount of data and little relevant literature with similar study design.

Visualization

The first thing that needed to be done was create a visual for each ego's network, so they were created using the VennMaker diagram maps. Once in VennMaker, there are many choices for formatting ego and alter attributes, so deciding how to best represent our data was a task. There needed to be separate distinctions for men/women as well as URM/non-URM individuals. The choices were limited to color, shape, and size, so men were chosen to be represented by blue circles and women were to be represented as red circles. Initially, URM individuals were made to be smaller circles and non-URM individuals to be larger circles simply because so many more egos had more URM individuals listed in their support networks, so they would fit better in the Venn. However, after presenting some initial findings at a conference, it was a concern that non-URM individuals being larger circles might be portrayed as being more dominant, which was not the intention. Therefore, non-URM individuals are small circles and URM individuals are large circles.

Then it was necessary to organize by role and by frequency. VennMaker allows different sectors as well as concentric circles, so sectors were chosen to represent roles and the concentric circles to signify frequency of interaction. For each of the three surveys, a separate network map needed to be constructed. It was necessary to enter in the actors as well as their attributes; however, they then needed to be manually dragged to the sector and concentric circle to which they belonged. Once done, pseudonyms were assigned in VennMaker to allow anonymous identifiability from one survey to the next. Lastly, the alters that stayed consistent through all three surveys were tied with a "relation" line. This was a bold green line connecting the ego to the alters to represent continuity across the three surveys.

Once these three ego network maps were next to one another, there was visual contrast that showed alters in different shapes signifying if they were URM or non-URM; colors to signify men/women; different proximity zones from the center of the circle (the ego), which showed frequency of interaction; as well as different pie slices, which showed the role of the alters (family/significant other, friends/peers, etc.). Three of these visual Venns were created; one for each survey time frame. Once they were all next to one another (see Figure 2.4), compositional changes of the network makeup could be seen from one survey to the next, generating new research questions. In the first diagram below, the ego, Adriana (pseudonym), is represented in the center. In this case, she is a URM Hispanic participant, is shown as red (woman), and a larger circle (showing URM). Alters that are closest to the ego are in daily contact with her; in this case, she has two non-URM men that she seeks support from daily—one friend/peer and one that is family/significant other. The increased distance between an alter and an ego indicates less frequent contact.

Ethnic and Gender Homophily

To begin, we sought to know from whom the URM students were seeking support. Were they intentionally seeking others like themselves (homophily) as far as gender and race? Homophily is the intentional or unintentional association with people who are similar to us (Christakis & Fowler, 2010). Individual relationships are more homogenous than one could expect. The environments in which people find themselves coincide with their individual choices to form homogeneous networks (Blau, 1977; P. Marsden, 1988; McPherson & Smith-Lovin, 1987). Therefore, URM students that are at PWIs are in an environment not conducive to these homogeneous relationships. Egos and alters are typically matched on attributes such as race and class (Lin & Dumin, 1986; P. Marsden, 1988; Moren-Cross & Lin, 2008). Scott and Carrington

(2011) noted that "Institutions such as workplaces, schools, neighborhoods, and voluntary organizations tend to bring people of similar education, age, race, and gender together, creating a relatively homogeneous pool of 'eligibles' from which choice then exerts its secondary impact" (p. 109). Depending on the setting, some aspects of homophily may be more obvious than others. For instance, racial homophily is very prevalent in the United States (Moren-Cross & Lin, 2008).

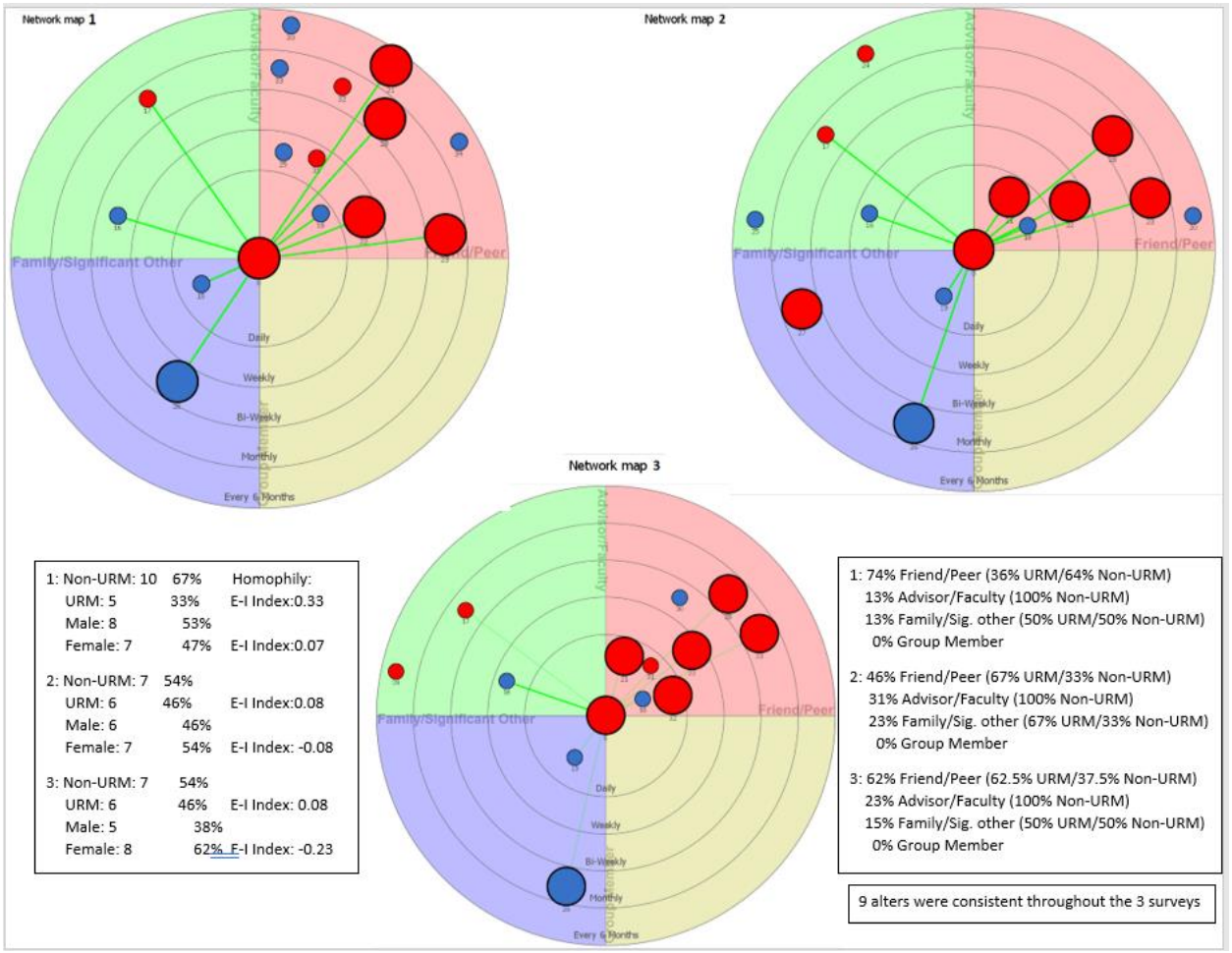

Figure 2.4. Network maps made in VennMaker for all three surveys to show visualization of Adriana's support network.

To investigate and measure homophily, analysis was done using Krackhard's E-I Index (E-I/E+I) for the attributes URM and gender. This equation references "internal" connections (I) to mean similarity to themselves or "external" (E) to mean dissimilarity in comparison to themselves in relation to the attribute (Crossley et al., 2015). These data are always expressed as a number between -1 and +1. A value of -1 implies complete homophily, while a value of +1 indicates complete heterophily (dissimilarity). If a network is equally comprised of alters that are alike and unlike themselves, that would have a value of 0.

First, we looked at whole networks for each ego's network for each of the three surveys. For example, in the support network above, Adriana named 15 people that made up her support network in the first survey. Ten of them were non-URM individuals, and 5 were URM individuals. The calculation for this E-I index is as follows:

$\frac{10-5}{10+5} = 0.33\ E - I\ Index.$

Thus, we take the number of alters NOT like her (10) and subtract the number of alters LIKE her (5) and then divide by total alters for that time (15) = 5/15 = 0.33. On the scale described above, Adriana's whole support network for this period of time with an E-I index of 0.33 is greater than 0 and less than 1, meaning her support network consists of more people unlike her with regard to URM status. This was done for each of her surveys as well as for all egos in the study (see Figure 2.4 for Adriana's three surveys' data).

After individual averages were found, participants were grouped into their self-identified groups of Black students or Hispanic/Latinx students and averages were found for these Black and Hispanic/Latinx participants. This was graphed to show overall URM E-I index comparison for Black and Hispanic/Latinx students over the three surveys (see Figure 2.5). This shows us whether Hispanic/Latinx students and/or Black students are seeking a support network filled with

other people from URM groups. The last averages found was for women overall URM E-I index comparison; since all of the Black participants were women, we wanted to compare Black women to Hispanic women (see Figure 2.6).

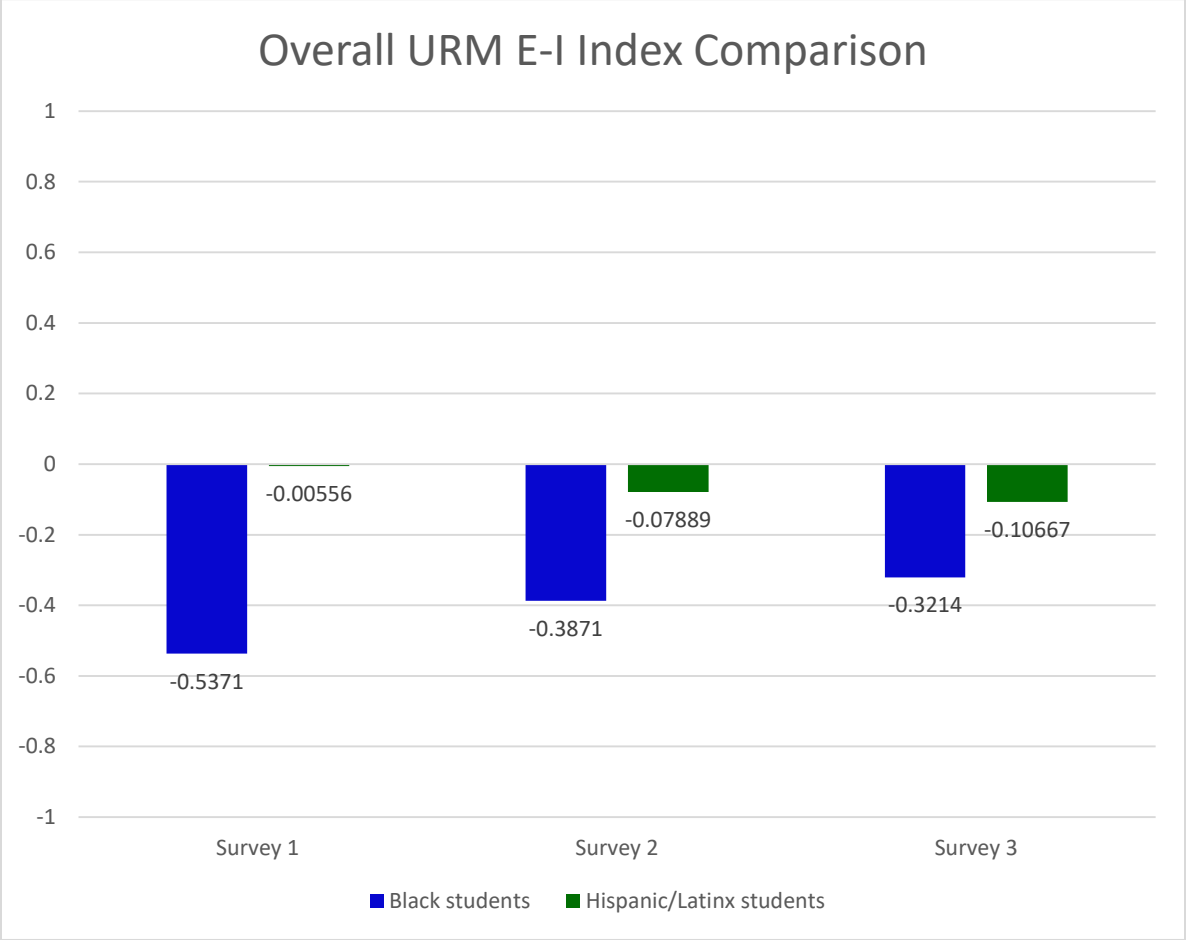

Figure 2.5. Overall averaged URM E-I Index for Black and Hispanic/Latinx participants across all three surveys (-1 signifying complete homophily and +1 showing complete heterophily).

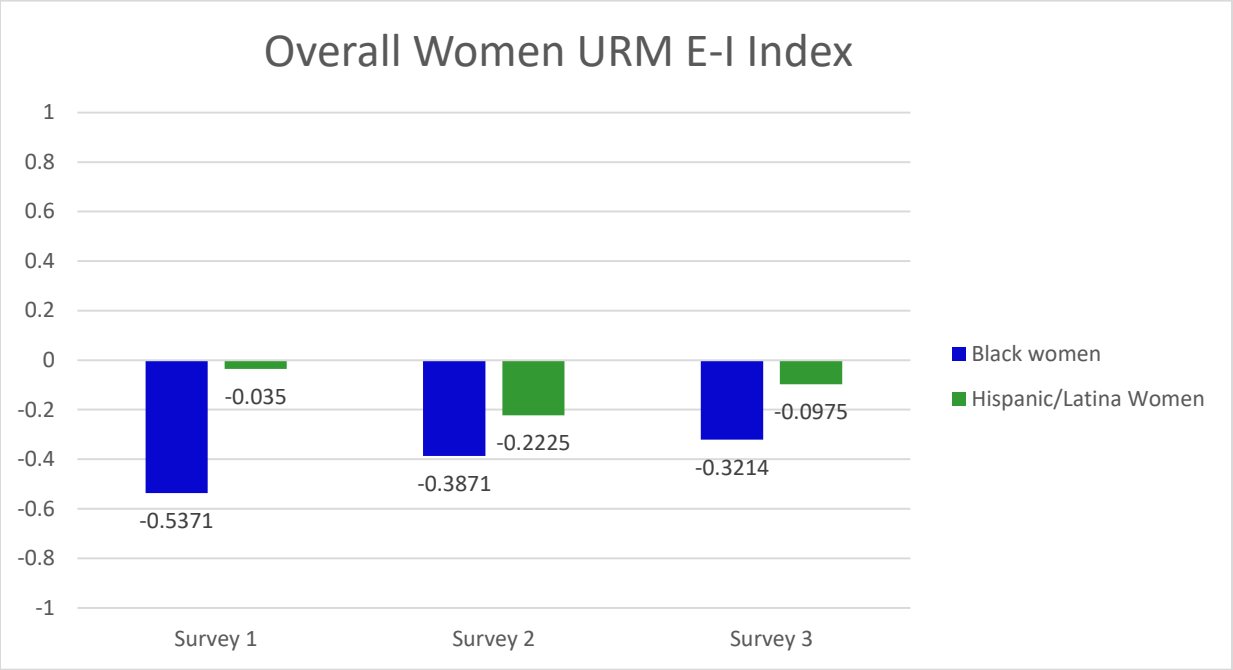

Figure 2.6. Overall averaged URM E-I Index for Black and Hispanic/Latina Women participants across all three surveys (-1 signifying complete homophily and +1 showing complete heterophily).

Homophily on one dimension (such as URM status) will not guarantee homophily on other dimensions (such as gender) (Scott & Carrington, 2011). Therefore, the next question sought to see if these egos were seeking homophily as far as gender. Looking at gender, the following calculation for E-I index was completed for Adriana:

$\frac{8-7}{8+7} = 0.07\ E - I\ Index.$

Similar to calculating URM E-I index, there were 8 men and 7 women alters in her first survey, so 8 (unlike her) -7 (like her) divided by total alters (15). Adriana's gender E-I index is slightly positive, yet very close to 0 having a relatively equal balance of men and women in her first support network as a whole (see Figure 2.7 for Adriana's three surveys' data).

The overall network gender E-I index calculations were then found in the same manner individually and then averaged for Black participants and Hispanic/Latinx participants. This was

also graphed to show overall gender E-I index comparison for Black participants and Hispanic/Latinx participants over the three surveys (see Figure 2.8). Figure 2.6 has shown that Black participants' E-I index for all three time frames were substantially more negative than the Hispanic/Latinx participants' E-I index as an average. Similar to URM status, the overall gender E-I index was calculated for women in order to compare the Black women participants and Hispanic/Latina women participants (see Figure 2.9).

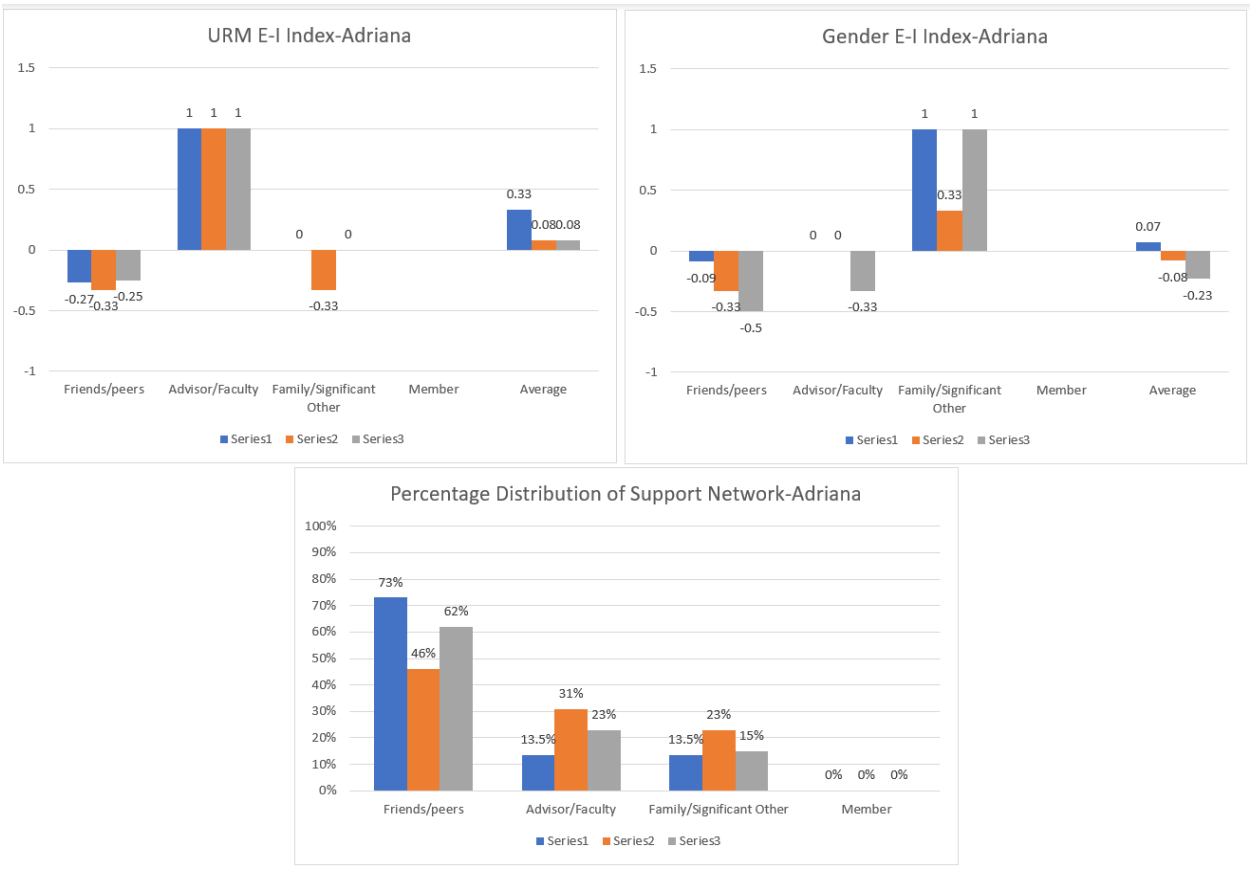

Figure 2.7. Adriana's URM and Gender E-I Index graphs as well as her Percentage Distribution of Support Network graph.

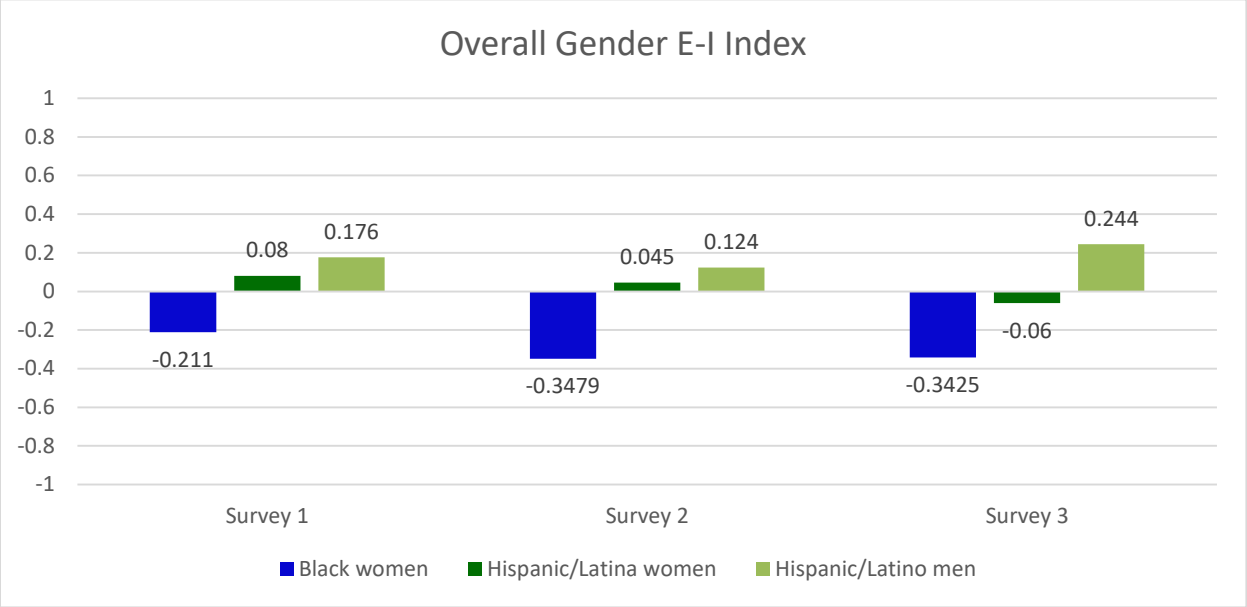

Figure 2.8. Overall averaged Gender E-I Index for Black and Hispanic/Latinx participants across all three surveys (-1 signifying complete homophily and +1 showing complete heterophily).

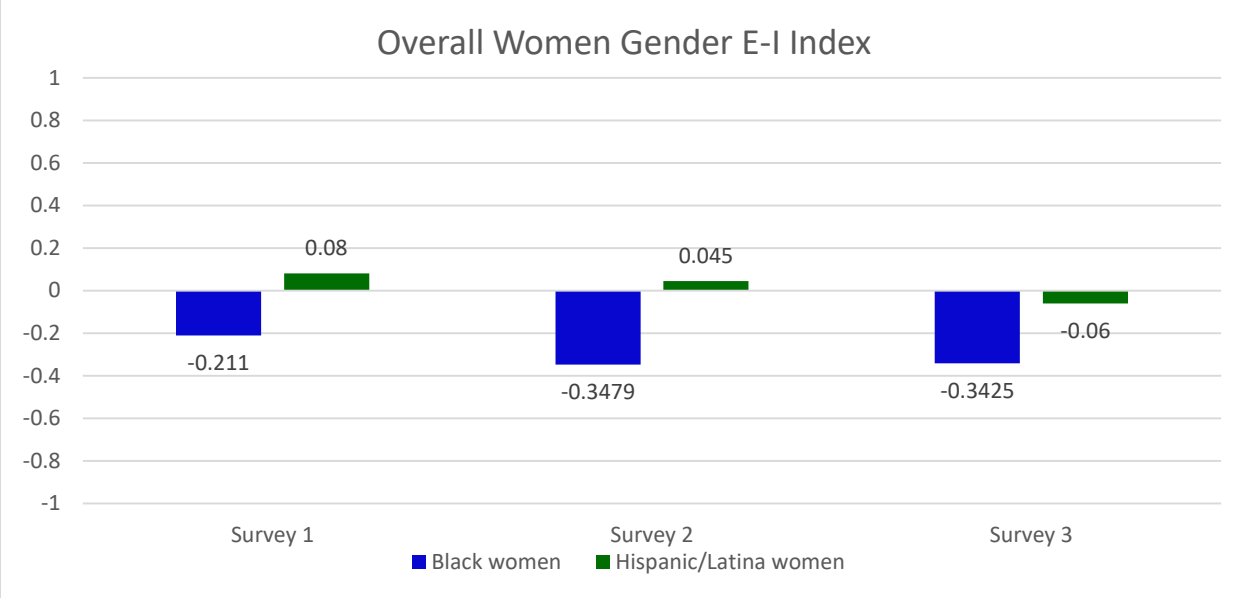

Figure 2.9. Overall averaged Gender E-I Index for Black and Hispanic/Latinx Women participants across all three surveys (-1 signifying complete homophily and +1 showing complete heterophily).

These data showed us that our Black participants were seeking greater gender and URM homophily over the Hispanic/Latinx participants. After the 16 egos' three surveys (48 total) were analyzed for URM and gender homophily (96 sets of data analysis) and were put into the above graph sets, it was felt that this data analysis was exhausted. With all the emphasis thus far being on gender and race all around the VennMaker diagram, it was time to move on to looking at roles within the egos' networks.

Roles

With whole ego-networks, groups were formed by separating alters into roles. Initially, we had five categories that separated alters into groups: friends, peers, family/significant others, advisors/faculty, and group members. This worked well for some participants; however, many egos had alters that overlapped roles. For instance, some alters were considered peers in their program, yet also were labeled as friends. There were also some participants that listed the same alter in all three surveys, but in the first they called them a peer, in the second survey they were a friend/peer, and then in the final survey they were identified as a friend. To maintain consistency, friends and peers were grouped together to have four distinct categories of support network alters: friends/peers, family/significant others, advisors/faculty members, and group members.

Composition of Networks within Roles

Another obvious trait that was of note while looking at the VennMaker network maps was how egos had different numbers of alters in each support network role/category. Therefore, the question arose to look at the percentage composition of support networks and how their networks were distributed, for example, the percentage of alters in their support network that are friends/peers versus the percentage of alters in their support network that are family/significant others. This was calculated by counting how many alters were in each category divided by the

total number of alters in the whole network. Calculations were done for every individual's three surveys (see above Figure 2.4 for Adriana's individual data) and then averaged to look at Black and Hispanic/Latinx students overall. Figure 2.10 shows the percentage distribution of support network comparison across time. The blue hues are the Black participants through survey 1, 2, and 3, while the yellow hues represent the Hispanic participants across surveys 1, 2, and 3. This visual allows us to see how the change in the percentage of distribution of support networks changes across time for our Black participants compared to our Hispanic/Latinx participants.

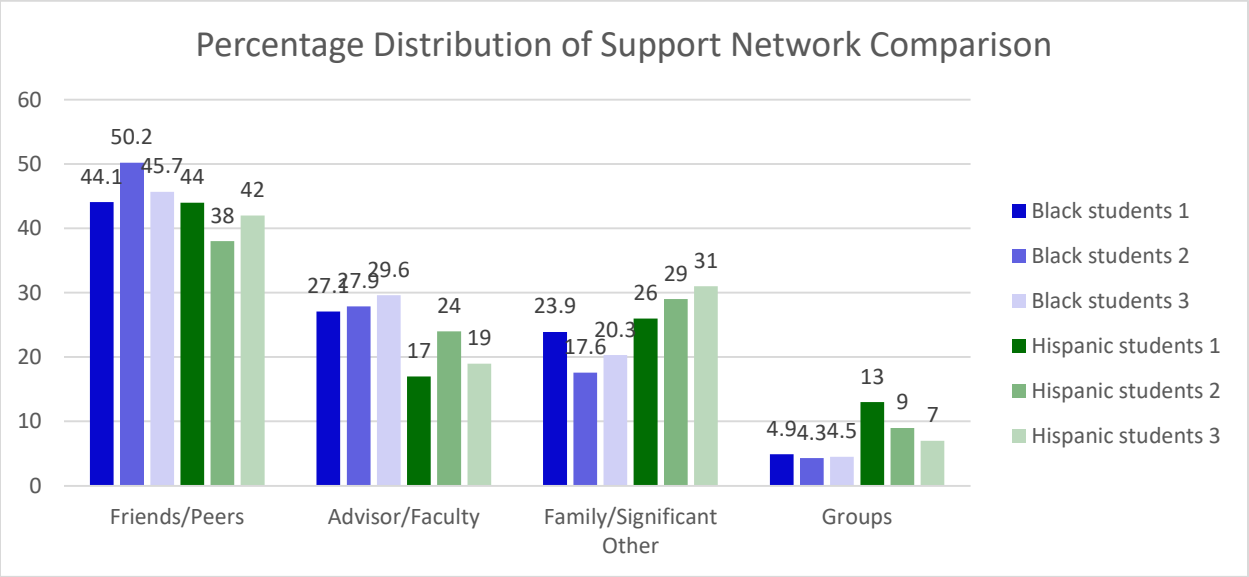

Figure 2.10. Average percentage distribution of support network comparing Black students and Hispanic/Latinx students.

In Figure 2.4, we can see that in Adriana's first network map she has 11 of the 15 alters in her friend/peer group (74% of her support network), 2 of the 15 advisors/faculty (13%), 2 of the 15 family/significant others (13%), and 0% in any group memberships. This is also shown in Figure 2.7 with her other two surveys' data.

Within Roles Ethnic and Gender Composition and Homophily

Once each participant's network was split into roles, it became apparent how the support was distributed, but the questions arose as to who occupied those positions within those roles, and were the egos seeking homophily in some roles more than other roles? For example, are the URM egos seeking gender or URM homophily support from friends/peers or more from their family/significant others, or possibly from advisors/faculty?

With Adriana's data from Figure 2.4 above, it is obvious that Adriana's largest support initially came from her friends and peers. With this further analysis, we were able to find that within Adriana's friend/peer group, 36% were URM and 64% were Non-URM for an E-I Index of 0.27, showing that she initially had a substantially more racially heterophilous friend/peer network. Her friends/peers dropped down to 46% for the second survey with her having a greater need for support from advisors/faculty members, but it then increased back up to 62% by the last survey. It is noteworthy that by the end of graduate school, her friend/peer network was composed of 62.5% URM for an E-I index of -0.25, which is a large shift toward homophily. It was interesting to note that only five of her friends remained consistent through all three surveys, and her second largest support network was her advisor/faculty members, which was always 100% non-URM.

Each ego's roles were analyzed individually for every survey. E-I indexes were found for each role by counting how many URM and non-URM individuals were in each role as well as how many women and men occupied that same space. With these data, the E-I index was calculated and then averages were also calculated according to URM status within every role (friends/peers, advisor/faculty, family/significant other, member). Graphs were made to show Black women's average URM E-I index by category (Figure 2.11), Hispanic/Latinx student

average URM E-I index by category (Figure 2.12), and then a graph that combined both Black students' and Hispanic/Latinx students' average URM E-I Index by category (Figure 2.13) across time.

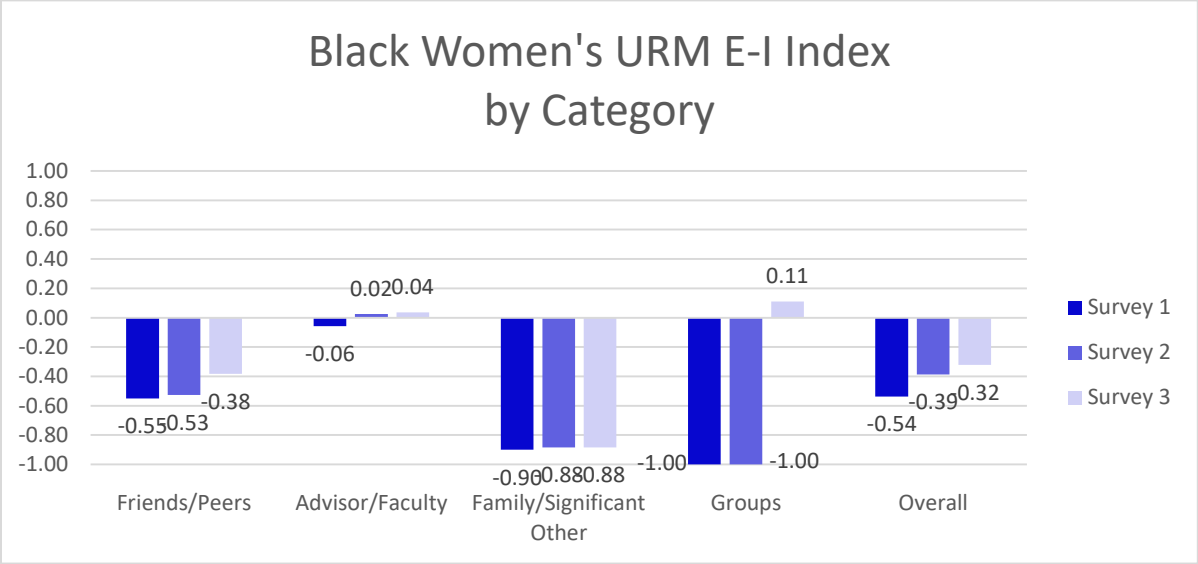

Figure 2.11. Overall Black women averaged URM E-I Index by category across all three surveys (-1 signifying complete homophily and +1 showing complete heterophily).

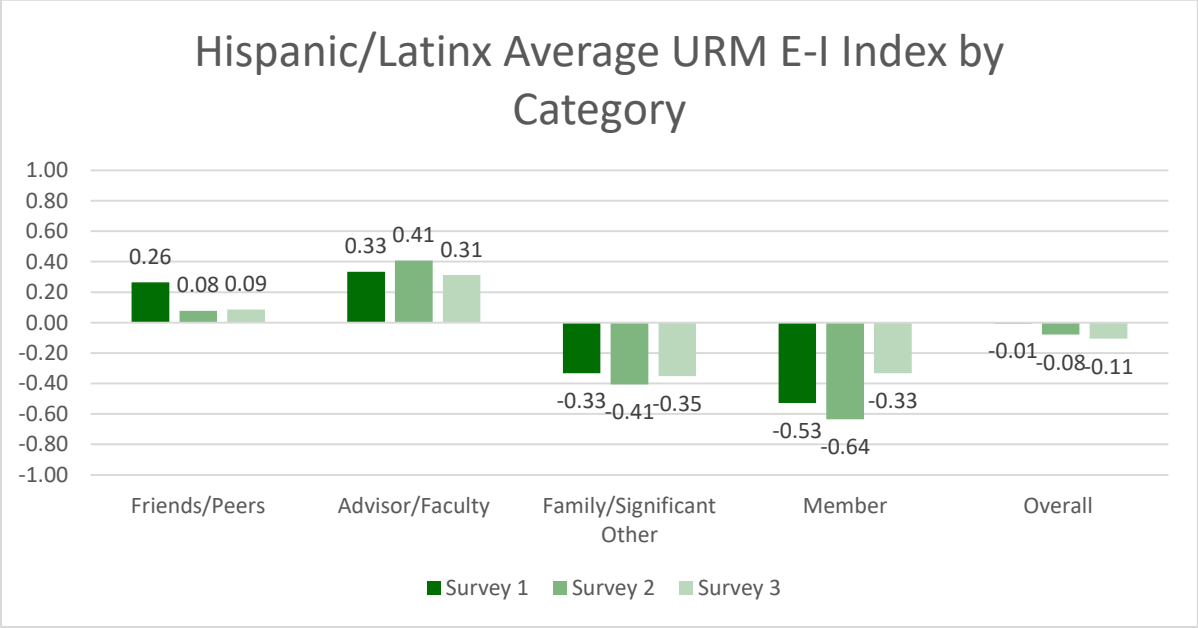

Figure 2.12. Overall Hispanic/Latinx student averaged URM E-I Index by category across all three surveys (-1 signifying complete homophily and +1 showing complete heterophily).

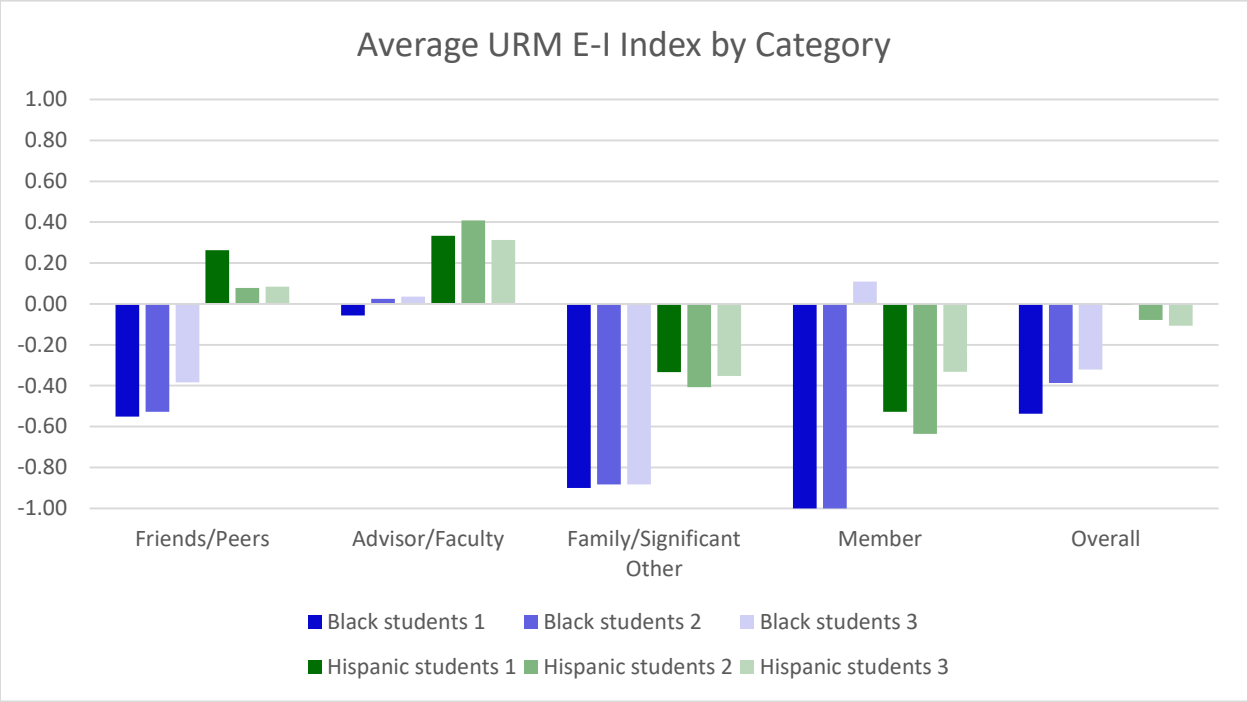

Figure 2.13. Overall Black and Hispanic/Latinx student averaged URM E-I Index by Category across all three surveys (-1 signifying complete homophily and +1 showing complete heterophily).

Analysis was also completed with graphs made to show Black student average gender E-I index individually, as well as averaged by category (Figure 2.14); Hispanic/Latinx student average gender E-I index by individually, as well as by category (Figure 2.15); and then a graph that combined both Black and Hispanic/Latinx students' average gender E-I Index by category (Figure 2.16) across time. This allowed a more visual means to see if the URM students were seeking homophily or heterophily in regard to gender within the different roles of their support networks.

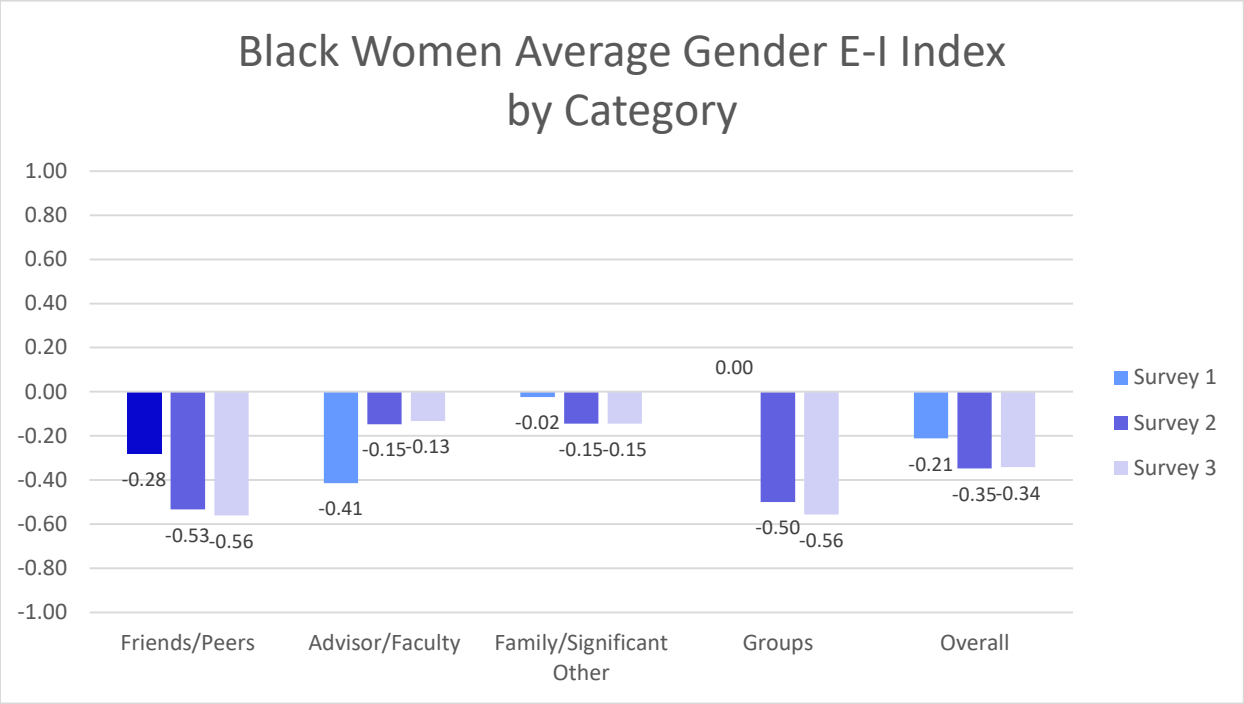

Figure 2.14. Overall Black women averaged Gender E-I Index by category across all three surveys (-1 signifying complete homophily and +1 showing complete heterophily).

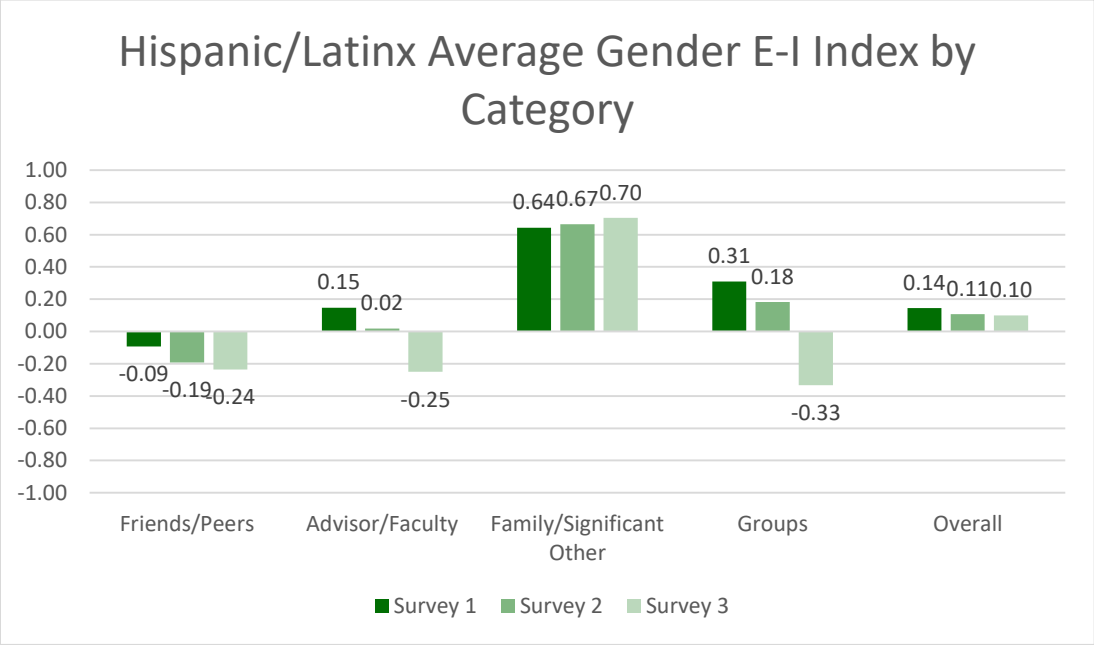

Figure 2.15. Overall Hispanic/Latinx student averaged Gender E-I Index by category across all three surveys (-1 signifying complete homophily and +1 showing complete heterophily).

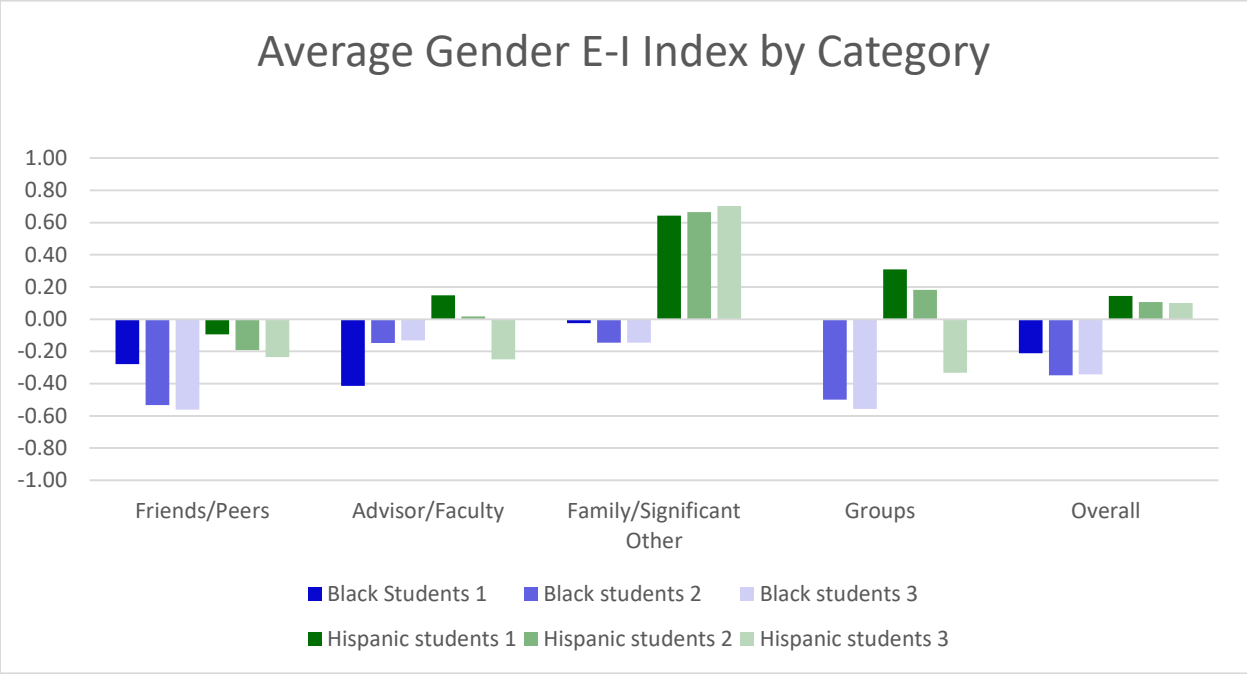

Figure 2.16. Overall Black and Hispanic/Latinx student averaged Gender E-I Index by category across all three surveys (-1 signifying complete homophily and +1 showing complete heterophily).

Network Turnover

After analyzing the VennMaker network maps more, the alters that remained consistent throughout all three surveys became an interest. Every ego had some alters that stayed consistent (indicated by the green lines that connect the ego to the alter) across all three surveys, but some were being added and dropped. The next task became finding out how that network was changing overall from one time frame to the next.

Network turnover was calculated by adding the alters dropped between two points to alters added during same period and then dividing by the total number of unique alters pooled across time points. Network turnover is always a number between 0 and 1, 1 signifying a complete turnover and 0 signifying no change within that time frame. This was calculated from

survey 1 to 2, 2 to 3, and overall network turnover from 1 to 3. For each participant, this analysis was initially done as a whole network. However, the data were somewhat inconclusive. In the first round of turnover, Black student turnover was slightly higher than Hispanic student turnover, the opposite was true for the second round, and the overall turnover was almost identical (see Figure 2.17). Because these data were not initially striking, they were temporarily set aside.

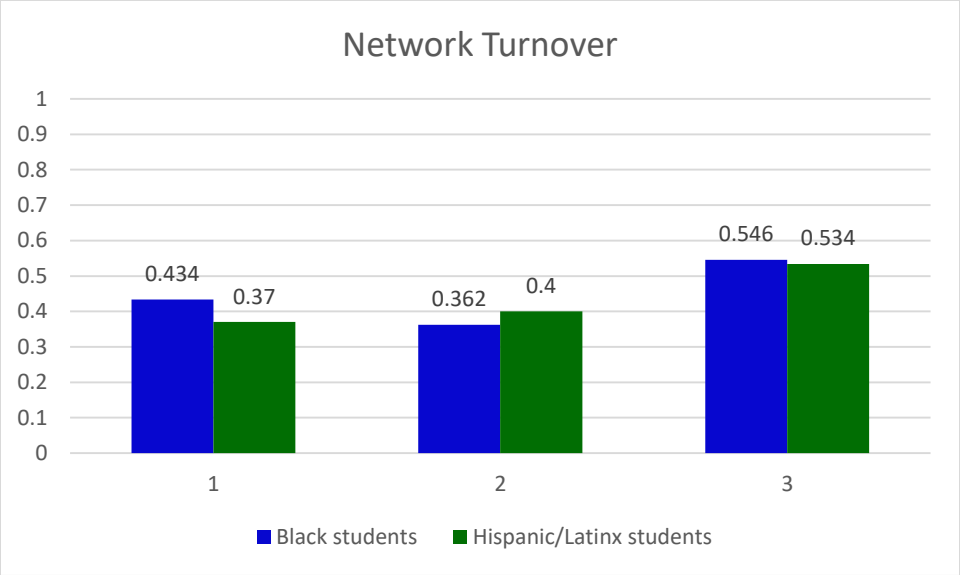

Figure 2.17. Overall network turnover for Black and Hispanic/Latinx students across all three surveys (on a scale of 0-1; 0 meaning no turnover and 1 meaning complete turnover).

Much later, a new question appeared from the data. Yes, both Black and Hispanic/Latinx students had similar network turnover, but who was specifically being added and dropped? Were the alters dissimilar to the ego being dropped and were they bringing in new alters with similar attributes as themselves? With this said, the alter characteristics that were measured would allow some distinction as to who was dropped or added. Therefore, each participant's network turnover was then analyzed in several aspects. The quantity of women that were added or dropped from

one survey to the next was compared to total women in that same time frame. The next calculation looked at the quantity of women that were added or dropped from one survey to the next compared to the total number of people. The same statistics were done to analyze the turnover of men/men, men/total, URM/URM, URM/total, non-URM/non-URM, and non-URM/total. This was done for all three time frames indicated above. Averages were then calculated for Black and Hispanic/Latinx students (see Figure 2.18). These are shown as a whole across all three surveys as well as individual surveys to compare any differences. This analysis provided substantially more information. The Black students' network turnover had much higher turnover rates for men/men as well as for URM/URM compared to the Hispanic/Latinx students. Both URM groups had a low turnover of women, and while both groups had high turnover rates for non-URM individuals compared to the number of non-URM individuals, their overall non-URM turnover compared to their network total was low.

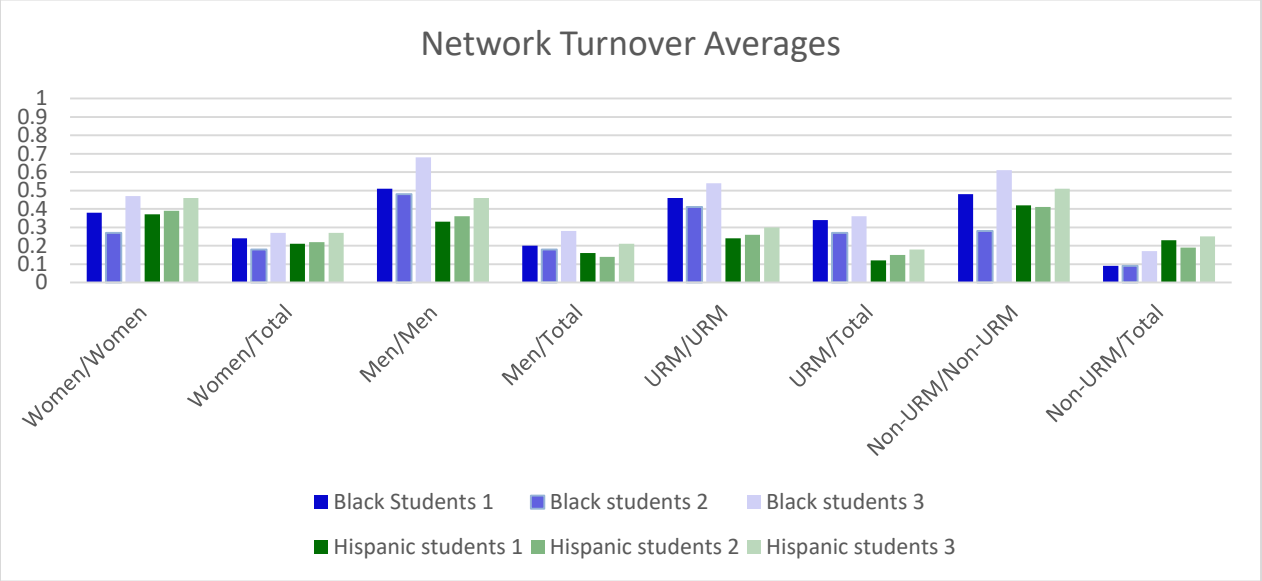

Figure 2.18. Specific network turnover for Black and Hispanic/Latinx students across all three surveys (on a scale of 0-1; 0 meaning no turnover and 1 meaning complete turnover).

Conclusions

URM graduate students are at a higher risk of leaving graduate programs, especially when they lack a strong support network (Allen, 1992; Davis, 1994; Hatch & Mommsen, 1984; Pidgeon, 2008). Research has shown that it is critical for these URM graduate students to develop relationships with faculty and peers within their program to help them with persistence through these programs (Joseph, 2012). Therefore, it is critical to understand who forms these support networks, who the key members are, and what roles they play.

This article has provided a detailed methodology for the analysis of egocentric social network data for a very unique set of egos, whom they turn to for support, and how that changed over the course of their graduate school experience. This has been a learning experience with new research questions continuously appearing, figuring out if they are able to be answered with the data collected, and how to analyze data to get there.

The methods presented in this paper would allow detailed analysis of social supports, the distribution of support networks, gender and racial homophily overall and specifically by roles, and the specific turnover rates overall as well as gender and racial turnover.

Throughout this study, there were several lessons learned that will assist researchers conducting a similar study. First, participation rates improve when survey completion is incentivized. This study is limited by the small data pool. Second, we would recommend that social network surveys be completed before the corresponding interviews. This would allow for verification of their support network in-person at the interview. It would also be advantageous to plan for a fourth social network survey to be given after graduation to be able to have one more data point for that critical time frame.

This article has the potential to help researchers who have social network data on not only a diverse population of people, but also longitudinal data over time about those same individuals. URM graduate students have reportedly "felt socially ostracized" as well as have "experienced emotional pain from both failed relationships and social isolation" at PWIs, which has in response led to these URM students attaining graduate degrees less often than non-URM students (Allen, 1992). This article showed how it is possible to look at the individual as well as group composition of support networks by looking deeper into who they are made up of, the size of their networks; network distribution; network turnover and whether men, women, URM, or non-URMs are being replaced; gender and ethnic homophily; and how to visually represent all of this information. With this information at hand from this study, lessons may be learned about these networks to better support URM students by providing the institution with evidence of the importance that, in order for URM graduate students to persist, they need a supportive social environment at these universities.

CHAPTER III

THE COMPOSITION OF SOCIAL SUPPORT NETWORKS OF URM GRADUATE STUDENTS AT PREDOMINANTLY WHITE INSTITUTIONS

Introduction

Underrepresented minority (URM) students in science, technology, engineering, and math (STEM) and social, behavioral, and economic science (SBE) programs have exceptionally low degree-completion rates compared to other student groups, especially at predominantly white institutions (PWIs) (Huang et al., 2000). Although degrees awarded to minority students have increased over the past few decades, URM students earned only 22% of bachelor's and 9% of doctoral degrees in 2016 (National Science Foundation, 2019) despite making up a substantial portion of the United States population. Retention of these minority students is a substantial challenge to increasing the diversity of STEM/SBE professionals since over 66% of Black students attending PWIs fail to complete their degrees (Gloria, Robinson, et al., 1999). It has been predicted that by the year 2040, the college-age Hispanic population will increase from 3 million to more than 8 million, yet the Hispanic population that will enroll in college will only increase from fewer than 1 million to about 2 million (Cole & Espinoza, 2008). Low enrollment and degree completion rates by URM students coincide with the demand for workers in STEM fields that far exceeds the supply of STEM job-seeking graduates (Byars-Winston et al., 2010; National Science Board, 2008). Despite the presence of many programs designed to increase minority participation in STEM programs, the proportion of minority graduates from STEM programs remains low compared to that of non-URM graduates.

One key motivation for the participation, persistence, and retention of URM graduate students is to have a talented and diverse scientific community that represents society, which is currently lacking. One benefit of having this diversity includes increased creativity while solving problems, as students from underrepresented groups are more likely to explore questions and problems beyond those that are currently on the scientific community's radar. Some studies suggest that a team with a diverse blend of perspectives is linked to increased productivity (Campbell, 2018; Hodapp & Brown, 2018). Another study's top leadership expressed that "even if people are uncomfortable at times with diversity, it's worth the fresh perspectives that it brings" (Powell, 2018, p.10). Powell (2018) noted that having diverse perspectives increased the frequency of "aha" moments because of having a group of very different kinds of people looking at the same data from different perspectives. In another lab, Powell also mentioned the importance of having the group interact socially and scientifically, as the time together helps "to dissolve cultural biases and misunderstandings" (p. 10) and create an atmosphere that is more tolerant, flexible, accepting, and ultimately cohesive. It is imperative to have this talented and diverse scientific workforce in order for the United States to uphold its global competitiveness in an increasingly diverse society (Campbell, 2018; Gibbs et al., 2014). However, in order to reach this goal, support is essential for all young scientists, especially URM students.

Minority-serving institutions have played a significant role in helping minority students achieve college degrees. However, because most colleges and universities are PWIs, it is necessary to understand the factors that affect the minority students that attend these institutions. PWIs stereotypically reflect white, cis-male, middle-class perspectives. Although all students experience academic stresses and adjustment challenges, the transition to college living is more difficult for minority students (Gloria & Rodriguez, 2000). URM students often feel more

isolated, culturally alienated, and unwanted in their programs or universities than white students (Gloria & Rodriguez, 2000). Sailes (1993) studied 45 African-Americans who did not complete their degree at a large Midwestern PWI and reported that one of the main reasons was racial tension and perceived hostility from the university environment. In a study involving almost 1,200 students from four Midwestern universities, 28% of African American students reported feeling marginalized in their campus environment and interactions with staff, faculty, academic advisors, and other students (Grossett, Cuyjet, & Cockriel, 1998). Latinx students have also reported feeling alienated and experiencing hostile campus climates, which translated to having greater difficulty forming a sense of belonging to the college and also a tough time adjusting academically and socially (Cole & Espinoza, 2008).

Given minority students' feelings of isolation and hostility on campus, and difficulty with developing a sense of belonging, we need to better understand the social support networks of the URM graduate students who do persist at PWIs. The campus environment, particularly when perceived as discriminatory, hostile, alienating, or isolating, can impede URM students' participation and persistence in higher education, yet having a social support network during college was one indicator of persistence, as well as higher levels of college satisfaction (Allen, 1992; Cole & Espinoza, 2008; Gloria, Robinson, et al., 1999; Grandy, 1998; Hernandez & Lopez, 2004). Tinto (1975) believed that social support allowed students to become socially integrated and involved in the academic environment, thus decreasing decisions not to persist. In support of Tinto, DeFour and Hirsch (1990) found that among 89 African-American graduate and professional school students, those who had out-of-class contact with African-American faculty and students were less likely to consider dropping out of school. A support group of peers that are effectively handling similar challenges can model coping and persistence behaviors,

therefore helping URM individuals that are in distress (Gloria, Robinson, et al., 1999; Kimbrough, Molock, & Walton, 1996). In another study, Latinx students found opportunities to make new friends from similar cultural and socioeconomic backgrounds by being involved with specific campus groups and organizations; it is through these peer relationships that they found a caring and supportive community at their university (Hernandez, 2000; Hernandez & Lopez, 2004).

Theoretical Framework: Social Support

Individuals are connected to other people for a purpose; friendship, love, and emotional and social support are a few reasons people seek relationships with others. Lumino et al. (2016) described social support as being a "complex, dynamic, and multidimensional concept, partially overlapping with social relationships" (p. 182) and can be in the form of perceived or actual support from a variety of relationships (Cohen et al., 2000). While social support is highly dependent on and even constrained by many personal, environmental, locational, and cultural factors, it cannot be assumed to be a permanent fixture in one's social network (Gottlieb & Bergen, 2010; Kadushin, 2012). People intentionally make and remake their social support networks all the time, depending on their life situation and the psychological or material support they find themselves needing (Christakis & Fowler, 2010). These relationships are not one-sided but are mutualistic between parties. Close relationships tend to create more types of support than acquaintances, while ties with a specific role tend to offer a more specific type of support (Gottlieb & Bergen, 2010). It is also important to identify the sources of support in terms of different categories of social ties (e.g., family members, friends, neighbors, etc.) to get a picture of where their social support resources are coming from or if they are socially isolated (Barrera, 1986).

Everyone has a unique map of social networks, with URM students arguably having a greater need for social support networks due to their feelings of isolation and the negative stereotypes they experience during their studies. Their social support could include a friendship network, a support network, a network of colleagues from the workplace, or networks of individuals from activities, sports, or clubs (Prell, 2012). A person can be a member of many different networks by having these individual connections. For example, one might have their workplace friends that they see daily and share important life events with, but their friends from high school are also important and are the ones that they are on the phone with when they need a certain kind of support. It is a deliberate act for people to choose the structure of their network and to form social connections with a specific number of individuals. Then, it also is an intentional effort to decide with whom they share varying degrees of intimacy and affection along with the length of time these connections are active (Christakis & Fowler, 2010; Crossley et al., 2015; Everett & Borgatti, 2005; Perry et al., 2018). Christakis and Fowler (2010) also say that individuals tend to reside in certain spots within "the naturally occurring and continuously evolving social networks that surround us" (p. 15). Social support has been shown to facilitate the success of URM students in STEM fields (Gloria et al., 2005; Gloria, Robinson, et al., 1999; Harper, 2006; Williams et al., 2017). In addition, having a support system can positively affect motivation, help the development of one's scientist identity, and foster feelings of belonging to the community of scientists at large. Specifically, having the social support from peers or faculty at the college level that share the same race has been shown to positively affect URM students' assimilation and comfort (Williams et al., 2017).

When considering individuals' support networks, or ego-nets (ego-networks), one of the most extensively used research designs in social network analysis is the personal network

research design. Ego-nets focus on the individual URM participant (the ego), the nature of their connections to people (alters) in their support network, and the characteristics of those alters (Borgatti et al., 2013). The first of two steps in this study's research design included a name generator, which allowed the researcher to obtain an exhaustive list of alters that were important social supports in the ego's life. The second step was the name interpreter, where the ego provided attributes about each of the alters they named, including gender, URM status, type of relationship, and frequency of interaction. These survey data, combined with corresponding interview data, allowed us to create complete social network structures. Each ego-net is unique as it varies in size, structure, and composition. However, ego-net analysis allows us to use it in comparison to much larger populations (Crossley et al., 2015). Therefore, understanding URM graduate students' social support networks at PWIs is critical because of the quantity of PWIs and URM graduate students' low persistence at these institutions. We can use the data from this study to help URM students succeed in graduate school and as scientists. In this paper, we present data from a 3-year longitudinal study in which we analyze the support networks of URM students at PWIs as well as qualitatively focus on the views and perceptions of those students.

Research Questions

- Are persisting URM graduate students seeking support from certain people in certain roles?
- What do their support networks look like?
- What roles and relationships are most valued?
- Are they getting the support they feel they need?
- Does their network composition change as they progress through graduate school?

Methods, Setting, Design, and Participants

This study was reviewed and approved by Western Michigan University's Institutional Review Board, Project Number 14-06-16.

For this longitudinal study, the registrar for three Midwestern PWIs sent out a survey in the spring of 2015 to all non-white graduate students in their first or second year of a doctoral or master's-to-doctoral STEM or SBE program. Participants that took this survey and self-identified as URM in these programs were included in the study. A subset of survey respondents volunteered to complete six biannual interviews between 2015 and 2018. All interview participants were also included in the social networking aspect of the study. Social networking surveys were given during the spring 2016, spring 2017, and spring 2018 semesters. Through the surveys and corresponding interviews, we were able to collect both social networking data and qualitative data. In this paper's data set, we will be focusing on the 16 participants that completed all three social networking surveys and all six interviews. Of the 16 participants, seven identified as Black women. The remaining nine participants identified as Hispanic/Latinx, with five identifying as men and four identifying as women.

The reliability and trustworthiness of a qualitative study is a fundamental part of certifying the transparency and quality of qualitative research (Korstjens & Moser, 2018). Lincoln and Guba (1985) discussed the importance of credibility, transferability, dependability, and confirmability with qualitative research with regard to the trustworthiness of a qualitative study. The research team valued these aspects and followed many strategies to ensure they were all met. This study had a strong research design and a detailed interview protocol that all team members agreed upon prior to the start of the project. Interviews were all conducted in the same time frame for all participants at their chosen location on or near their campus. All participants at

all PWIs were sent the social networking surveys at the same time, were asked the same questions, and were sent follow-up emails to member check and ensure social network accuracy. Triangulation was also used to show validity in this research and enhance the process of this research with data being collected from interviews as well as through the social network surveys. The data were then analyzed by multiple researchers; the interviews were analyzed independently, followed by comparing the interpretations with the research team. If any team member had different interpretations or findings from the data, discussions were held until an appropriate interpretation was agreed upon that best represented the meaning of the data. Two researchers held regular meetings during the process of analysis. In addition, regular analytical sessions were held with the research team. Discussions were held among the research team members about emerging data to ensure that assumptions were accurate and to maintain transparency throughout the development of findings throughout the study. The longitudinal design showed dependability as themes were noted consistently among participants over time and under different conditions (Korstjens & Moser, 2018). A copy of the final manuscript was sent to the participants in the study for their opinions and feedback as another means of member checking and displaying the credibility of the study.

Data Collection/Analysis

For the social networking surveys, a Qualtrics survey was sent to participants with name generator questions such as “Select faculty members in your program with whom you have a mentoring or advising relationship with and/or feel comfortable turning to for support.” Once a person was selected, additional name interpreter questions were collected for that alter, including their frequency of contact with them, the race/ethnicity of the alter, and gender. Multiple name generator questions asking about advisors/faculty, friends, peers, family members, Graduate

Student Association (GSA)/campus organization group members, religious community members, or program society members to whom they felt they could turn for support or had a relationship with compiled an exhaustive list of alters that were considered part of their support network.

Interview data has also been of vital importance for the qualitative research aspect. In this study, five members of the research team conducted 194 interviews over the six unique semi-structured interview sessions. Audio recordings were transcribed and then coded by themes. The social network codes were organized into subthemes that specifically described support from advisors/faculty, family, friends/peers, groups, race/ethnicity, gender, and overall general support. The inclusion of interview data allowed more specific stories to be identified and showed the real, raw experiences of URM graduate students at PWIs.

Results

In the following results, we will be examining the structure of URM students' support networks, where their support comes from, and in what capacity. We will look at similarities and differences found amongst the Black and Hispanic/Latinx students in terms of where they are seeking support, as well as quotes from them to illustrate the importance of different aspects of their support networks. The social networking aspect of the surveys and the qualitative aspect from the interviews form a cohesive story about what URM students need and find lacking in their graduate programs.

In Figure 3.1, we examine the distribution of support networks. Although the *y*-axis maximum is at 60%, it is calculated on a 100% scale. The *x*-axis has the four different role categories for the alters in the support network: friends/peers, advisor/faculty, family/significant other, and group member (on-campus organization, off-campus organization, church, club, sports team, etc.).

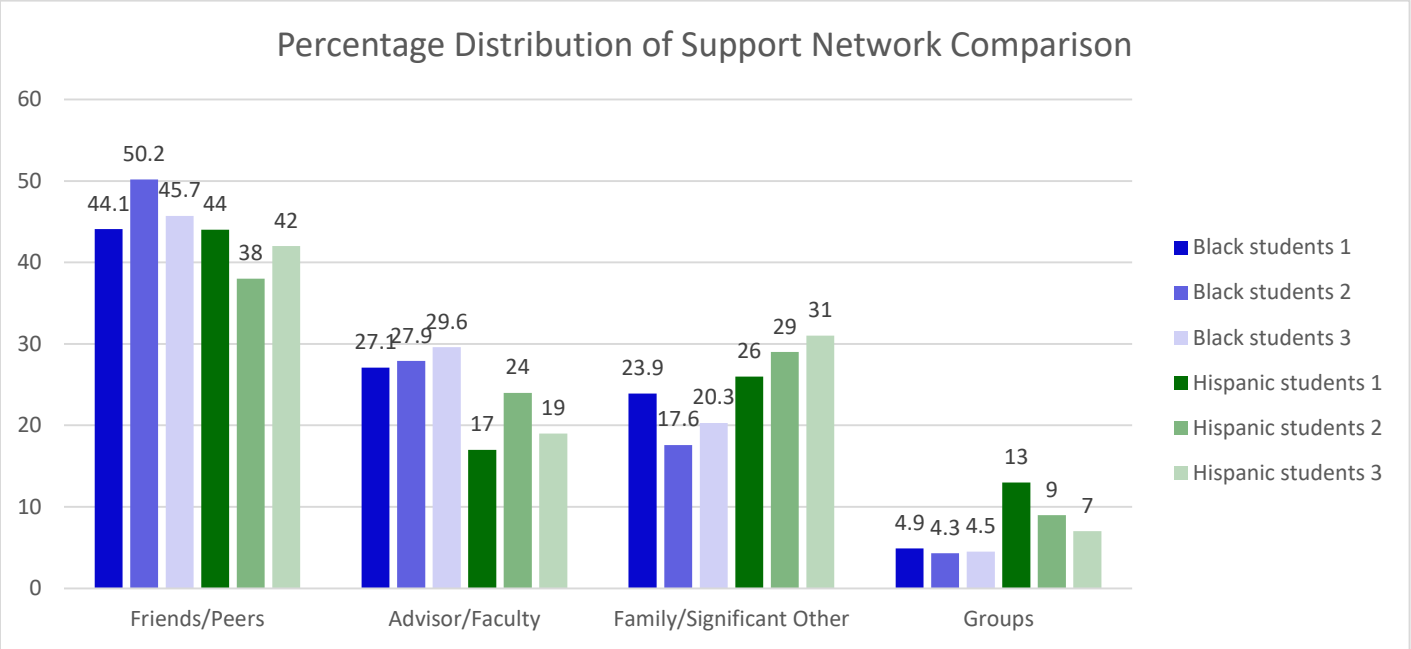

Figure 3.1. Distribution of support networks by survey, race/ethnicity of the participant, and support category.

The first survey (Black students 1 and Hispanic students 1) represents their support networks at the beginning of their graduate school experience (spring 2016). The second survey (Black students 2 and Hispanic students 2) represents their support networks in the spring of 2017, and the third survey (Black students 3 and Hispanic students 3) was given in the spring of 2018 as they were nearing the end of their graduate programs.

Friend/Peer Support

Most notably, the Black and Hispanic/Latinx students both had the highest percentages of support coming from their friends and peers throughout all three surveys, with Black students having friends/peers as 44%, 50%, and 46% of their support network, and the Hispanic/Latinx students' friends/peers as 44%, 38%, and 42% of their support network. The interview excerpts in Table 3.1 represent the importance of friends and peers for participants in graduate school.

Table 3.1

Friends/Peers Supporting Interview Excerpts

Friend/Peer support	Representative quotes
Amber (Black Student)	"My friends, here anyways, are in a similar position, so I almost feel, well, maybe we can talk about it, and stuff like that. And I think it's because they're in the immediate space; they're kind of going through the same thing."
Samantha (Black Student)	"I give a lot of time to school. The social life and my friends are the people at school. I had a girls' night at my place where we caught up on TV that we had missed all week. And we made pizza, and we just made food and watched TV that we didn't watch because we were busy all week. So, sometimes it's just really simple things." She compared her outside friends to current school friends by stating, "So, I have friends who are like 'We are praying for you.' And prayer is greatly appreciated, but who can talk it through with me are typically people who are within this space."
Vanessa (Black Student)	"I'd say that they [peers] are all very positive. Very cooperative, collaborative, like people are always offering up feedback on everybody else's ideas…so they're the most amazing group of people I've probably ever interacted with…When I first got here last year, some of the people from the other years reached out to me to hang out and get food and all of that, so I was worried starting from scratch having to build a friend circle, but they were great about reaching out and making sure I was included in what they were doing over the summer which was awesome."
Angela (Hispanic Student)	"We [my peers] developed a close relationship. So, they're basically my friends and colleagues, so we spend a lot of time outside of the lab also. We watch movies or quality time. They help me a lot…they're very, very friendly people…I mean, they're the only friends that we have."
Matthew (Hispanic Student)	"I really turn to my friends who are also my cohort; because they're all writing their own master's thesis and some of them are taking the same classes. So, we're having similar experiences and it's good to just to bounce ideas and experiences off of each other to know you're not the only one struggling with this stuff and get their advice."
Ethan (Hispanic Student)	"I keep meeting more people from my cohort, my peers, which is good. I'm getting some good social network there…I guess I have a closer group of friends that I met from the other ways, I guess. I guess we bonded through from being Latinos, but they're in all sorts of program—statistics, industrial engineering, and environmental science."

As seen by the participants' experiences and survey data, URM graduate students genuinely value and need the support of friends and peers in graduate school. These friends/peers understand what they are going through, relate to their experiences, and are, therefore, the most substantial parts of their support networks. They find that they are able to bond with and seek support from other students experiencing the same stresses and who also understand the time demands of graduate school better than family members or friends outside of their university. These friends can especially be a huge source of support when it comes to graduate school's time demands. Those that join in the hours of study sessions, writing sessions, and lab time have a different kind of connection and relationship that is needed, especially for URM students at a PWI.

Advisor/Faculty Support

The second highest support for the Black students came from their advisors and other faculty members (27%, 28%, and 30%). The Hispanic/Latinx students identified advisors and faculty members as important parts of their support system coming in at 17%, 24%, and 19%; however, the Black students were much more passionate about their relationships with their advisors and had more to say about the support that they received (which can be seen in Table 3.2 below). It appears that the race/ethnicity of the advisor played a more substantial role with Black women, as they had a greater tendency to connect with Black advisors within our sample.

Although the Hispanic/Latinx students did not specifically discuss their need to seek out advisors for their support networks in the interview process, it was still valued and important to them. The Black students tended to be more verbal about their need for those relationships in their support networks, specifically with other Black faculty and mentors. They found the

support from them as validating, encouraging, caring, and from a place of understanding the struggles they are facing in a PWI as well as graduate school in general.

Table 3.2

Advisor/Faculty Supporting Interview Excerpts

Advisor/Faculty	Representative quotes
Jayla (Black student)	"My relationship with my (URM) advisor is amazing, actually. He's really supportive. Just a week or two ago, he emailed me and told me how proud he was of me and how well he thought I was doing in the program and how other people have said I'm doing really in the program. So, that meant a lot."
Samantha (Black student)	"Ultimately what made the decision [to attend this university] for me was I met my adviser who is an African American male in leadership…and he just made it clear that he'd be here to support me. He knows what it's going to take. He was not as interested in my academic interests, but who I was as a well-rounded person." "The first year I was here, every two weeks, me and his [her URM advisor's] other two students and another professor and her students, would all meet together…we would have these mentorship advising sessions all together. I think that was one of the most beneficial things. It was really nice and supportive to know that every two weeks I'm going into this space and I can lay it all out…we're all students of color."
Vanessa (Black student)	"So, I have two advisors. One…is amazing. She lets me work on the research that I want to, great mentor, always asks me about how I am, how's life, and she really takes the time to get to know me, I feel like. My other advisor…she's also amazing. She's very precise with her work and very hands on, so I feel like together the two of them make the perfect mentor for me."

Family/Significant Others

Support from family and significant others made up a smaller portion of Black students' support networks (24%, 18%, and 20%). However, Hispanic/Latinx students sought substantial support from family and significant others (26%, 29%, and 31%), making this category/role the second-highest for the Hispanic/Latinx students. Based on the social networking survey data, Hispanic/Latinx students added more family members/significant others into their support

network as they progressed through graduate school. Interestingly, the way support was received from family members was discussed consistently amongst all URM students (see Table 3.3 for representative quotes).

Table 3.3

Family/Significant Others Supporting Interview Excerpts

Family/ Significant others	Representative quotes
Jayla (Black student)	"My family's been really supportive. They don't necessarily know what I'm doing, but they are supportive. They're like, 'You're smart; you'll figure it out. You chose to do this, so we believe in you.' So, they're supportive in that regard. I'm not sure that they fully understand what I'm doing, but they're like, 'You wanted to do this, so we support you in doing this.'" "I think that not everybody in my family understands. It's always an interesting process trying to explain what I do during the holidays when somebody asks, or why I didn't wanna go to law school. Or if I'm going to law school after this, which is not happening at all…they mean well. They just don't really get it."
Samantha (Black student)	"They know it's happening. But supportive, I don't know. That implies I'm doing something. I don't know if I've ever even gotten a congratulations…Their main thing is whatever makes me happy. And they're happy that I've found exactly what I feel I was put on this earth to do. So, they're happy with whatever that looks like."
Linette (Black student)	"I don't have support from my family, so it is very much a solitary endeavor for me." "My family hasn't been terribly supportive. Initially they weren't supportive at all, but they have grown more supportive. Not as supportive as I'd like them to be."
Mayra (Black student)	"My family is like—doesn't really understand. They're proud and brag on me all the time, but they don't really understand what I'm doing."
Adriana (Hispanic student)	"Yeah, they're supportive. I don't talk to them much, very estranged from all of them because I just don't talk to them. I guess they know what I'm doing, but I don't think they understand. Because they don't understand, I see it as they don't care, but they do. So, they're supportive of me, but not necessarily of what I'm doing because they don't understand it, and they don't really ask about it. They just assume that I'm working and that I'm successful because I don't live at home. So, I'm like, 'Sure, yeah. That's true in some way.'"

Table 3.3—Continued

Family/ Significant others	Representative quotes
Caroline (Hispanic student)	"In terms of external support, like friends and family that aren't in the department, I feel like they actually weren't that helpful because they would just be like, 'Oh, you'll be fine.' I'm like, 'This is the most crazy part of my life, thus far. The most intense situation I've ever been in…' So, there was definitely a lack of understanding there."
Nathan (Hispanic student)	"I don't wanna worry them about that kind of thing. And I don't want them to know either. So, I don't talk to them about those kinds of things [school problems] and whatnot. But I still talk to them about other things like how I'm doing and stuff occasionally."
Ethan (Hispanic student)	"I mean, I have friends and family, but I don't really feel the kind of support I would feel like I need to motivate me to go over these obstacles that we've been talking about because they have no idea what it's like….so if I talk to them about it, they're like 'Oh you can do it, you're smart.' And they'll try to be supportive in that way. So, I guess within this context, I'm not gonna list them as support, but I guess I do find that in other graduate students when I talk to them, even if they're not necessarily close friends….Mom is very much just throw the 'It's OK' blanket on everything, and my dad always projects his own experiences on whatever I talk about, so it's hard for me to feel like he knows what I'm going through."
Flor (Hispanic student)	"It's hard. The further along I go, the more distance there is between what I do and what my family understands what I'm doing."

Family support is complicated for the Black and Hispanic/Latinx students alike. Many students avoid talking about graduate school with family because they get tired of explaining what they are doing while not getting support for their needs and problems. Other students expressed that their family supported them, but they did not want to worry their family members by sharing their graduate school challenges with them. Many expressed their families as being proud of them, and knowing that they are loved, but described a disconnect with them. They still discussed talking to them frequently and considered them as support for other aspects in their life, but when it came to graduate school specifically, most families were unaware of what it is

all about. Family members told many students, “You’re smart, you’ll figure it out, you’ll be fine, it’ll be OK,” but that was not the kind of support they wanted or needed. However, because that was all they found their families were able to give in that respect, they tended to seek out support from others who “got it” and understood what they were going through, like peers, friends, advisors, and different student groups.

Groups

On average, both Black and Hispanic/Latinx students identified group members as the smallest proportion of their network, albeit a critical subset. Some of these vital groups that they were a part of include those such as Black Graduate Student Association (BGSA), Society of Women Engineers (SWE), Society of Hispanic Professional Engineers (SHPE), Black Student Psychological Association (BSPA), Society for Advancement of Chicanos/Hispanics and Native Americans in Science (SACNAS), and Alliances for Graduate Education and the Professoriate (AGEP). People they met at these different groups likely became part of their friend network because both Black and Hispanic/Latinx students talked at length about the importance of these groups in graduate school. According to the social networking survey data in Figure 3.1, Hispanic/Latinx students relied on these group members a bit more than the Black students as these group members still comprised 13%, 9%, and 7% of the Hispanic/Latinx support networks, while only being 5%, 4%, and 5% of the support networks for the Black graduate students. Although these percentages were by far the smallest, these groups meant a great deal to all URM students (see their experiences described below in Table 3.4).

Table 3.4

Groups/Organizations Supporting Interview Excerpts

Groups	Representative quotes
Amber (Black student)	about BGSA: "I definitely feel like it's helped me to connect with some other folks on campus."
Jayla (Black student)	"Like, being in [this state], it's not the most colored-people-friendly environment. Being with people who I know can understand is really nice, and I get that at AGEP…It's been a great space and supportive space, and it's how I met people of color outside of my department, and that was a really powerful and important experience." "In terms of being a person of color, I get that home feeling with the people from AGEP and Black GSA that when…sometimes you just need to be around people who all look like you because they can understand a little bit better about what's happening. So that's always nice…Being in these groups have help to stay connected to people because graduate school can be such an isolating experience."
Samantha (Black student)	"Really for me, it's important to get to know other students of color…so, we don't necessarily have a support system at home, so really supporting one another here, and when we meet other people, bringing them into the fold. So, I think even though we don't have a huge percentage of students of color in the [program], it's more than a lot of places on campus. So, having that space, and a place that's supportive, but also, we just hang out together. We have socials. We had a gala. We have a research symposium so we can present our research in front of one another, and get feedback from one another. So, it's a supportive place socially and academically for whatever we need."
Linette (Black student)	"The Black GSA is where a lot of my friendships that provide emotional and social support come from…If I had not been a member of the Black GSA, last year would have been much harder for me. And probably not as successful. They also provide academic support."
Vanessa (Black student)	"I think it just created a wider network of people that could talk to. I feel that it's a space where students can go to talk about things that may be race-related, or that have a certain—things that may be coming up for them that may not happen with other students. It's kinda a safe space to talk about things, which—where I grew up was predominantly white, and undergrad, I went to [university], which was somewhat diverse, but I wasn't part of any Black student groups there, and so for me, this program seemed very diverse…this feels like a large Black community, which I had never really thought about as something that I would potentially need or anything like that."

Table 3.4—Continued

Groups	Representative quotes
Courtney (Black student)	"It's [SHPE] a group I'm happy to be involved with because sometimes it's very hard to see sometimes even another minority." About Grad SWE: "I like to see women being able to bond, especially engineering women being able to bond and share something like that." About AGEP: "It's beneficial to people like myself in STEM who are either minority by gender or ethnicity." "We have this book club, and it actually is just Black women in graduate school at [city] …it's just really good that we have that, that we have each other."
Angela (Hispanic student)	SLOAN helped expose her "to other minorities, to other Hispanics, so that was great, knowing that there's other people…I think it's a great community. Especially like minorities like Hispanics, so you don't feel so lonely if you come from someplace far." About potentially joining SHPE: "I don't know a lot of Hispanics here…it would be nice. It's always nice to have [Hispanic] friends"
Adriana (Hispanic student)	"So I guess I joined SHPE because they're Hispanic and I felt like I was lacking that in my program, and I needed some more Hispanic people to be around with to understand the things that I eat or do or say and maybe to speak in Spanish once in a while. So that's why I went to them, and it was awesome. Those people were super great."
Caroline (Hispanic student)	"I think the best thing that's happened over the past few months is forming stronger relationships with other people who are Latino or Latina in the department, as well as not in the department and generally in SACNAS here. I think that's been really, really helpful for me and being able to talk through these particular things or grievances with a specific person. I think it's almost like beyond a support network. You have to find the people that really you can connect to, depending on whatever your identity may be, or whatever your particular mental illness may be, or whatever the case is."

Table 3.4—Continued

Groups	Representative quotes
Nathan (Hispanic student)	"I guess I struggled with meeting people or fitting in, or finding a support group initially…pretty much everyone else there is like Caucasian, so it's kind of hard to have someone who understands you and your background. Which then, kind of lead me to seek out external organizations or support groups…so I went out of my department, out of my school to find a support group so that I could have that relationship with people." "SHPE and having the support network with the other graduate students…we have similar backgrounds. I guess it helps you adjust in the sense of having that group. I'm not sure. I probably wouldn't even have considered a graduate school if I wasn't a part of that. I wouldn't have met the support networks that I have now."
Matthew (Hispanic student)	"They [the groups] have helped me feel involved in the school, In the community. I've met a lot of people. It's very important because they, most of them, give me the opportunity to express the Latino part of my identity."
Flor (Hispanic student)	"Without these groups, I would be miserable, I know I would be…so I know sometimes it's hard for people, especially if they're in north campus or something like that, to actually find the Latinos is kind of hard. So, I make an effort to tell them, 'Oh, we have this group, and we have this group. We have these events' and all that stuff, so make sure that they don't feel isolated or anything like that, let them know that there are others out there."

Although groups represent the smallest proportion of support networks in Figure 3.1, it is arguably valued at one of the highest. Numerically, the survey may not represent the groups to their actual value, as it is likely that many of the people that the URM graduate students met through these groups became important friends and were listed in the "friends" section on the survey. The Hispanic/Latinx and Black students had similar experiences and struggled with being surrounded by predominantly white students. They struggled to fit in and find their niches, but getting involved in one or more of the many campus or local groups and surrounding themselves with others like themselves made an enormous impact. It provided the feeling of

"home" to be around others that looked like them, while also providing emotional, academic, and social support at a difficult time in their lives. It allowed them to express their identities, feel validated, and feel involved in the school and within the community. Without these groups, these students may have very likely struggled to persist through graduate school.

Discussion

In this study, we investigated the composition of underrepresented minority graduate students' support networks and whether those proportions matched the value within those networks as they progressed through their STEM and SBE programs in graduate school. This study was advanced by analyzing interview data from URM students as they discussed the importance of having a variety of people with different roles in their support network, especially those at their institution that shared the same experiences and same URM status. Their reports are consistent with previous literature on social support, as we can see that there are differences in the kinds of support people receive from their support network (Wellman & Wortley, 1989, 1990). These URM graduate students wanted to feel understood and have a community of people surrounding them that could comprehend and relate to how isolating the graduate school experience was and that could support each other through that experience.

As discussed earlier, URM students experience isolation, alienation, and lack of support when at a PWI. URM students often find it necessary to find or create their own social and cultural support networks to offset the loneliness and seclusion from the broader campus environment (Allen, 1985, 1992). These groups have fostered connections that allow URM students to express cultural and ethnic identities among students of color (Museus, 2008). We can see from our data that the largest percentages of Black and Hispanic/Latinx students' support network included friends and peers. Harper (2006) concluded that peer support played a vital

role in the success of students. When combined with group membership, which includes supportive people within the space of their university, this makes up 50% or more of most students' support networks. This echoes findings from other research that social network members from voluntary groups who are directly coping with stressful life experiences are more likely to offer friendships and critical social support than social network members that are not experiencing that stressor (Gage-Bouchard, LaValley, Panagakis, & Shelton, 2015; P. Marsden, 1988). Gardner and Barnes (2007) also found that students had increased social interaction with peers and faculty members from participating and being involved in departmental settings as well as graduate student organizations. Graduate student organizations are especially crucial for URM graduate students at PWIs, when the availability of faculty or other students of color is scarce, so they do not feel as if they are alone in their academic endeavors. McPherson et al. (2001) also echoed that people primarily have significant, quality contact with others, like themselves and within a common sociodemographic space, summarized by the phrase, "people like us" (p. 416).

In addition, the integration of URM students into their graduate departments and exposing them to URM faculty needs to become more of a priority. Our data show the importance of having advisors and faculty members in their support networks as it makes up 27%, 28%, and 30% for Black students' networks, and 17%, 24%, and 19% of Hispanic/Latinx students' networks. Dika (2012) supports this by stating, "It is well known that positive, frequent interaction with faculty is associated with greater learning, performance, and attainment" (p. 596). Graduate students that have successful experiences frequently have positive mentoring relationships with faculty (Tinto, 1975; Waldeck, Orrego, Plax, & Kearney, 1997). URM students thrive and develop best in environments where they feel valued, protected, accepted,

and socially connected, which advisors and other faculty members can provide. Supportive environments from faculty and advisors might include the comfort of knowing that it is safe to "take the risks associated with intellectual growth and development" (p. 40) as well as providing students with positive feedback, support, understanding, and who communicate that they care about the students' welfare (Allen, 1992).

Although quantitatively smaller than friends and peers, support from family and significant others is an essential and reliable form of support for URM graduate students. The availability of the support from this category is immeasurable. Many graduate students reported that they could call their spouse or parent anytime and they would be there no matter what, even if they did not understand. Many said that their parents would book a flight to come to stay with them if they expressed concern or worry about their situation at school. Even though parents, siblings, and even significant others were often physically distant, the emotional support they provided, even though they did not fully understand the complexity of the graduate school experience, was significant and essential.

There are several limitations to this study. First, the sample used in this study is not representative of all URM students in graduate programs. The size of the population was modest; a larger participant group would have allowed for a more complex and robust analysis. Also, the participants were from PWIs in the Midwest; therefore, results might be different in other areas of the country. As noted, all of the Black students that participated in the three surveys identified as women, so this study lacks representation from students who identify as Black men. This study also relied on self-reported information in both the surveys and interviews, both of which are subject to participants' honesty and accurate recollection of past events. Lastly, there were five different interviewers on the project, each with their own interview styles during the semi-

structured interviews, so interviewer effects may have encouraged or discouraged participants to share information.

Despite these limitations, this study significantly contributes to the literature on URM students' experiences in doctoral programs in several ways. Social support from various sources is necessary for URM graduate students at PWIs, with most of their support coming from friends, peers, and those in their cohort. Therefore, the university needs to make more of an effort to make this a diverse group and do a better job of helping students form connections, particularly with other URM students. Having advisors and faculty support (especially those of color) is another critical factor in URM students' success and persistence in graduate school. Familial support is also important to graduate students, albeit different.

Moreover, having on-campus groups to support relationships with others like themselves so that they have others going through a similar experience is vital. Without more support in these areas, we are doing a disservice to the URM population, higher education equity, the nation's economic competitiveness in the global economy, and, ultimately, the nation's workforce. It is arguably necessary to have URM students in graduate programs so that non-URM students learn to work with people who differ from themselves, learn to overcome biases about ability, and confront their unconscious racism. To achieve this, however, would require a substantial investment on the part of non-URM students, non-URM faculty, and the university.

Although this study did not explore the social support networks of non-URM graduate students, there has been enough prior data to know that URM graduate students experience more isolation and stress than non-URM graduate students, therefore implying that social support is a critical need, particularly for URM students. The findings from this study provide evidence of the role institutions must play as far as providing groups for URM students to find others like

themselves. It also depicts the importance of having a diverse support network, especially the availability of URM peers, cohort members, faculty, advisors, campus groups, and organizations.

Future research may incorporate the network analysis of those network members named on network surveys to investigate if the support is bidirectional to compare perceptions. It would also be interesting to track the network composition of these URM graduate students after graduation to see how their network changes and if they rely on different people while they start a new stage of their life/career. It is essential to continue to research and follow URM students that persist through graduate school and beyond, as these students will become mentors to other URM students, and to ensure they have the social support they need to be successful. These measures will ultimately enhance the STEM workforce by incorporating alternative perspectives brought by URM professionals.

CHAPTER IV

EXPLORING RACIAL AND GENDER HOMOPHILY IN SUPPORT NETWORKS FOR BLACK AND LATINA WOMEN GRADUATE STUDENTS AT PREDOMINANTLY WHITE INSTITUTIONS

Introduction

Women of Color in STEM

Women, especially women from historically underrepresented groups including Black and Latino/a/x students, continue to encounter systemic difficulties while pursuing graduate degrees in STEM and SBE programs. They face three oppressions: gender, race/ethnicity, and that of their chosen science field. According to STEM literature, women and underrepresented minorities tend to have higher disparities in levels of achievement as well as higher STEM attrition rates when compared to white women, white men, or even men of color, especially at the most advanced levels of education (Chen & Soldner, 2013; Griffith, 2010; Huang et al., 2000; "Unraveling the Double Bind: Women of Color in STEM," 2011). Specifically, Chen and Soldner (2013) found that female STEM students were 16 percentage points higher than their male peers in regard to switching to a non-STEM major at 43% for females compared to only 27% for males. Baird, Buchinsky, and Sovero (2016) found that minority students (Black and Hispanic students) were 18 percentage points more likely to switch out of STEM majors compared to non-minority students (white and Asian students). Baird et al. (2016) also noted that the dropout rates were much larger for minority students, 23.1% for Hispanic students and 29.3% for Black students compared to non-minority students (19.8% for white students and 9% for Asian students). Current data from 2019 show that women comprise 48% of the overall

workforce but constitute only 27% of the science and engineering workforce (Martinez & Christnacht, 2021). Women from historically underrepresented groups (Black/African American, Hispanic/Latina, Native American/American Indian, Alaska Native, Hawaiian/Pacific Islander) are 16% of the population but earn only 3% of bachelor's degrees in engineering, 5% of bachelor's degrees in computer sciences, and 6% of bachelor's degrees in physical sciences (National Girls Collaborative Project, 2013). Women from these minority groups comprise fewer than 1 in 10 employed scientists and engineers (National Girls Collaborative Project, 2013). These data represent an extraordinary loss of talent, scientific training, and experience that could be contributed to the scientific community if more minority women could be retained in their graduate programs.

Homophily

Many studies have shown that women have more extensive and more homophilous networks than men do, often seeking more emotional, instrumental, psychological, and social support from their networks and claiming that it is vital for survival in male-dominated spaces (Gewin, 2019; Graham-Bermann, Eastin, & Bermann, 2001; Kaufman, 1978; Nokkala, Ćulum, & Fumasoli, 2017; Rodriguez-Madrid et al., 2018; Rothstein & Davey, 1995). Research has repeatedly shown that women of color find STEM programs especially unwelcoming and isolating due to being the token URM or woman, not belonging, being left out of study groups, and feeling invisible (Joseph, 2012; Ong, 2005; Ong, Smith, & Ko, 2018). Sedlack (2011) noted that women and students of color need to be involved in a community with which they identify to find support and be successful in their academic pursuits. They noted that those

> who are active in a community learn how to handle the system, exhibit leadership, and develop their self-concepts in such groups. Therefore, those who have been involved in a community, often based on race and/or gender, are more successful in college than are those not so involved. (p. 196)

Terhune (2008) noted the specific importance of community and social support among Black women. In their study they found that "support networks enabled the women to cope with the social and cultural isolation they experienced" (p. 555). Terhune (2008) also noted that the participants in their study found it necessary to return to their hometowns, to their original support networks, and to connect to a larger Black community to refuel and reenergize them. These studies have shown that dually marginalized women need to find homophilous support networks with other women and/or those with similar attributes.

People who have similarities with one another are more likely to form a connection than dissimilar people are. Therefore, support networks made up of friends, spouses, acquaintances, co-workers, and colleagues are all more likely to have similar attributes with respect to race, age, gender, socioeconomic status, shared cultural backgrounds, similar language, and education than a random group of people, especially in the context of a school environment (Blau, 1977; Byrne, 1961; Kalmijn, 1994; Kossinets & Watts, 2009; P. Marsden, 1988; P. V. Marsden, 1987; McPherson et al., 2001; Schrum, Cheek, & Hunter, 1988; Scott & Carrington, 2011; Verbrugge, 1977). Humans have a fundamental need to feel safe and have a sense of belonging. One way for this to occur is to stay within one's "social cocoon" (p. 56) as the connections between similar people lead to feelings of well-being, contentment, and security (Kadushin, 2012). Christakis and Fowler (2010) said that homophily is the "conscious or unconscious tendency to associate with people who resemble us" (p. 17). Kossinets and Watts (2009) described homophily as "one of the most striking and robust empirical regularities of social life" (p. 405). People simply prefer to form ties with others with similar attributes (McPherson et al., 2001). Kossinets and Watts (2009) said that trust and solidarity are easier to establish with those who are similar to oneself and simplifies the process of communication. Homophily is induced by in-group bias and

personal choice, and having shared cultures makes connections easier (Kalmijn, 1994; Kossinets & Watts, 2009; McPherson & Smith-Lovin, 1987; McPherson et al., 2001). Studies have also concluded that homophilous ties were more stable, lasted longer, had more significant benefits, and were easier to maintain (Santos & Reigadas, 2005).

Support

Research has shown that supportive educational environments during college are positively linked to retention and persistence for women and students of color in STEM education (Bonous-Hammarth, 2000; Cole & Espinoza, 2008; Gloria et al., 2005; Grandy, 1998; Ong et al., 2018; Palmer et al., 2011; Tate & Linn, 2005). More specifically, support for students of color includes role models of color that can share their experiences and knowledge, lesson sharing from advanced students from similar ethnic groups, and relationships with staff of color. Furthermore, support that students of color receive from peers, mentors, and faculty is critical to STEM education (Bonous-Hammarth, 2000; Grandy, 1998; Palmer et al., 2011). Students of color who establish support from minority or women faculty, as well as peers and other students from the same ethnic group, have been found to have less discomfort at PWIs (Cole & Espinoza, 2008; Gloria et al., 2005; Grandy, 1998; Griffin, 1991; Kimbrough et al., 1996). Tate and Linn (2005) noted that cultural campus organizations have provided homophilous spaces for women and students of color that have "helped to facilitate students' social integration by providing a sense of cultural connection, a space to develop and express their racial/ethnic or gender identities as well as to give back to their communities by supporting other students like themselves" (p. 209). However, research shows that faculty of color only make up 12% of full-time professorships, making it difficult to find faculty of color to serve as mentors (McClain & Perry, 2017). Tinto (1975) and McClain and Perry (2017) theorized that social support allowed

students to become socially integrated and involved in the academic environment, thus decreasing decisions not to persist. DeFour and Hirsch (1990) found that among African-American graduate and professional school students, those who had out of class contact with African-American faculty and students were less likely to consider dropping out of school. A support group of peers that are effectively handling similar challenges can model coping and persistence behaviors, therefore helping URM students that are in distress (Gloria, Robinson, et al., 1999; Kimbrough et al., 1996). In another study, Latino students found opportunities to make new friends from similar cultural and socioeconomic backgrounds by being involved with specific campus groups and organizations. Through these peer relationships, they found a caring and supportive community at their university (Hernandez, 2000; Hernandez & Lopez, 2004).

Attributes Desired

As noted above, there are many attributes that people may seek uniformity with when they are choosing their social network. However, race/ethnicity and gender appear to be the two strongest attributes where homophily is desired (McPherson et al., 2001). McPherson et al. (2001) discussed numerous studies that have looked at the tendency toward homophily in many different social networks because a shared culture and a shared gender often equates to a shared experience and sense of belonging. Perry et al. (2018) suggested that one argument as to why homophily arises is purely preference: "Homophily is, quite literally, liking of one's similar—the tendency to *prefer* those similar to oneself on socially significant attributes such as race, gender, education, religion, and social class" (p. 167). First, they noted that, overall, research on homophily explores the circumstances under which homophily is more apt to happen. For instance, the factors within a network of relationships that led to particular ties and what kinds of similarities allowed these ties to form are of interest (McPherson et al., 2001). Prell (2012)

claims that individuals will seek out and find others similar to themselves and form ties with them, regardless of the organizational setting. For example, friendship ties are seen as developing due to individuals being in a similar age group or coming from a similar educational background. In addition to preference, Perry et al. (2018) also suggest that homophily could be a product of availability and/or opportunity. On a predominantly white campus, it is easier for white students to form support networks with other white students than it is for minority students to find other minority students that they would want to include in their support network due to less availability of those with similar attributes (Kadushin, 2012). Prell (2012) agreed that ties will form between those with similar attributes but also noted that "a voluntary organization that has a particular focus will draw in members who share that focus and this similarity among the actors will also coincide with other similarities" (p. 129). Thus, the group composition produces homophily. This is observed with students from minority groups who are seeking similar attributes with members of student organizations, church groups, club sports, and graduate student organizations who can be part of their social support network.

In this longitudinal study, we expected to see Black and Latina women students seeking homophily within two different demographic attributes—race and gender—which are significant relationship characteristics in college support networks (Park, Lee, & Kim, 2012). However, when URM graduate students are at a PWI, an environment where there is not naturally much opportunity for homophily, it was unclear how desire for homophily in social networks would be affected and whether more diverse social networks would be observed as a result. Interview and social networking survey data were used to analyze the gender and cultural attributes of members of Black and Latina women's social support networks while enrolled in graduate programs at PWIs. With three social networking surveys and six interviews over three years, this unique set

of longitudinal data made it possible to investigate the role of social support and composition of support networks throughout their graduate school experience. This paper is uniquely situated to explore the social support networks of Black and Latina women graduate students in STEM and SBE graduate programs and identify tendencies toward homophily on two different attributes, gender and URM identities.

Theoretical Frameworks – Egocentric Network Analysis and Critical Race Theory

Egocentric network analysis is one of the two theoretical frameworks used in this study as it focuses the investigation on individuals and the interpersonal relationships that they are embedded in. This personal network analysis exposes the intimate structure of an individual's social circle, including how people are connected to the ego, how similar they are to the ego, and how diverse they are (S. Lee et al., 2018). Data from egocentric studies can take samples from specific populations and generalize to a larger body of individuals (Perry et al., 2018). Egocentric research allows for the exploration of patterns that are seen within networks as well as prediction of the ego's social network from variables that describe how the ego is connected to their alters, characteristics of the alters, and why egos have the networks that they have (Perry et al., 2018). In this research project, we focused on the egos' reports about who was in their social support network and whom they found supportive over time, not on the alters' views or anyone else's standpoint. It is from these data that we can study the homophily within the egos' support networks directly, which is a standard and well-accepted method in social network analysis research (Borgatti et al., 2013; Christakis & Fowler, 2010; Prell, 2012; Scott, 2017). Using egocentric network analysis, we were able to explore relationship ties beyond what is seen by an outside observer and examine, as Scott (2017) noted, "their structural properties and their implications for social action" (p. 2).

Critical race theory (CRT) is another lens used in this study and is a relevant theoretical framework to use when investigating narratives from underrepresented populations. This framework is appropriate as it shares and empowers voices and perspectives who have been, according to Bell (1995), as "oppressed, distorted, ignored, silenced, destroyed, appropriated, commodified, and marginalized" (p. 901). Daftary (2018) adds that CRT then "encourages a problem to be placed in social, political, and historical context while considering issues of power, privilege, racism, and other forms of oppression" (p. 1). While this study explores the support networks (or lack thereof) of Black and Latina women graduate students, it adopts the perspective called for by critical race theory that Bell (1995) describes as, "specifically, a demand that racial problems be viewed from the perspective of minority groups, rather than a white perspective" (p. 906). While we focus on the egos' narrative, their truths and voices direct the study's narrative and findings. The URM participants' experiences and perspectives related to their social networks allowed us to critique academic institutions' structure and systemic racism, sexism, and classism built into the university setting. The difference CRT provides that many other theoretical frameworks lack lies in its intention for social justice. Critical race theory is a lens used to expose racism, and, in this case, how it affects Black and Latina students' lives, and how the university system is continuously failing them.

Methods, Setting, Design, and Participants

Human Subjects Institutional Review Board approval was granted at Western Michigan University for Project Number 14-06-16, allowing participant recruitment and interview and survey data collection to begin for this longitudinal study.

In the spring of 2015, the registrar at three Midwestern PWIs sent out a survey invitation to all non-white graduate students in their first or second year of a doctoral or master's-to-

doctoral STEM or SBE program. Individuals were included in this social network homophily study if they took the pre-survey, self-identified as a member of an underrepresented minority group (Black/African American, Hispanic/Latino/a/x, Native American/American Indian, Native Alaskan, Hawaiian/Pacific Islander), were enrolled as a first- or second-year doctoral student in a STEM or SBE graduate program, completed six biannual interviews over 3 years between 2015 and 2018, and completed three social networking surveys. These social networking surveys collected participants' reports of individuals in their social networks during spring 2016, spring 2017, and spring 2018 semesters (in future graphs termed *survey 1, survey 2,* and *survey 3*). Social networking data and qualitative data were collected through surveys and corresponding interviews. This paper will be focusing on the 11 women participants that completed all six interviews and all three social networking surveys. Seven of the 11 participants self-identified as Black women. The four remaining self-identified as Hispanic/Latina women. We chose to focus this study on only women because we did not have any Black men complete all the surveys. Also, analyzing data across racial/ethnic identities and gender simultaneously introduced too much variability, and literature indicated that women were more likely than men to seek out homophily in their social networks.

In the social network surveys, numerous name generators were asked to obtain the most accurate social support network for the URM graduate students. An example of a name-generator question used in this study was, "What faculty members in your program do you have a mentoring or advising relationship with and/or feel comfortable turning to for support?" Another prompt was, "What students in your program do you most socialize with or turn to for advice or support?" Other questions inquired about supportive students outside of their program, and support members from religious organizations, campus organizations, student government,

graduate program societies, and family. For each of these name generators, they were asked name-interpreter questions about each alter named. First, they were directed to choose if the alter named identified as a URM or non-URM. The survey specified that Black/African American, Native American, Hawaiian/Pacific Islander, Hispanic/Latino would be termed URM and that non-URM included those that may be white/Caucasian or Asian. They were also asked to identify the alters as men/women and their role in their social network (friend, peer, family, faculty, etc.). For each of the 11 participants, also termed egos, their three social network survey responses were arranged in an Excel spreadsheet. For each alter named, their attributes of race/ethnicity, gender, and role were aligned for homophily analysis.

Reliability and validity are crucial to ensure credible and trustworthy research. Therefore, this study involved a strong research design with research conducted carefully and consistently with appropriate methods used. Triangulation methods were also used when combining survey data with interview data, which strengthens the validity and reliability of research and the findings. We had a large research team who all agreed how the data would be collected, how to conduct interviews with the pre-determined interview protocols, and how to code interview transcripts. Intercoder agreement was reached within the research group and discussions took place when reading the transcribed transcripts to ensure all social networking codes were collected consistently. All participants received the same social networking surveys and directions to complete them. Additionally, a draft of the article was sent to the participants involved, allowing them to comment and confirm that their experiences were accurately represented.

Data Collection/Analysis

Egocentric network analysis can be done using standard statistical methods. Krackhardt's E-I Index ($EI = \frac{E-I}{E+I}$) was used to calculate overall whole-network homophily and homophily within their network subgroups (Krackhardt & Stern, 1988). This calculation expresses the "number of alters different from ego (external ties *E*) minus the number of alters the same as ego (internal ties *I*), divided by the number of alters. This is a reverse measure of homophily since a larger number indicates greater heterophily" (Perry et al., 2018, pp. 168-169). These data are always expressed as a number between -1 and +1, with -1 representing complete homophily (all network members with the selected characteristic in common with the ego) and +1 representing complete heterophily (all network members with the selected characteristic different from the ego). To calculate overall URM E-I indexes for this data set, all alters listed from the first survey were counted by their attribute as URM or non-URM individuals. The URM total would then be subtracted from the non-URM total and divided by the total number of alters listed in survey 1. This was calculated for all three surveys for both Black and Hispanic/Latina students. These data were further analyzed as the alters were divided into the support roles of the ego. For each role, URM E-I indexes were then calculated. For instance, in survey 1, all of the alters were divided into their designated support role: friend/peer, advisor/faculty, family/significant other, or group member. For each role, the number of non-URM and URM alters were counted, and the E-I index was calculated as it was above. This was also done for the second and third surveys.

Similar to calculating the URM E-I index, gender E-I index was then calculated. First, the overall gender E-I index was calculated for the whole network for surveys 1, 2, and 3. Every alter in the ego's support network was either classified as male or female on the survey (note that man and woman have since been used to better represent gender identity rather than biological

sex). Therefore, since the egos were all women, the E-I index would be all of the men listed minus all of the women listed, divided by the total number of alters. After this was completed, the alters were then analyzed in their respective support roles. Gender E-I indexes were calculated by role for all three surveys.

There were substantial interview data to accompany the survey data investigating whether URM graduate students sought racial/ethnic and gender homophily. Six interviews were conducted biannually and were aligned to the three yearly social networking surveys. Interviews were semi-structured and included a wide array of questions with a substantial focus on social support. For example, we asked participants if there were any significant changes in their support network, if they turned to new people for support, what changes had happened, and elaborated on these prompts. We also asked what individuals in their life were most supportive of them being a graduate student at that moment and whether they had any updates about the support they obtained from their family and/or significant other. All interview data were coded for any social support persons that were explicitly mentioned. If there were people mentioned in the interview data left off the survey data for the aligned time frame, we emailed the participant to verify if the alter was an appropriate addition and asked for those particular alters' attributes. We had a reliable representation of each ego's support network during each time frame with survey and interview data. With this complete list of alters and their corresponding attributes, we were able to study patterns and examine each ego's social support network's makeup, specifically regarding homophily within their racial/ethnic and gender groups.

Results/Findings

In this section, the following main themes are discussed, which all emerged from the social networking data and interviews:

1. Black women students' social support networks show more URM homophily than Hispanic/Latina women students did.
2. Black women students exhibited more gender homophily than Hispanic/Latina women students.
3. Hispanic/Latina women students had networks that were generally equally distributed across URM and non-URM.
4. When looking at specific categories in their support networks, Black women students showed homophily in all areas except advisors/faculty.
5. Hispanic/Latina women students had proportionally more non-URM friends/peers, advisors/faculty, and family than Black students.

In the following sections, themes are delineated, and quotes from participants are presented to preserve their experiences' essential aspects.

URM Homophily

When looking at the overall URM E-I Index in Figure 4.1, a general trend is that Black women's social networks exhibit URM homophily more than those of Hispanic/Latina women. Black students' networks all had negative E-I Indexes throughout the three surveys, with values being -0.5371, -0.3871, and -0.3214. This indicates that Black women were more likely than Hispanic/Latina women to have more URM-identifying individuals in their networks than non-URM identifying individuals.

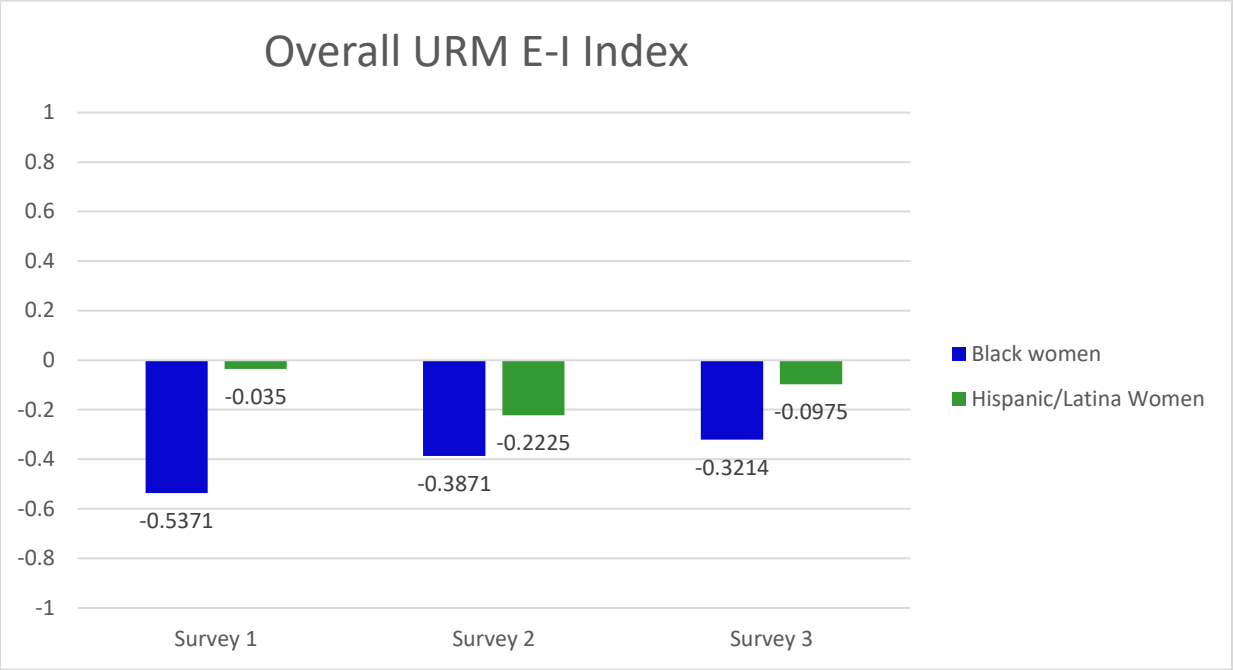

Figure 4.1. Overall Black women and Hispanic/Latina women's average URM homophily (utilizing E-I Index).

A common trend for many Black students was to have started graduate school with ample support from friends/peers and family/significant others that were also URM individuals who were not in graduate school. Over time, some of these alters were perceived to be less supportive as they did not understand the challenges of graduate school while individuals in graduate school were able to provide more robust support. The rise in E-I index after the first survey reflects this shift from prior support persons to more support from other graduate students. For example, Amber noted,

> Initially I was having a hard time because…I didn't think about myself as a person of color, as a woman, in this space… We're [two friends from University that are the most supportive] often on a group chat where we're talking about the struggles of the day. So yeah, and I think it's because they're in the immediate space they're kind of going through the same thing.

Jayla also commented,

> You definitely have to do the work and you definitely have to find places where you connect with people. Not just in the program, but outside of the program. You gotta build places where you connect because I get different things from different people. Like girls in my cohort are great, but there are some things that I can't necessarily talk to them about. My family's great, but they don't always understand. My friends at home they're great too, but they're not here! And so, I had to make friends here, so I'm not always alone…I have spaces where I feel like I can be—feel more comfortable in that identity because there all more people of color, and I can talk about certain things that I wouldn't talk about with people in my department.

Samantha noted that her friends from back home were still great, but she said,

> I think people who understand this experience can support in a very different way. So, I have friends who are like, "We're praying for you," that type of stuff… And prayer is greatly appreciated but who can talk it through with me are typically people who are within this space. I think probably my closest friends are BGSA [Black Graduate Student Association] members, so we hang out or study together.

She needed people within the physical space of graduate school and old friends to pray for her, but the connections through BGSA were instrumental for her. Vanessa noted how much she loved and appreciated her parents,

> But they don't really understand what I do really, so it's hard to get support from them… I'd say before I was very limited to my husband of just talking to him about like everything. There were things that he didn't understand because he wasn't here, and so now I feel like my support network is a lot bigger because I can talk to the other students here about "What is going on? What do you think I should do?" Or like, "I am hating this right now."

On the other hand, Hispanic/Latina student E-I indexes were all very close to 0, meaning that they had a relatively even split between URM and non-URM members of their support networks, with values at -0.00556, -0.07889, and -0.10667, respectively. An interesting theme that arose was that they might not necessarily seek others precisely like themselves but would often surround themselves with a variety of people. Many of these Hispanic/Latina women discussed that they "passed as white" and felt that they visibly fit in with their cohort, peers, and other students. However, they still felt the desire to be surrounded by other Latinx students to counter all the "whiteness" surrounding them. While Hispanic/Latina students had more non-

URM alters in their support network than Black students, they did not discuss their non-URM alters much. The few examples found included Caroline, noting that the entire grad school environment was "just weird to me. I don't know. I usually surround myself with a vast variety of people and so to be so limited by people who are white… it's weird." While the overall averages were interesting, we wanted to parse the data out by category of network members in order to understand students' social networks better.

Black Women's URM E-I Index

Looking deeper within their support networks (in Figure 4.2) and to whom they turn for support, Black women are relying more heavily on URM individuals within their friends/peers, family/significant others, and group members, as shown by E-I indexes of -0.55, -0.53, -0.38, -0.9, -0.88, -0.88, -1, and -1. The two -1 values are representative of small populations (four and three URM alters, respectively). Interestingly, advisors and faculty members that the Black participants found supportive were about half non-URM and half URM (E-I indexes of -0.06, 0.02, and 0.04). There is an availability factor when it comes to URM faculty at these PWI universities, and when there are limited numbers of URM faculty, URM students have to have other advisors to turn to, leading them to non-URM advisors, faculty, and committee members.

When examining the interview data, several students expressed the desire and need for more support from URM advisors. Mayra, for instance, stated her desire for more faculty of color to support her:

> People change advisors all the time. I think it's easier for white women and men to do that than for people of color in general and women of color, in particular. So to find a good advisor, someone that's really out there to protect you and look after you and be your advocate when they need to be…the women and the women of color, specifically, their stuff gets much more nit picking and stuff like that, than the males, and especially the white males, in our class. I just think there's this bias against women and women of color that makes it really difficult, that you have to work twice as hard, also.

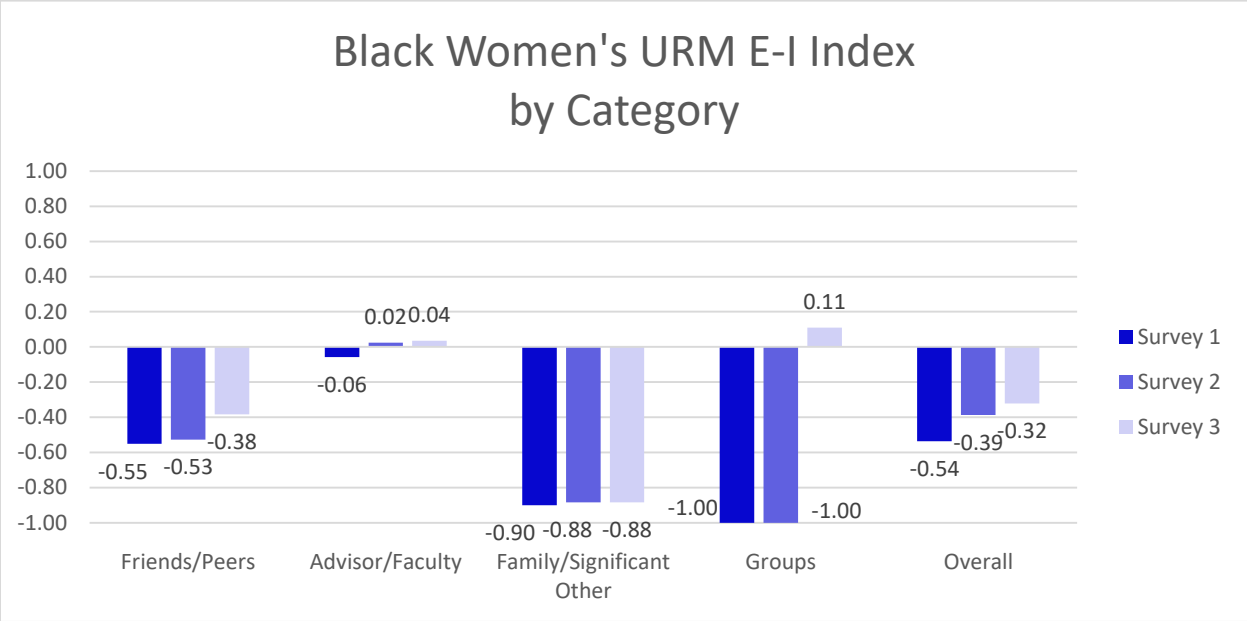

Figure 4.2. Black women's average URM homophily (utilizing E-I Index) by role/category.

Another example was when Mayra discussed going back to her undergraduate mentor at an HBCU for support rather than turning to her current advisor. She explained:

> She's a white woman. She gets some stuff, and she tries to understand. But I don't think she understands what it's like to be a Black woman trying to navigate academia. That's why I still consult with my undergrad mentor on projects, on life in general, on academia, and what it feels like being Black, and trying to be an academic. I complain about this all the time to the women of color in my cohort. I'm like, "I need to find some Black women mentors."

These women wanted to form connections with Black faculty, though they were often not available at the schools at which they were enrolled.

All of the Black women mentioned that it was important to have people supporting them. However, several specifically spoke of their need to seek out and be connected to other people like themselves, explicitly noting that they needed other "students of color" and "faculty of color." Linette said that she wished her advisor were Black because "being around more Black people makes me feel more of a sense of belonging. Black people understand me more." Jayla

stressed the importance of finding students who have shared identities and therefore understood her:

> There's things that I know that I can't necessarily talk to them about [white students in cohort], so I have other people I can talk to about those things… They understand, but it'll never to the same as talking to somebody who is able to identify.

Samantha expressed gratitude for supportive faculty of color and what a difference it made in her experience:

> I think we have great faculty of color…the ones that are there, they're very supportive. They had the Black faculty/student get together for the [program] a couple weeks ago at one of the faculty member's homes. And that's when they—we talked about what this really is—what is this experience, how can they support us, and just have conversations, and they answered questions. So, I feel like our faculties are really open with us to support us.

These excerpts highlight the desire and need for these Black women to be supported by others like themselves, often finding that white students, faculty, and advisors do not understand what they are going through. Complete homophily is obviously not met as we can see in Figure 4.3 that the overall E-I index is never exactly -1. However, there were areas where they were able to find more support from other Black individuals, especially from friends/peers, family/significant others, and from group members. Despite these trends, there were times that some Black students did not seek support from other Black people. Samantha had an interesting comment:

> I guess one thing that's interesting this year is I have had more tension with my Black female colleagues which has been interesting because I don't feel like I do anything. But I think that's something that, unfortunately, is common in the African American community. Black women, for some reason, have tension and, typically…I think I get along with a lot of the guys because they don't do the drama…so that's been, I guess, more of a challenge this year because I don't get it.

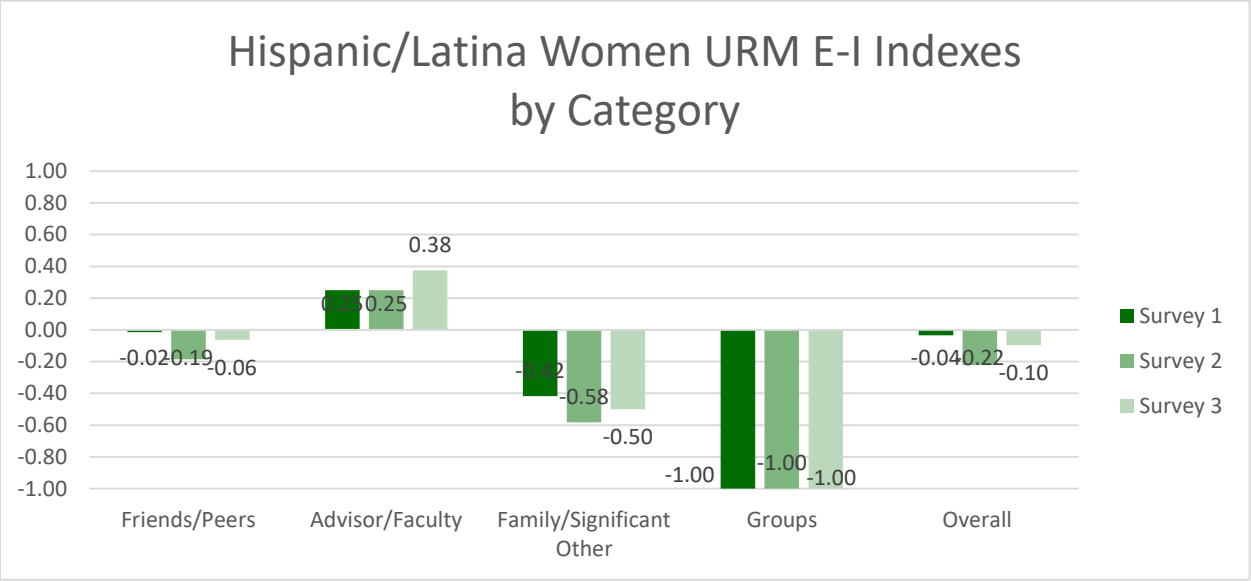

Figure 4.3. Hispanic/Latina women's average URM homophily (utilizing E-I Index) by role/category.

Samantha also discussed her friendship with a white female colleague and how the support she received from her was functionally different from what she was accustomed to, which might be why help us understand why other Black women seek other Black women.

> There was one friend specifically who—she's a white colleague and I don't—and I say that only because I think I'm one of the first, probably, people of color she's been friends with so I think knowing how to support may look different for different friends…and I think also for people of color especially you're taught to like "suck it up and keep goin'." And so her offering support to me was like, "Let's cry and watch Lifetime and eat ice cream." And I'm like, "absolutely not," that's not what I'm gonna do. My mom would hate me for doing that….so I think at that point in time was our friendship shift…because I think she also started to see that she didn't know how to be there for me.

There was a fundamental difference in how Samantha and her friend coped with difficulty, and for Samantha, this caused their friendship to change.

Linette provided a counterexample, as she initially sought out a Black advisor, but after having difficulties, ended up switching to a white woman advisor. She expressed in a very emotional statement, "I don't trust her [her first advisor]. I don't think that—it's hard to trust

someone who teaches about microaggressions and Black woman struggles, and then they act in ways that are oppressive to you." After she switched advisors and chose the white woman, she noted that

> She has been more supportive to me than the Black female has been…And it's one thing to feel invisible at a PWI of like people who are white, but when your Black advisor doesn't give you the same sort of support that you need, it's too much.

While we can say that the Black women students sought more support overall from those that were similar to them as far as race/ethnicity based on the social networking data, the interview data provided some powerful personal experiences to show that support can come from anywhere as well as from many different people. Homophilous relationships do not promise social support, as noted with Linette and her first advisor, yet for Black women in a primarily white environment, there was a sense of feeling understood and seen that existed with other Black women that was often needed. There is value in having multiple people in one's support network as it is unlikely that any one person can fulfill every aspect of support needed in one's life, especially as a URM graduate student at a PWI.

Hispanic/Latina Women's URM E-I Index

The Hispanic/Latina women participants' overall averages in Figure 4.1 for URM homophily are very close to 0, although very slightly negative (-0.00556, -0.07889, -0.10667). This shows that just over half of their support network is URM, and slightly less than half is non-URM. However, there are areas where they have more homophily than others. As shown in Figure 4.3, their friends/peers are slightly positive yet very close to zero, indicating that they have almost equal URM and non-URM friends/peers. Their advisor/faculty support network had the most significant positive averages of 0.33, 0.41, and 0.31, showing that more of the people they turned to for support in this area were non-URM. These two subcategories could be a

conscious choice but may very likely be the result of the limited availability of other Hispanic students and faculty in their programs. Family/significant others and group members were the areas of support where they had the most homophily, as might be expected. Although we would assume most family members of URM graduate students would be URM, there were a few scenarios when a parent was non-URM and many times when their significant others were non-URM. It is worth noting that many of the Hispanic/Latina participants noted that they "passed as white," so this could make the E-I index of their support networks more positive if they are choosing to be in white networks because that is where they feel they are supposed to be based on how they look and speak.

Membership in Hispanic/Latinx student groups was regularly mentioned as a way to connect with other Hispanic/Latinx students, such as the Society for Hispanic Professional Engineers (SHPE), the Society for Advancement of Chicanos/Hispanics & Native Americans in Science (SACNAS), and SLOAN, a group of minority students in STEM doctoral programs. In reference to being involved with campus affinity groups, Caroline said,

> I think it's really fortified that I can be Latina and a scientist, and there's no problem with that, despite what I can see in my department, which is nothing. I think it's helped me to not see as much discordance between the two as I had previously… I have gotten involved with the SACNAS chapter here, as well as gone to the conference, which is just like—going to the conference was really, really re-affirming. It was just very empowering and so that in and of itself, made me feel a lot better about being in the position I am in as well as understanding my identity.

Angela was another participant who found generous support with others involved in SLOAN and noted that

> It was very helpful…it exposed me to other minorities, to other Hispanics, so that was great, knowing that there's other people...it's a great community for first year, especially minorities like Hispanics. There're a lot of Puerto Ricans in there so you don't feel so lonely if you come from someplace far.

Margarita continued to say that SLOAN helped her because

> It's hard being away from your family because I'm Hispanic and family is a big thing in my culture. It would be nice to have friends and just keep in touch with your culture. Like, I have no one to speak Spanish to. That's when I call my parents.

Flor found solace with any other Latinx students she could find, and although she was "fine" with her cohort, she was "really good friends with the other Latino in my cohort." She continued to say,

> I have good friends here…they're Latinos, too, so we find each other because there are the Latino events that you go to and you meet them…and I met a lot of them through the director of Latino studies who is a friend of ours and he's also Puerto Rican. And like I said, he's super outgoing and you're walking down the street and he hears someone speaking in Spanish and he'll just turn around and ask them like "You're speaking Spanish! Where are you from? Hello, my name is so-and-so. These are my friends and she's in [program]." So, a lot of Latino people like that.

While four of the 11 participants (36%) were Hispanic, there is significantly less interview data where they specifically discuss seeking others like themselves with regard to cultural identity or URM status. Hispanic students would rarely use the phrase "students of color" or "faculty of color" when discussing other URM individuals with similar race/ethnicity. However, they did often mention that culture was important, and they found it lacking at the PWI they were attending. Many other Hispanic students referenced how important their support networks were in general without explicitly saying that they were seeking other Hispanics, which, according to their surveys, shows how evenly distributed their networks were as far as being URM or non-URM.

Gender Homophily

The second attribute that we are examining in this study is whether URM women seek others similar to themselves with regard to gender identity. Wellman and Wortley (1990) stated that gender is directly associated with support, particularly women who are more likely to provide emotional support to friends and family regardless of gender identity. In Figure 4.4, we

examine overall gender E-I indexes comparing Black women's and Hispanic/Latina women's tendency to seek support from other women.

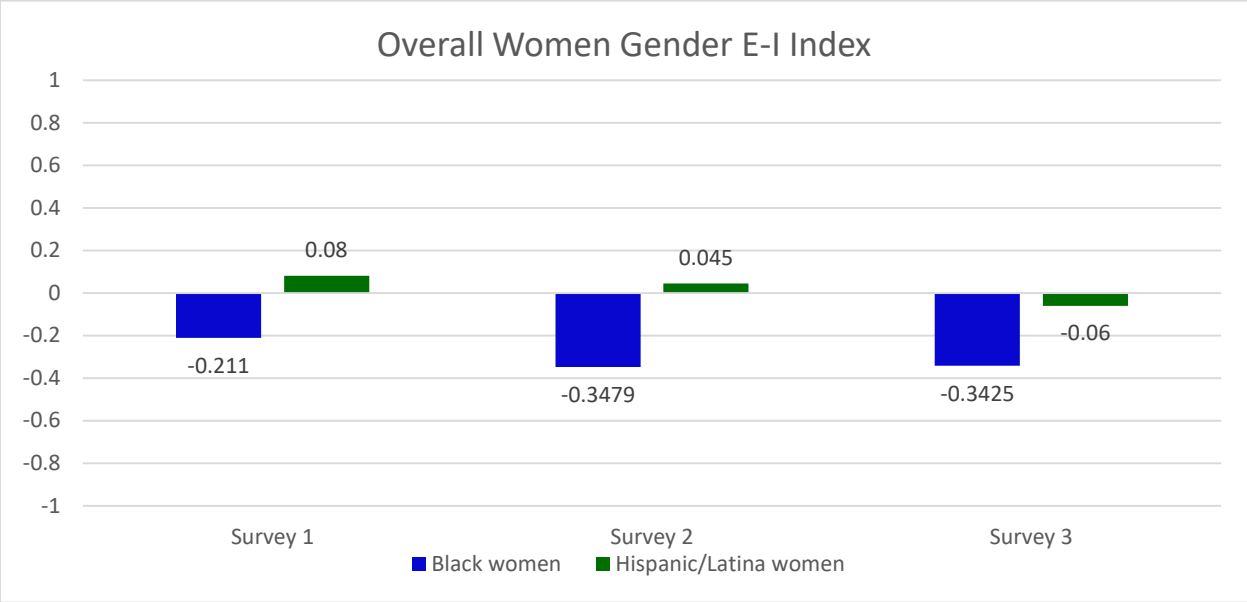

Figure 4.4. Overall Black and Hispanic/Latina women's average gender homophily (utilizing E-I Index).

As far as the overall gender E-I index across all three surveys shown in Figure 4.4, the Black women students averaged E-I indices of -0.211, -0.3479, and -0.3425. This shows that Black women in our study had more support from women than from men. For the Hispanic/Latina women in our study, the E-I indexes showed values close to 0, which meant that their support networks were almost equally comprised of men and women. Although these findings were interesting, we decided to break down whole support networks into categories for the Black and Hispanic/Latina women students (Figure 4.5 and Figure 4.6).

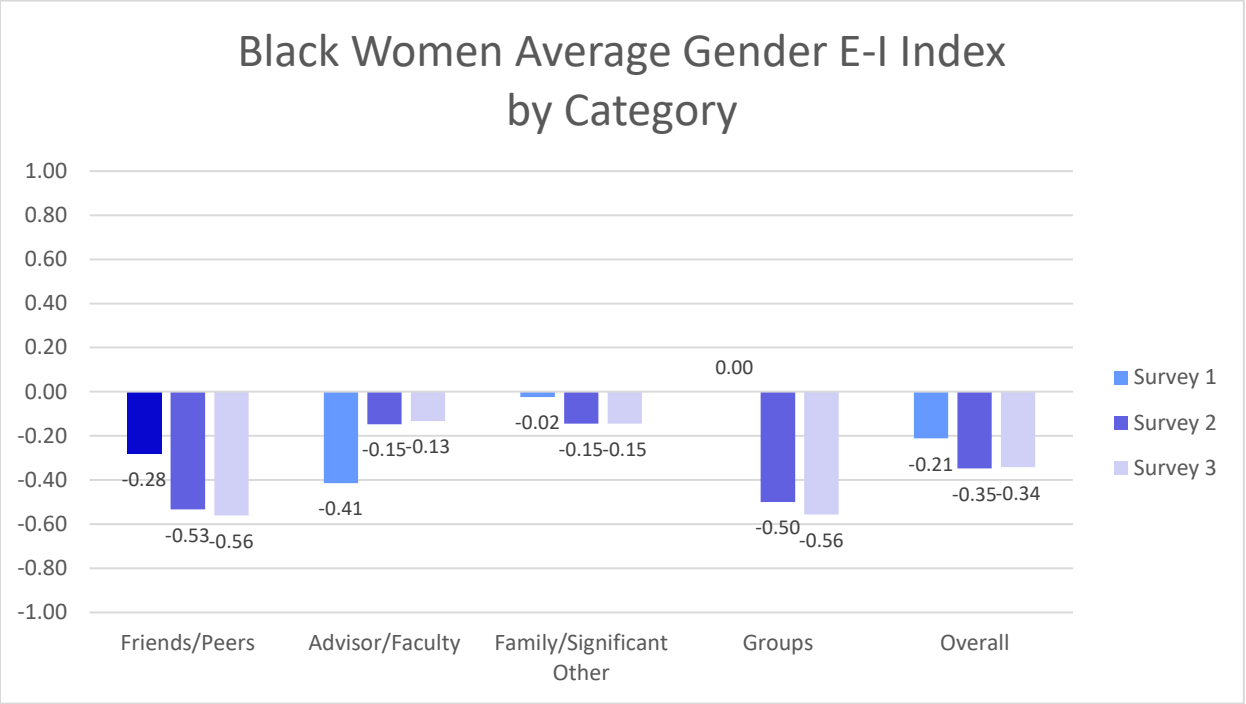

Figure 4.5. Black women's average gender homophily (utilizing E-I Index) by role/category.

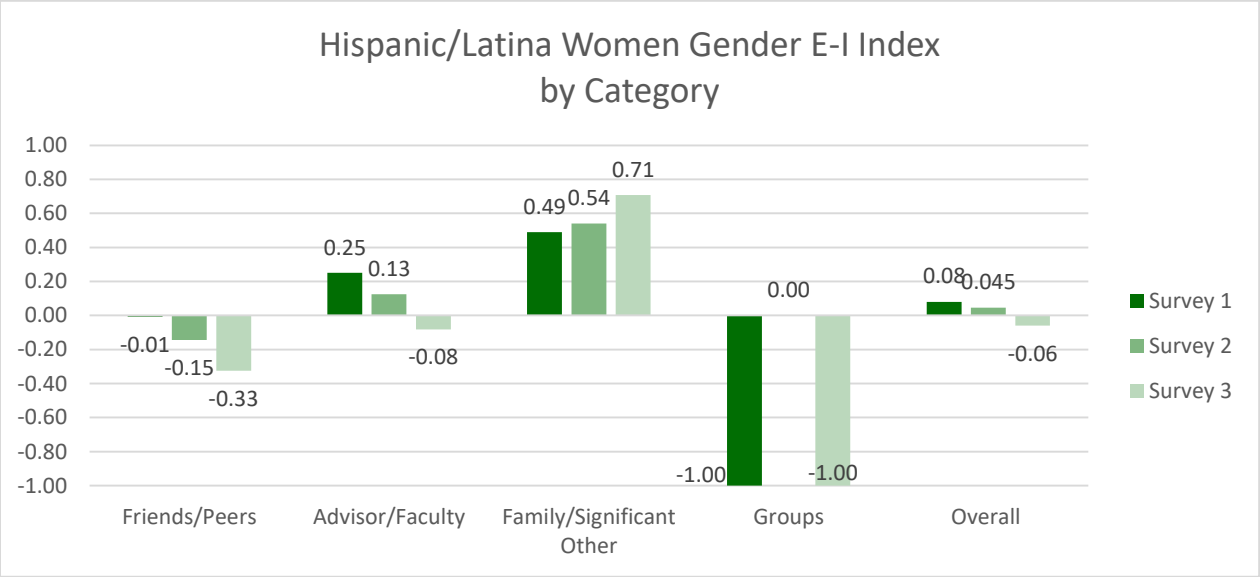

Figure 4.6. Hispanic/Latina women's gender homophily (utilizing E-I Index) by role/category (0 implies equal numbers of men and women in support network, -1 implies all women, and +1 implies all men).

Black Women Gender Homophily

The first noticeable trend when looking at Figure 4.5 was that the E-I indices for Black women were all zero or negative for every category, showing that they had equal numbers of or more women than men in every aspect of their support network. For the first survey, those that were considered family/significant other support and group membership support were equal parts men and women. For surveys 1, 2, and 3 for friends/peers, survey 1 for advisors/faculty, and survey 2 and 3 for group members, there was a noticeable trend toward gender homophily in their support networks.

Three Black women participants specifically discussed the importance of having other women in their support network. Amber said, "My circle is primarily Black women." Jayla was in a cohort of seven students, five of whom were women. She described her relationship with them, saying,

> I have a really strong relationship with the women in my cohort. So really if I have an issue, I can talk to them about it…we are all pretty close which has been really nice because we're all really supportive of each other.

Linette found that sharing her experiences with other women of color helped keep her in her graduate program. She explained,

> I feel like I have really been successful in creating a critical friends group to support me, because at one point I was ready to leave university, and so I've started to talk to other women of color and I found that so many other women of color had the exact same experience that I do…so that has been really affirming to me to know that it's not just me.

As we can see from the data, Black women students showed an overall tendency toward gender homophily, particularly with friends/peers and group membership. The averages were close to zero when looking at family/significant other because most of the women discussed a mother and a father, or a mother and a boyfriend/husband, which would zero out that gender

homophily calculation. When combined with interview data, we can see the importance and necessity of Black women seeking other women for support. Two of the three quotes included here specifically mention Black women or "women of color" being key support members.

Hispanic/Latina Women Gender Homophily

The Hispanic/Latina women's average gender E-I index by category, Figure 4.6, has a bit more variation. All three of the friends/peers surveys, the third surveys for faculty, and the first and third surveys for group members showed more homophily, but 7 of the 12 categories showed an E-I index of 0 or positive values, showing support from equal numbers of men and women or more support from men than women. The greatest values showing heterophily came from their family/significant others with values at 0.49, 0.54, and 0.71.

Unlike the Black women, the Hispanic/Latina women did not openly discuss much preference regarding gender in their support networks in their interviews. Compared to Black women's E-I indices (Figure 4.5), Hispanic/Latina women's gender E-I index showed much more variation. From the survey and interview data, it seemed Black women needed more women in their support networks than Hispanic/Latina women.

Discussion

In this chapter, we focused on the egocentric networks of 11 URM women graduate students at PWIs. We were specifically examining two of the most prominent attributes associated with social support networks, race/ethnicity and gender, and the extent of overall homophily and homophily in specific roles within participants' networks. Homophily is a common theme in social network analysis literature (Borgatti et al., 2013; Christakis & Fowler, 2010; Prell, 2012; Scott, 2017), as humans are known to choose others who are like themselves in one or more ways for friendships, partners, mentors, etc. McPherson et al. (2001) stated that

homophily occurs at a higher rate than heterophily does, particularly with regard to race/ethnic/cultural and gender identities, and especially with women. P. V. Marsden (1987) found in a national study that only 8% of adults had a close tie with a person of another race, showing that people tend to have close ties with others who are similar to themselves. McPherson et al. (2001) also pointed out that the "most basic source of homophily is space: We are more likely to have contact with those who are closer to us in geographic location than those who are distant" (p. 429), such as within the constraints of a university setting. Students of color, especially women of color, have a great need for social support and homophily in graduate programs at PWIs. This article explored what patterns in homophily emerge for Black and Hispanic/Latina women graduate students who are surrounded by a predominantly white population and looked to see if gender homophily is sought by women in STEM/SBE graduate programs.

In this egocentric network analysis, we focused on the focal node, the ego, and the nodes they reported being directly connected to, their alters. According to our data, Black women graduate students at PWIs had overall URM and gender homophily across all three surveys and six interviews, indicating their networks have more URM individuals than non-URM individuals and more women than men. In fact, Black women graduate students have support networks with a higher ratio of URM support alters than Hispanic/Latina women students in every aspect of their support networks. Harper (2006) noted in their study that much of the college success of students from underrepresented minority backgrounds was attributed to the support and meaningful engagement with the same-race peers. It enhanced their participant college experiences by providing support networks and encouraging their scholarly achievement. The Black women in this study expressed substantially more need and desire to have same race and gender peer and faculty support. As we saw in the interview data, most Black women felt

connections with other students of color, particularly other Black women, were of paramount importance in pursuing a graduate degree. The Hispanic/Latina women did not exhibit this trend as noticeably in their social network data. In their interviews, however, most discussed a desire to be around more diversity, others who spoke Spanish, people that understood their culture, food, or background. Their URM E-I index was overall slightly negative for all three surveys, showing a very slight trend toward homophily; however, it also showed that they found more URM support from their family/significant others and group memberships because their friends/peers and advisors/faculty were much more non-URM, making the overall E-I index very close to zero.

One notable feature in the advisors/faculty section of the social networks in Figure 4.2 shows the Black women had an E-I index very close to 0, meaning they had equal numbers of mentors and advisors that were URM and non-URM. However, many students expressed in their interviews the desire to have more "faculty of color," indicating that the diversity of their social networks was likely due to the inability to find advisors/faculty of the same race/ethnicity rather than seeking out faculty/advisors from different races/ethnicities. Santos and Reigadas (2005) said that

> when mentors and mentees share common viewpoints through similar ethnic or cultural backgrounds, homogeneity in values, norms, and expectations may enhance the perceived supportiveness of the relationship. That is, ethnic and cultural similarities may serve as a foundation for developing effective communication and trust in the mentoring relationship, thereby fostering greater instrumental and personal aid. (p. 340)

While the E-I indexes for both Hispanic/Latina and Black women were not negative, there was a strong desire for these students to have advisors, faculty members, committee members, or some kind of mentor who shared their racial/ethnic/cultural background. It was clear that it would

make them feel more supported and validated as they could relate better to them and not feel so alone in their academic endeavors as a person of color.

While homophilous relationships have numerous benefits, heterophilous ties can be incredibly beneficial as they have been shown to reduce discrimination, decrease implicit and explicit racial/ethnic bias, and increase access to social resources and information for individuals from marginalized groups. McPherson et al. (2001) stated that homophily limits our social worlds and divides society while restricting the information one receives and the relationships one can access. Homophily and the concept of ethnic segregation has been especially visible in friendship networks in a school setting, such as graduate school (Kandel, 1978; Kao & Joyner, 2016; Schrum et al., 1988). Having a diverse network has educational benefits to all students, as Sidhu (2013) expresses that "exposure to different backgrounds and perspectives requires people to defend and even reformulate their respective worldviews, and that diversity enriches what we think about ourselves and one another" (p. 3). If people build diverse and healthy relationships, then there is a much greater opportunity for them to come together and solve common problems (Axner, 2020). To build these relationships, it is important to understand and appreciate many cultures by establishing relationships with people from cultures unlike our own. Axner (2020) noted how vital it is to build relationships with other cultures and suggested numerous methods:

> Make a conscious decision to establish friendships with people from other cultures, put yourself in situations where you will meet people of other cultures, examine your biases about people from other cultures, ask people questions about their cultures, customs, and views, read about other people's cultures and histories, listen to people tell their stories, notice differences in communication styles and values; don't assume that the majority's way is the right way, risk making mistakes, and learn to be an ally. (pp. 3-4)

At a predominantly white institution, it would benefit everyone to have relationships with those of other cultures while also recognizing the need for belonging and community by marginalized students, particularly women of color. If based on trust and good intentions, these

relationships could aid in the success of and degree completion for URM and non-URM graduate students. Institutions need to create both affinity groups where identities can be affirmed and organizations where diverse groups can work together to build inclusive communities, overcome internalized bias, and tackle systemic racism. This is why the enrollment of a critical mass of URM students at a university is necessary, so URM students, especially women, no longer feel isolated or tokenized. URM students "cannot function or express themselves unless they are surrounded by a sufficient number of persons of like race or ethnicity" and "are categorically incapable of articulating themselves as individuals" (Sidhu, 2013, p. 3), and are instead restricting to representing entire groups of people.

People have a universal need to be supported by others with shared attributes and experiences to feel understood and supported. Ong et al. (2018) discussed how in order to attempt to retain women of color in STEM graduate programs, institutions need to focus attention on enrolling a critical mass of women of color and creating safe social spaces that "offer support and enhance feelings of belonging in STEM" (p. 207). We can see from our data that having the opportunity to find support from similar people in groups such as BGSA, SHPE, SACNAS, and others has been instrumental to our participants as far as finding relationships that support them and enable them to persist in their programs. It is necessary to understand and support these spaces as a way to alleviate the isolation and strain experienced by women of color in higher education, which makes them more susceptible to dropping out of their programs. Research has shown that many women of color succeed and persist in STEM education and careers when they are included in spaces where they find support from others like themselves.

It is also important, however, for the institution to help facilitate relationships amongst different cultures and populations at the university to combat systemic racism, inherent bias, and

prejudice while helping to prepare all students for the professional world where they will need to work with a diversity of perspectives and ideas. Sidhu (2013) noted that even the Supreme Court has agreed that diversity provides an educational benefit to all students. Baldwin, August, and Bennett (2020) noted that diversity is seen as individuals that are "different from other individuals in many possible ways and that we can all learn things from people whose ideas, beliefs, attitudes, values, backgrounds, experiences, and behaviors are different from our own" (p. 92). Diversity needs to be celebrated. It enriches one's self-awareness and prepares people for accepting others different from themselves, which can benefit them as they go through educational settings and careers. There is an increasing urgency for universities to enroll and support a critical mass of URM students to achieve this. However, in order to get to this point, we need to address the inherent challenges presented to women of color in higher education that does not celebrate or respect people who look like them, does not promote success in their studies and research, and does not support them as they strive toward further education and careers in STEM and SBE fields (Ong et al., 2018; Wang, Leu, & Shoda, 2011). It is of the utmost importance that we find people and places to support URM students, particularly women, in higher education to achieve and reflect all of the benefits of diversity in STEM and SBE fields.

Conclusions

In an organizational setting such as a PWI, where the population is predominantly white students, the university needs to pay particular attention to the value of critical mass, or the number and/or percentage of students in underrepresented groups enrolled to reach a point where these students no longer feel isolated (Sidhu, 2013). This leads to many other questions discussed by Malcom and Malcom-Piqueux (2013): How much diversity is needed? How do we know

when/if critical mass has been reached? How can diversity be sustained? There are so many necessary actions in addition to building and maintaining critical mass after students are admitted, including "a welcoming environment, supportive mentors, and the construction of a supportive research community" (Malcom & Malcom-Piqueux, 2013, p. 177).

Not only is reaching a critical mass necessary for students in URM groups, but it is also imperative for non-URM students to build relationships with people from other cultures and backgrounds. Axner (2020) noted that "If each person builds a network of diverse and strong relationships, we can come together and solve problems that we have in common" (p. 2), whether this is in the classroom, the workforce, or any life situation. It is essential for people, particularly those in majority or privileged groups, to deliberately seek heterophilous relationships and make the conscious decision to establish friendships with individuals from other cultures to overcome systemic racism. Many studies argue the benefits of forming ties with people different from oneself, as homophily can divide society by creating barriers between races, genders, age groups, occupations, and social statuses. Seeking others with similar attributes to oneself also restricts information flow, interactions experienced, and the attitudes formed (McPherson et al., 2001), whereas heterophilous relationships can expose one to different perspectives and resources (H. Ibarra, 1992; S. Lee et al., 2018). This could benefit our very profoundly divided country as we battle systemic racism. Many Americans live in neighborhoods that are homogeneous in terms of racial and ethnic backgrounds. This inherently limits the opportunity to interact with, learn from, and befriend people who are different from us. With a little effort to learn about another's culture, perspectives, experiences, and background, this could ultimately strengthen communities.

In the end, we are all humans, and similar to how Axner (2020) said, "we all love deeply, want to learn, have hopes and dreams, and have experienced pain and fear" (p. 2). Workforce environments could also benefit if people with different religious, ethnic, racial, and socioeconomic backgrounds establish relationships with people they know little about. Despite these reasons to have heterophilous ties, it remains difficult to form them in higher education due to the low abundance of URM students and the systemic racism that underlies all interactions within the academic environment. Larger numbers of URM graduate students are necessary. Even though the United States Supreme Court has recognized the need for a "critical mass" of minority students "to make the classroom discourse richer and fuller" and less white, there have been minimal gains as far as diversity in higher education (Cornell Law School, 2003). Even if critical mass is reached, it remains challenging to recruit and retain URM students. URM students face barriers in higher education, especially at PWIs, that non-URM individuals do not as they express being isolated, lonely, unsupported, and alienated and experiencing racially hostile situations (Codjoe, 2010).

Limitations

With this study, there are some limitations that we encountered. Because this was an egocentric design, all the information about the alters was elicited from the ego and, therefore, could be inaccurate. If there were any omissions or misrepresentations in the alters the egos provided, this could affect the E-I index calculations and therefore the analysis of homophily trends. Secondly, the egos identified their network members as URM or non-URM on their social networking surveys, but if this study were to be done again, we would ask for an indication of actual racial/ethnic/cultural identity to be able to further identify the makeup of networks. In addition to those changes on the surveys, the gender options were binary

(man/woman), and if we were conduct this survey again, we would use more inclusive language. Additionally, because of this study's longitudinal nature and the use of name generators for the surveys, Perry et al. (2018) noted that this is prone to errors, such as the egos forgetting to name alters. This is a problem when looking at data longitudinally because the researcher cannot decipher if the alter was dropped because the relationship changed or if they were accidentally left off. We tried to minimize this potential issue by emailing the participants the Excel spreadsheet of all three of their surveys and asking them to review them, tell us of any changes seen, explain drops and adds of alters, or specify if there were any errors due to forgetting. We also used the interviews in addition to surveys to address this concern.

Perry et al. (2018) also pointed out that "another threat to data quality in longitudinal ego network designs is panel conditioning" (p. 252). Since there were three social networking surveys and six face-to-face interviews, there was the potential for participants to respond differently in follow-up waves of our study due to multiple surveys and interview questions. There is the potential that these egos intentionally omitted alters on the surveys and their interviews as it required time and effort to record them. We tried to address this concern by asking several support network questions during the interview to get as many alters named as possible. Inconsistencies with interviews and interviewer bias were also possible limitations, as five interviewers were on our research team. If the interviewer did not prompt for specific alters and their attributes, this could affect one ego's documented social network. We tried to limit this by training interviewers, using an interview guide, combining survey data with interview data, and then emailing the egos to verify that the information was accurate.

Future Research

Ideally, we would follow these participants as they finished graduate school and moved on to start their career as a Ph.D. scientist. It would be interesting to follow up with them to see how their support network changed as they moved locations, what their support network composition looks like currently, and document whether they looked for a position in a more diverse area where they were more likely to find others who shared their identities or if that did not matter as much to them. It would be interesting to have them reflect on their graduate school support networks once they were out of their programs, specifically thinking about homophily. Did they seek out homophily, and were they successful or unsuccessful? If they did not have homophily, would they go back and try harder to find similar support people? If they did have homophily, would they go back and try to diversify? What are their perspectives on the diversity of their network (helpful, harmful, no effect)? How does it compare to the diversity of their network now? It would also be beneficial for future students from underrepresented backgrounds at PWIs to gather advice from these participants who successfully completed graduate programs, such as where and how to find gender and racial/ethnic/cultural homophily for those interested in seeking it.

CHAPTER V

BLACK AND LATINO/A/X GRADUATE STUDENTS' EXPERIENCES OF LONELINESS AND ISOLATION AT PWIS AND THE TRANSITION TO FEELINGS OF SUPPORT, INCLUSION, AND VALIDATION

Introduction

Definitions of Loneliness/General Research Related to Loneliness

Between 1997 and 2017, the United States population grew by over 50 million people with much of this growth comprised of people of color. There are currently more non-white than white children at every age from infant to 10 years, producing the first minority-white generation at 49.6 percent (Frey, 2018). It has been projected that the growth of racial and ethnic groups within the United States will continue; however, disparities in degree completion and workforce attainment and salary are predicted to persist (Espinosa et al., 2019). The United States needs to recruit and retain more URM students in STEM and SBE graduate programs to add diversity to the scientific community and workforce. Ong et al. (2011) pointed out the vitality of scientific advancement and innovation "for maintaining national security, economic competitiveness, and quality of life for our citizens" (p. 173), and that the United States is in danger of lagging behind other developed countries. Increasing the number of minorities completing advanced degrees in STEM fields could provide "a much-needed force for sustaining America's economic vitality" (p. 173), as well as help combat the adverse effects of low socioeconomic status and increase social status mobility for this group. Having more individuals from underrepresented groups with advanced degrees in the workforce also has been shown to lead to greater productivity (Campbell, 2018; Hodapp & Brown, 2018), fresh perspectives (Powell, 2018), and the breaking down of cultural barriers while learning to accept those different from oneself (Campbell, 2018;

Gibbs et al., 2014). It is critically important to understand the challenges graduate students from underrepresented groups face to identify structural barriers to success and achieve equity in STEM and SBE fields. All graduate students encounter roadblocks and challenges throughout their time in college, but students from underrepresented minority groups face additional challenges, especially when it comes to feelings of loneliness, isolation, and lack of support (Carter, 2006; Hawkley & Cacioppo, 2010).

Feelings of loneliness have been described as a negative, unpleasant, and distressing subjective experience that arises from a qualitative or quantitative deficiency in a person's relationships (Bernardon, Babb, Hakim-Larson, & Gragg, 2011; Cacioppo & Cacioppo, 2018; Perlman, 1988). Jones and Moore (1987) defined loneliness as "the psychological state resulting from a discrepancy between ideal and perceived personal relationships" (p. 145). while others have described it as a form of social and emotional isolation that is not fully understood (Hawkley & Cacioppo, 2010). For minority populations in graduate STEM and SBE programs at PWIs, loneliness is thought to be experienced due to social isolation and lacking a sense of belonging (Walton & Cohen, 2007). The reminders about their underrepresentation and their level of acceptance within the department or university can add to feelings of isolation and loneliness.

Undergraduate Experiences With Loneliness

Research suggests that many minority students experience self-doubts in higher education institutions. It is necessary for them to feel acceptance and build connections at PWIs to successfully persist to graduation (Mendoza-Denton, Downey, Purdie, Davis, & Pietrzak, 2002). Research also suggests that URM graduate students' attrition at a PWI can be partially ascribed to their feelings of loneliness and isolation within their academic programs due to their race

(Hamilton, 2001; R. A. Ibarra, 2001). Negative effects from these feelings are seen on student performance, persistence, life satisfaction, and mental and physical health (Bernardon et al., 2011; DiTommaso & Spinner, 1997; Fisher et al., 2019; Graham, Frederick, Byars-Winston, Hunter, & Handelsman, 2013). The need for connectedness and social support is an essential human motivation (Baumeister & Leary, 1995) that predicts future life successes and outcomes (Walton & Cohen, 2007). Walton and Cohen (2007) also suggested that historically excluded ethnic groups are likely to be more sensitive to loneliness issues in schools and workplaces in the United States when they see that their group members are numerically underrepresented. Fisher et al. (2019) further described that the need for connections within their department, program, or university, in general, can lead to heightened feelings of anxiousness that can become all-consuming and can "trigger strong emotional and physiological reactions, further disrupting performance" (p. 2). Additionally, literature has shown that this can eventually cause those students to be disengaged, actively avoid situations and environments, and develop coping mechanisms against the threatening and continued exposure to discrimination (Fisher et al., 2019; Mendoza-Denton, Pietrzak, & Downey, 2008).

Loneliness has also been thought of as existing due to a lack of a social network, which is defined as a group of people who provide an individual with company and feelings of being part of a greater community (Yanguas, Pinazo-Henandis, & Tarazona-Santabalbina, 2018). In times of intense social change, like deciding to go to graduate school, moving across the country, leaving an existing social support network, and dedicating the next 5-6 years of life to a Ph.D. program, one's social support network proves to be especially salient when combating feelings of loneliness, especially for students who view themselves as different from others (Cacioppo, Fowler, & Christakis, 2009; DiTommaso & Spinner, 1997; C. Y. Lee & Goldstein, 2016; Suarez,

Fowers, Garwood, & Szapocznik, 1997). One study by Zhao, Kong, and Wang (2012) found that as many as 80% of college students experienced these feelings. While research has shown that loneliness subsides throughout the school year, a large proportion of students claimed to still be lonely up to 7 months later (Jones & Moore, 1987). Those URM students that experienced these feelings of loneliness and isolation are in dire of a support network, especially from others that understand the physical space of graduate school.

Challenges Facing Grad Students From Minority Groups

In prior social support network research, Tullis and Grunert Kowalske (2020) stated that while all individuals have their own distinctive social support network, URM students debatably have "a greater need for social support networks due to their feelings of isolation and the negative stereotypes they experience during their studies" (p. 3). Social support refers to the perceived or actual support and help one obtains through social interactions and a variety of relationships that can help ease emotional burdens and boost social adaptation (Cohen et al., 2000; Thoits, 2011). Social connections play an essential role when people, families, and communities are confronted with difficult problems. Murthy (2020) stated that "while loneliness engenders despair and ever more isolation, togetherness raises optimism and creativity" (p. xxi). This is particularly applicable to students from underrepresented minority groups in a PWI environment where they are surrounded by so many people who are unlike themselves with regard to racial, ethnic, and cultural identities. Murthy also said that social support networks helped give people a sense of belonging by being connected to something and to one another while also making their lives more joyful, stronger, and prosperous. Many studies have explored the relationships between having social support connections and feelings of loneliness, demonstrating the power of human connection when it comes to combatting harmful feelings,

having higher levels of satisfaction, graduate school persistence, and a sense of belonging (Allen, 1992; Cole & Espinoza, 2008; Gloria, Robinson, et al., 1999; Grandy, 1998; Hernandez & Lopez, 2004; Murthy, 2020; Tinto, 1975). Conversely, many studies have shown a negative correlation between social support and loneliness for individuals having either little social support or perceiving their relationships as being of an unsatisfactory quality, which would contribute heavily to feelings of loneliness (Hawkley & Cacioppo, 2010; Kong, Zhao, & You, 2012; Ni, Yang, Zhang, & Dong, 2015; Nicolaisen & Thorsen, 2014).

Prior research has shown that the completion rates for students from minority groups decrease substantially as they progress through education (Adair, 2001). Much research has also been conducted looking at undergraduates combatting loneliness and the factors that influence it to develop interventions (Ozben, 2013; Zhao et al., 2012). However, research is lacking with regard to examining loneliness and social support for students from underrepresented minority groups in STEM and SBE graduate programs at PWIs. While research on social support for minority undergraduate students can provide some insight into the experiences of graduate students, it is limited due to various differences between undergraduate and graduate students. These differences include things such as experiencing a different academic rigor in graduate school, being older and more mature, and having professional and life experience. Additionally, minority students' underrepresentation is more pronounced in graduate programs at PWIs; therefore, their experiences and feelings could be vastly different. Therefore, the research questions explored in this study include:

- How do Black and Latino/a/x graduate students at PWIs describe their social support networks?

- What feelings of loneliness and isolation are they encountering in their graduate programs?
- What changes in their social support networks do they describe over time?

Frameworks – Critical Race Theory and Constructivist Grounded Theory

Critical race theory, CRT, has guided this study due to its focus on the lived experiences of individuals who identify as people of color. CRT uses narratives or counter stories to highlight the embedded racism and oppression of white-dominated society, including institutions of higher education (Aguirre, 2010; Robertson & Chaney, 2017). According to Robertson and Chaney (2017), CRT has frequently been applied as a theoretical lens to support other methodological approaches, such as emergent coding and constructivist grounded theory, to "explore the circumstances of powerless groups" (p. 265). The utility of CRT in this study allows the stories of those identifying as Black and Latino/a/x to have a voice and be provided a venue to share their experiences. Our analysis and interpretation of their experiences is guided by their perceptions and word choice, so the only changes to quotes are removal of potentially identifying information. CRT focuses on social justice, and this work can be used to help make changes to address the inequity and oppression of non-white students within higher educational institutions.

Since CRT does not have a specified methodology, it was paired with constructivist grounded theory to help guide the analysis and data collection. With constructivist grounded theory, the process of generating findings from qualitative research is viewed as a social construction (Charmaz, 2006). As with grounded theory, it allows storylines and themes to develop and emerge from the data. It recognizes that researchers will likely encounter data and themes they are not initially aware of or capable of predicting, and allows for iterative data collection and analysis to continually generate emerging themes. Charmaz (2006) noted that the

constructivist viewpoint negates the idea that the researchers are neutral observers without preconceptions that may mold analysis, but that "their values shape the very facts that they can identify" (p. 13). This stance is particularly relevant when using a framework such as critical race theory, which is inherently value-laden. With constructivist grounded theory, the researcher should center, understand, and share participants' points of view (Charmaz, 2000) while building a model based upon their interpretation of the data about participants' experiences, diversity, reality, networks, relationships, views, values, and beliefs. Charmaz (2005) also noted that any conclusions or models developed under constructivist grounded methodology are suggestive and incomplete, subject to refinement as further data are gathered, analyzed, and understood in the context of other research.

Methods, Setting, Design, Participants, and Data Collection/Analysis

The study presented here is part of a larger, longitudinal HSIRB-approved project that studied the experiences of 23 Black and Latino/a/x graduate students at three PWIs in the Midwest. The participants for this study were recruited through an email invitation to a survey that the registrars at three PWIs sent out to all non-white graduate students in their first or second year of a doctoral or master's-to-doctoral STEM or SBE program. From there, any surveys from Asian-America-identifying students were excluded. This left students that self-identified as Black/African American, Hispanic/Latinx/Puerto Rican, Native American/Alaska Native, or Native Hawaiian/Pacific Islander in these programs. All students who completed this survey received a $25 gift card as compensation for their time. At the conclusion of the survey, participants were prompted to complete an unlinked form with their contact information if they were interested in participating in the interview portion of the study. Potential participants were informed of a graduated incentive scale for participating in the interviews prior to volunteering.

All individuals that indicated interest in participating were contacted to schedule interviews, with 38 individuals scheduling and completing the first interview. To encourage continued participation and reduce attrition, participants received $25 gift cards after interviews 1 and 2, $50 gift cards after interviews 3 and 4, and $100 gift cards after interviews 5 and 6. Thirty participants completed six unique semi-structured interviews between the spring of 2015 and the fall of 2017. Open-ended questions were used in the interviews, so the interviews' length varied with how much information the participants provided but lasted about 60 minutes on average.

During the interviews, participants were asked questions about their experiences in graduate school, their identities, their social support networks, and their sense of belonging within their program. Interview questions and prompts related to social support networks included:

- Who do you turn to when you are having a difficult time (in or out of the graduate program)?
- Give us an update on your relationships with your cohort and peers in your graduate program.
- How do you feel about who you are at this point in your graduate program?
- Who are some of the people that support you?
- Have there been any changes in your support network since we have last talked?
- What groups do you belong to and how have these groups helped you adjust to your graduate program?
- Have you been made to feel you did not belong in your graduate program and can you tell me about this experience?

- Have you been made to feel you did belong and can you tell me about this experience?

All interviews were audio-recorded and professionally transcribed before being analyzed. Transcripts were read multiple times in their entirety, with researchers writing memos to start the analysis process. With interviews as the primary source of data collection, we continually looked through interview data and compared participant perspectives and experiences, conducted new interviews, and re-analyzed data to build understanding of the participants' experiences (Creswell, 2013). Since each participant had six interviews, we were able to watch their stories develop over time. Through their points of view, we were able to understand their experiences and get a glimpse into their reality. Through this lens, we found similarities and differences across the participants' data and identified common themes throughout their experiences in graduate school. Discussions were held with other researchers on the project to verify that the quotes extracted from interviews were interpreted correctly in context and were valid for this study. These quotes were arranged by participant with their assigned pseudonym, so trends and general analysis could be compared.

Participants were also asked to complete a follow-up social networking and progress/career update survey given during the spring 2020 semester and received a $25 gift card as compensation. The follow-up survey included social support network items as well as an open-ended question asking them if or how their support network had changed since the conclusion of the study. The responses to this question were analyzed along with the interview data for this manuscript. This paper will utilize the data from 23 students who completed all six interviews and the follow-up survey, focusing on the emergent themes of loneliness and isolation.

This qualitative research aimed to capture the experiences of those who identify as being Black or Latino/a/x at predominantly white institutions, so it is important that the information gathered be dependable and reliable. Gathering data from participants at three PWIs in a similar region of the country allowed us to construct a trustworthy study and identify common occurring themes and findings that are, according to Lincoln and Guba (1985), "worth paying attention to." Credibility has also been established by thoroughly identifying and describing the participants that were involved in the study (Elo et al., 2014). Triangulating data gathered via interviews and the final social networking survey helped improve the analysis of the research questions as well as with the data collection. Golafshani (2015) noted that the means of this data triangulation strengthens a study and leads to a more "valid, reliable and diverse construction of realities" (p. 604). The strong research design of this study and the uniformity of data collection among the research team also add to the trustworthiness of this study. The interview protocols were followed consistently by the interviewers, which allowed the research team to see emerging themes among participants throughout the semi-structured interviews when reading the transcripts. Intercoder agreement was also reached to ensure consistency and credibility. Finally, to ensure that this research was dependable and portrayed the sample accurately, the final article was emailed to all the participants involved in the study to allow them the opportunity to express whether they felt that any misrepresentation was portrayed.

Findings

Several themes emerged from our data amongst the graduate students in this study that revolved around their intense feelings of isolation and loneliness. These students, who identified as Black or Latino/a/x, often expressed their desire to belong to this graduate school space; however, many admitted to thoughts of leaving, quitting, or just resigning to the fact that maybe

they will never feel included or part of the community. The three main themes we identified were specific challenges with loneliness and isolation due to identity in their programs and disconnection as a graduate student, the relief brought on by finding support and solace in campus groups and organizations, and then the recurrence of the feelings of loneliness and isolation as they transitioned out of graduate school.

Loneliness and Isolation Due to Identity in Their Programs and as Graduate Students

Some participants felt lonely and isolated because of their identity. Samantha, a Black woman, said in her first interview,

> It honestly could be a very lonely experience…I probably get more emotional about that because—I can't remember who said it—but, it's not a space that was designed for us, so it's like going against a system. And, having to fit into a system, but being conscious that it's not for you.

In his third interview, Seth, a Black man, discussed feeling isolated because he did not fit in with his graduate peers.

> Voicing an opinion that doesn't necessarily agree with the mainstream, which happens to be people whose skin color does not match mine, regardless of what color that may or may not be, you often get labeled as "angry Black man." Which I'm not—well I don't feel like I am, but it happens when I have an opinion about something—when I have a thought. So, oftentimes to not have that happen, especially when there's a power differential and I need to get somewhere…I will not voice an opinion…I won't participate in class…So, it can be isolating, challenging scientifically, tiring.

Caroline, a Latina woman, said in interview four,

> There are maybe like four or five Latinx people in my entire department, which is rather large. And in [this city], at this university, it's such a small population, that I feel like I look around and I'm not surrounded by people I necessarily feel comfortable with, and that's frustrating more than anything. I think, especially, given the fact that I feel there haven't been any motions towards diversity in my department, it just makes it more apparent to me that I am a person of color. It stands out more because it makes me feel more isolated, and so I think that's the biggest challenge.

Nathan, a Hispanic/Latino man, had a similar experience and noted in his second interview,

> So that's the other thing because like I'm alone because—I mean I'm alone because I'm Hispanic, and then alone because I'm the only grad student that has to take classes because everybody else who does their master's here transition to Ph.D., so they have no classes; they just do research. I came in having to do classes with master's students who are not in the Ph.D. program, and all my Ph.D. cohort are not doing anything, so now I'm alone in that aspect too.

Adriana, a Latina women echoed similar feelings in her first interview, noting,

> It's lonely because I'm the only one [who identifies as Mexican American]…I definitely felt isolated and I didn't feel like part of a community… I didn't really have a close group of friends, so I felt like I didn't have a support system….I still don't because I still don't speak Spanish at all, really and I don't have many people around me that are Mexican.

Other students tried to connect with their cohort members, peers, advisors, and faculty, but ultimately felt unwelcomed, unseen, hurt, and isolated. Linette was one student who really struggled with these feelings. In her fifth interview, she said,

> I'm very isolated here. There are only one or two people that I really work with. But otherwise, it's not real collaborative. There's not as big a sense of community as I had initially, lately because I started to filter out folks, and for various reasons. It's not always enriching, and if it's not enriching, then I purge myself of it. Sounds like such a sad story, doesn't it?

In her sixth interview, Linette continued to feel similarly as she noted, "I don't feel welcome at all. I feel like a provider. I don't feel welcome. I don't feel a part of the community. Yeah, I just don't. And being in that space with my peers evokes feelings of sadness." Mayra discussed her feelings of exclusion and those of superficial relationships in her first interview by noting,

> I don't really go out of my way to talk to people in my cohort now that I'm not doing as much coursework, just because I don't see them. If I see them in the hallway… it's kind of like, we're friendly, but it's not like I'm gonna sit down with you and spill my life sort of thing.

James made the comment in his fifth interview that he did not feel his lab mates cared to be inclusive by noting, "That feeling in lab was never super friendly and familial, but it's definitely become more isolated."

Support Found in Campus Groups

For many students, they felt their support system did not come as easily as it did for non-URM graduate students. The support found often came through campus groups and organizations where Black or Latino/a/x students could be immersed with others who shared some of their identities and have that sense of community with others with shared culture. Groups like the Black Graduate Student Association (BGSA), Black Psychological Association (BPA), Society of Hispanic Professional Engineers (SHPE), Society for Advancement of Chicanos/Hispanics and Native Americans in Science (SACNAS), and other university-specific groups are just a few of the places where these graduate students found support and a means to help mitigate loneliness. The following experiences were much more uplifting during interviews, as the participants found more joy in experiences when they felt inclusion. As Samantha pointed out below, frequently, the URM students are told by their families to "suck it up" and to "get through it" because "they are smart," and from the outside, how hard can it be? Groups helped students identify communities with other Hispanic students or Black students who shared their identities, struggles, and experiences. In the data collected, we saw two main themes as far as what is valued in these groups: having support from people who understand the graduate school experience and having support from those who have a shared identity, especially when referring to race/ethnicity/culture and gender.

It is evident from some of the excerpts shared that participants felt that finding support throughout graduate school was a necessity. Many participants noted that finding support from people who could relate to their experiences as a graduate student and who had a shared identity was something that they did not know they necessarily needed, but were so thankful for finding the reassurance, comfort, and affirmation from those people. Most of the participants specifically

discussed that they needed support from people of color from within the institution who understood what they were going through in graduate school and formed very close relationships with them. Matthew, a Latino man, found that he appreciated the support from other grad students in different departments by saying in his first interview,

> I also have a group of peers outside of my cohort that I talk to regularly. Yeah, they're all from other departments. We met during summer institute last year and we've been super close ever since. I talk to them more than I talk to my cohort for example.

Mayra, a Black woman, found it difficult to feel supported by her outside friends, her boyfriend, and even her family because they were not immersed in her daily challenges. In her fourth interview she noted,

> I could vent to my boyfriend, and I could, potentially, vent to other people in the department, but having women of color, to just like, no matter what it is, just kinda like, be there to vent with—whether it's my program, or just PhD life in general, the fact that we might not even have a job when we finish, because of this election, I'm glad those people are here. It definitely makes this process a lot better. And, I feel like, if you're starting a PhD program, you're gonna need that. Because again, like I said, people don't really understand, if they're not doing this process, or haven't done this process before.

Samantha, a Black woman, referenced the support of friends she made at BGSA in her third interview by saying,

> And so to represent that we are here—like we are—people of color, Black folks are here… Where it was like a group of all people of color from different parts of the country and the world just sitting down and like, it's hard. And I think—I don't think we often think about the experience as a person of color, but like the experiences of just saying like "I don't know why I feel comfortable saying this in this space, but"—talking about how staying at [this university] is feeling like an outsider, not feeling supported or feeling like you just have to get through this because that's the narrative we get from our families… Like, you just deal with it, but when is there time for healing? And so, I didn't expect that going, but it became very, I mean, probably most people in the room were crying at different points.

Samantha found it therapeutic to find support from those that not only understood the challenges of graduate school, but also as a Black woman at a PWI. Similarly, Vanessa noted in her third interview that

> This feels like a large Black community, basically, that's available here, which I had never really thought about as something that I would potentially need or anything like that. It's good to have that space to talk about things that may be going on in the department that could be impacting groups more than others. Yeah, they're a good community, I guess, to have.

Some students, like Nathan, a Latino man, needed support from those that could intimately relate to his identity and needed to look outside of his program to find those that shared an identity with him. In his first interview he said,

> I guess I struggle with meeting people, or fitting in, or finding a support group initially… It's kind of hard to find people to relate to in that program. Pretty much everyone else there is like Caucasian, so it's kind of hard to have someone who understands you and your background. Which then, kind of led me to seek out external organizations or support groups. And currently, one that I'm in now, is one that I'm part of the executive board for, Society of Hispanic Engineering department, not even related to [my field of study]. So, I went out of my department, out of my school to find a support group so that I could have a relationship with people.

Many other students below found support from those sharing the graduate school experience as well as similar identities. When they were able to find campus groups with others that shared similar identities, it helped them to not feel as isolated and to form more of a community since they lacked that within their department. In her third interview, Angela discussed how much she valued SLOAN by saying, "I think it's a great community for first year, especially like minorities like Hispanics. There's a lot of Puerto Ricans in there so you don't feel so lonely if you come from someplace far." In his first interview, Matthew said that he was the only Latino in his program.

> But I don't feel isolated because there are a lot of organizations related to Latinos and Latinas succeeding in grad school and I'm a member of a few of them. So, there aren't many of us, but I still feel a sense of community with other minorities.

Jayla also struggled with feeling alone, despite being surrounded by other women in her department. While she valued having women in her cohort, she could only connect with them on certain things, and felt disconnected and lonely. In her fourth interview she noted,

> I think the women in my cohort are really understanding, and they try really hard to connect with me, but there are just some things that they can't understand. They can't understand my experience being Black. They can, to some degree, understand my experience in being a woman, but they don't understand me as a Black person all the time. They don't get those nuances. Some of them didn't grow up having Black friends, so it's not to say that they aren't good people, or really caring people. They don't always get it, so it's important to have a community of women—all Black women, all Black people—outside your department. We want to get—talk about things—Black issues, or things that are affecting women with that identity. It's good to have that out there in another place…getting involved helped me to feel connected and not like I was alone.

Similarly, Adriana was able to recognize that she needed support from other Hispanics because she felt excluded from the rest of her cohort and peers in her program. In her first interview she said,

> I felt like I was lacking that [SHPE] in my program, and I needed some more Hispanic people to be around with to understand the things that I eat or do or say and maybe to speak in Spanish once in a while. So that's why I went to them and it was awesome. Those people were super great. [If this group didn't exist] I guess I think that'd be really hard because I don't know who I'd talk to or who I would hang out with to have fun. I feel like I'd be stuck how I used to be when I first got here.

Courtney also recognized the value with having a way to connect with other Black women and realized how fortunate she was to have found a group that she could identify with. In the first interview when asked who was the most supportive of her in graduate school she said,

> Oh, definitely the people from summer institute. We have this book club and it actually is just Black women in graduate school at [university]. It's like 20 of us. We all come together…not everybody can do that…and it's just really good that we have that, that we have each other.

Caroline formed such strong relationships with others in the department as well as with the campus group SACNAS that shared the same racial/ethnic identity that she would not know what to do without them. In her fourth interview, Caroline said,

> I think the best thing that's happened over the past few months is forming stronger relationships with other people who are Latino or Latina in the department, as well as not in the department and generally in SACNAS here. I think that's been really, really helpful for me. I think it's almost like beyond a support network. You have to find the people

> that really you can connect to, depending on whatever your identity may be…or whatever the case is.

Flor discussed how unhappy, secluded, and lonely she was when she first got to her university. In her first interview, Flor said,

> We sought opportunities to meet other Latino students. We go to all the events here. We keep an eye out. We do all the townie stuff…we've gone through all of that because we decided if we're gonna do this, we have to do it completely. Otherwise, you're miserable.

Involvement in these groups did not solve all feelings of loneliness and isolation but, for many, it helped alleviate some of those feelings and create healthy relationships. They felt understood, verified, supported, and accepted. These students shared experiences and could empathize with them to not feel so alone in the process of graduate school at a PWI. Having these groups, communities, and outlets was a key to their persistence; many students commented that they did not know what they would have done without the support they received from these groups.

Post-Graduation Onset of Loneliness Themes

All the prior qualitative data were collected during graduate school through the interview process. We then followed up with the participants that persisted and completed graduate school to see if there were any changes in their support networks and if they had any feelings of loneliness or isolation post-graduation. We collected social networking data to look at specific network members, their attributes, frequency of interaction, and turnover throughout graduate school and after graduation and saw very minimal changes in their reported support networks after graduation. However, it became apparent that their feelings of loneliness and isolation reappeared when the participants were asked if there was any relevant information about their support network they would like to share or if it had changed at all since leaving their institution. Cacioppo et al. (2009) discussed a similar situation showing the inconsistencies between

individuals' feelings of loneliness and their reported number of social connections. One theme we saw emerge from the data included the difficulty of transitioning to their new role/institution/career in a new city with the feeling of having minimal or no support from their existing support network. Another prominent theme that emerged from the data was the feeling of having a diminished support network that they had formed in graduate school and feeling overwhelmed by having to rebuild their support network.

Difficult Transition-Minimal Support Network

In their final social networking surveys, the following participants were feeling like their support network was greatly reduced or completely gone due to moving away from their respective university. In the transition to their respective jobs they were feeling alone, despite having just previously reported a robust social network similar to the one reported on the prior networking survey from when they were in grad school. The feelings of loneliness, isolation, and not having anyone to connect with in their new location seemed to have these participants in a place where they felt as though they could not connect with their support network, leaving them feeling overwhelmed, alone, and having to start over.

> I don't have much of one [a support network] since my time at [university] ended. It's been an unexpectedly hard transition not having all my friends around anymore. We all got jobs around the country. I commute from a rural area to work so I don't have many opportunities to get out and meet people because I'm tired and live too far away. (Karen)

> I moved to [city] in August…My network isn't as strong as it was last year because I don't see people as much anymore. I've mainly been interacting with my spouse's colleagues in [city]…but I wouldn't say that I seek them out for advice. (Vanessa)

> I recently moved to [state] to begin a post-doc position. While I do not currently have a social network here, I plan to develop one. (Matthew)

> I just moved to [city] the last week of December, so I am still building relationships in this area and some of my frequent interactions from [university] have diminished as a result of the move. (Sheila)

> Since moving to [city] because my husband got a post-doc at [university], my social and academic support network has been reduced. I started working part time at [university's] conduct office and this has helped me feel more connected and like I have a community, but [current city] is much smaller and less diverse. Even though we found a group to play soccer with, they do not emphasize community as much as our previous group in [previous city] and we don't socialize outside of playing once a week. (Flor)

> My social support network has decreased since moving to [city] for a post-doc at [university], mostly because it is a new community of people. (Caroline)

> My social support network has changed since I moved away from [previous state] and started to work in [current state]…many of the folks from my social network have either graduated or are still physically in the space. (Amber)

> Since leaving the [city] area I have had to rebuild my support network. My experiences there were so traumatic that I have spent much of the last year tending to my mental health. That said, I am just now able to start seeking full-time employment. (Linette)

Diminished Relationships/Support

Other participants mentioned below seemed to recognize that their support network had either reduced or was gone completely. These participants did not maintain the connections from their previous university experience, and the diminished support obviously affected them negatively.

> Limited to primarily lab at work, no frequent contact from [university] at this time. (Nathan)

> To be honest, my social support circle is gone. [Name], my ex-wife, decided she wanted me to move back in with her when she couldn't afford her rent and then started treating me better when I got a good job offer. Go figure. I know I am being used but at least it fills the silence. (James)

> I feel that it's reduced significantly. I mainly talk to my previous PhD advisor/mentor, especially about my feelings and worries. It seems difficult to talk to my post-doc peers about the pressure and worries I have transitioning into a post-doc. It's overall been incredibly challenging, possibly the most unsure I've felt in many years. (Adriana)

> My social support network has definitely changed since graduating. I miss having opportunities to participate in student activities organized by the various organizations on campus. For a while I did maintain most of my social contacts since I stayed in [city], but people have slowly been graduating and moving elsewhere, which has reduced the number of people I interact with regularly. (Ethan)

The perceived lack of support they currently have as they start their post-doc, industry position, or faculty position is substantial. Most participants moved away from the cities they lived in when attending graduate school, so not having members of their support networks in their geographic vicinity made them feel alone again. Karen described how it has been a hard transition to move to a new place, not having her friends around and lacking opportunities to meet people. Even though he remained in the same city, Ethan talked about how he missed the student activities on campus and that his support network has reduced due to people moving and graduating. Linette completely lost her social support network, and she was working to rebuild it, but it greatly affected her mental health. James also lost his support circle, and while he knew he was being used by his ex-wife, having someone around was better than being lonely. It was an exceptionally challenging time for these participants as they transitioned into the next phase of their life, feeling like they are alone all over again.

Discussion

Loneliness has been described by Peplau (1984) as a "painful warning signal that a person's social relations are deficient in some important way" (p. 2). Literature also reinforces that social connections and social support are the antidote to these feelings of exclusion and isolation, with strong, supportive relationships allowing people to thrive and live happy, healthy, productive, and rewarding lives (Bernardon et al., 2011; C. Y. Lee & Goldstein, 2016; Murthy, 2020; Utz, Swenson, Caserta, Lund, & deVries, 2014). However, if these needs are not met, suffering is inevitable. There is a basic human need for a sense of community, for a support network, and strong relationships. From what we have seen with these data and previous literature, it is glaringly apparent that individuals that identify as Black or Latino/a/x at a PWI can experience elevated feelings of loneliness and isolation that can be detrimental to their

mental, emotional, and physical well-being (Allen, 1992; Bernardon et al., 2011; DiTommaso & Spinner, 1997; Gloria, Robinson, et al., 1999; Hawkley & Cacioppo, 2010; Murthy, 2020). Individuals who identify as Black or Latino/a/x in graduate programs at a PWI are at a disadvantage when it comes to having opportunities for social connections with others who can understand, identify with, and relate to them. With the data compiled in this study, it was evident that the connections were lacking at some point, affecting them significantly.

To understand how our participants managed these challenges at their PWIs, we relied on critical race theory to examine the insights, realities, and experiences of those identifying as Black or Latino/a/x who, as a group, are in a racially subordinate position at the PWI (Aguirre, 2010; Bell, 1995; Crenshaw, Gotanda, Peller, & Thomas, 1995). CRT was used to expose the racism and sexism that is structured in these higher education systems and give voices to those that have been systemically oppressed by sharing their narratives involving their marginalized experiences (Hiraldo, 2010). The students in this study repeatedly described being mentally, emotionally, and physically exhausted from feeling isolated. They described their experiences as people of color in their graduate programs as a painful, lonely, and secluding experience. As Samantha said and many echoed similarly, they felt like they were "going against a system" and that it was exhausting to fit into the system while being "conscious that it's not for you." The students in this study were constantly aware of their "othered" status and struggled to find spaces they could feel comfortable in, as Caroline noted when she said she was "not surrounded by people I necessarily feel comfortable with." The students in this study made mention of feeling unwelcome, unseen, isolated, lonely, or excluded from the rest of the graduate student community. Some mentioned that they talked to their cohort members and peers, but in a superficial manner. They could say hello, but they would not sit down to talk about more

personal challenges or have the depth of conversations needed to stave off loneliness. This is where social support is lacking for many graduate students from historically underrepresented groups. These students are aching for connection in the graduate school space. Having counterspaces, or safe places where they could form connections with other students sharing similar marginalized identities, helped them combat those feelings of loneliness, rejection, and unbelonging. Having support from others with common experiences helped them with feeling validated and accepted as they continued through graduate school. Of course, familial support is usually abundant, and they know their mother, father, grandmother, or aunt would be there in an instant to support them. However, there was a discrepancy between desired and achieved social support in those situations. It is undeniably necessary to have social support from those immersed in that same experience and physically within the institution.

Many participants in this study found groups to be an avenue to help fill the void and loneliness of their graduate experience. Groups such as BGSA, BPA, SACNAS, and SHPE were instrumental to many when they were miserable and alone. They described the comfort of being surrounded by other people with shared identities and experiences and the healing it provided. Many mentioned that these groups gave them the diversity they lacked in their program setting and provided a space where they shared common understandings and experiences. They described these spaces as a place where they could have real conversations with people and that there was a comfort in knowing that this support was coming from those that understood the Ph.D. process, unlike other people in their support network that were outside of the institution that did not understand the process. The qualitative interview data collected for this study have given us a better understanding of what kind of support graduate students from URM groups need to combat feelings of loneliness and isolation. They needed to find places and social

support with others who shared similar experiences, and they needed to have access to those spaces when they first arrive on campus.

A unique contribution of this work is the inclusion of data from a follow-up survey conducted 2½ years after the final interviews were conducted. This allowed us to explore participants' social support networks and experiences after the majority of them had left graduate school. We included social network questions to compare members of their networks during and after graduate school and open-response questions asking about their experiences and feelings related to social support. This follow-up survey, sent out in the spring of 2020, showed significant divergence between the social network and open-response data. The social networks, both in number of members and composition, did not substantially differ from their previous support networks when they felt included, involved, supported, and surrounded by other people who understood their experiences. The open-response data, however, showed a substantial difference in their perceived social support. They felt alone and isolated again despite having self-reported a similar support network that they had in previous years. The participants still listed an extensive list of people as being part of their support networks; however, they also reported that their support networks were gone, significantly reduced, or virtually nonexistent.

The participants involved in this study all persisted to graduation, yet we know that the attrition rates for URM graduate students is greater than 50% (CEOSE, 2010). The findings from this study, therefore, help us understand the experiences of students who complete their degrees. It is unclear whether students who leave graduate school before completing their degrees have similar experiences, whether their experiences lead them to leave their programs, or whether they are unable to find groups and social supports, which then causes them to leave their programs.

Future work should investigate the experiences of students who do not persist to better understand their experiences with loneliness, community, and social support.

Other limitations of this study relate to the small population and limited geographic area. The participants in this study were from historically underrepresented groups, indicating that there are not many potential participants to recruit. We tried to address this challenge by repeated recruitment invitations and offering monetary incentives for completion of the six interviews and the follow-up survey. Ultimately, 23 Black/African American and Hispanic/Latinx graduate students completed all six interviews and the follow-up survey that provided the data for this study. We were also limited to recruiting participants from three PWIs in the Midwest. Results may have varied had this been done in other parts of the country, particularly those that are more diverse. We had significantly more women participate than men, which potentially gave us more qualitative data because the women tended to want to talk longer and give more depth to their interviews. However, it would have been nice to have more men involved to compare their experiences, particularly Black men. Finally, as with all social network analysis and qualitative research, we relied on self-reported personal information and perceived experiences, recognizing that participants' realities may differ from what might be reported by others.

Implications

There is an urgency for diversity in all sectors, including higher education, as it directly benefits organizations by adding "credibility, creativity, and productivity" (Smith, 2015, p. 16) and brings creative contributions, a greater variety of perspectives, and improved financial performance (Gibbs et al., 2014; Hodapp & Brown, 2018; Powell, 2018; D. G. Smith, 2015). Having diversity at the graduate education level and the support for diverse students at PWIs is imperative and must be of greater importance as it becomes a social justice issue. It is morally

wrong to prohibit or exclude students from earning these elite degrees because of their racial/ethnic/cultural identity. By doing this, it also limits their earning potential, as STEM careers tend to be higher paying jobs, therefore benefiting the students as well as the whole system. PWIs need to explore past failures as an institution and work toward better ways to recruit and retain more graduate students from historically underrepresented groups for the benefit of individuals from these groups and society as a whole. Chang and Ledesma (2011) said that the "failure to intervene at the basic remedial level not only reduces the chances of realizing the benefits associated with a radically diverse student population, but also can fuel racial alienation, antipathy, higher rates of departure, and students' dissatisfaction with their overall college experience" (p. 84). The mental and physical health of all students is of great concern because we need this population to be successful and contribute to our workforce for the next several decades. Higher education is becoming a necessity for more and more Americans, and it is becoming more urgent that we address systemic issues that contribute to persistent inequities. As such, we hope that this research will contribute to more critical evaluations of how graduate education can better serve and support students from historically underrepresented groups.

CHAPTER VI

DISCUSSION

This chapter will provide an overview of the findings from this research. We will begin by summarizing the overall results and interpreting findings across the three papers presented. This will be followed by an overview of limitations, overarching conclusions, and suggestions for future research.

Summary of Findings

Overall, this research contributes to the literature through its focus on the graduate school experiences of students who identify as Black/African American and Hispanic/Latino/a/x at predominantly white institutions. Specifically, this work focused on social networks, perceived social support, and feelings of loneliness for these students. Three overarching themes that involved the support networks of URM graduate students at PWIs emerged from the work presented here. Having a diverse support network was a necessity, which would ideally include a variety of people in different roles able to satisfy different needs. Additionally, there was a strong desire for support to include individuals who shared similar attributes as far as race/ethnicity and gender because with those shared identities came a sense of shared experiences. URM graduate students that had perceived deficiencies in their support networks encountered negative feelings of isolation and loneliness. These unpleasant feelings were mostly alleviated once participants found groups where they felt they fit in and belonged; however, they tended to reappear after graduation when the URM students moved away from their support network. The following individual chapters focused on each of these themes in greater detail.

Chapter III examined the composition of Black/African American and Hispanic/Latino/a/x students' support networks and whether their reported social networks aligned with the value they found from them within those networks as they progressed through their STEM and SBE programs in graduate school. In combination with interview data from these participants, we understood the importance of having various people with different roles in their support network, especially those at their institution that shared the same experiences and same URM status. The most significant percentage of participants' social support networks were their friends and peers. Black students listed friends and peers as between 44-50% of the social support network across graduate school, while Hispanic/Latino/a/x students had them between 38 and 44%. This subset of their support network understood their daily challenges; could relate to their demanding schedules, experiences, and priorities; and were critically needed and valued as support alters. A substantial body of literature has previously shown that graduate students need support from other graduate students that are experiencing the same unique adjustments, with an even greater need for URM students due to the negative stereotypes they experience (Cole & Espinoza, 2008; Harper, 2006; Hernandez & Lopez, 2004; Kimbrough et al., 1996; Williams et al., 2017).

Similarly, finding support from campus groups and other organizations was very important for participants in this study. This also is in alignment with prior literature suggesting that being involved in campus groups and organizations, especially with those that share cultural and ethnic similarities, helps significantly with stress related to race or ethnicity marginalization or isolation (Gage-Bouchard et al., 2015; P. Marsden, 1988; McPherson et al., 2001; Museus, 2008; Williams et al., 2017). This category was 4-13% of social support networks, which is the lowest percentage of the categories identified; however, it was very likely that many alters in the

friends and peers category were originally from campus groups and organizations. There was an abundance of interview data describing the importance and necessity of those alters and organizations in their support networks, while also talking about how their friends in these organizations were vital to them. This is where they could form connections with other students with shared identities, feel the sense of home, not feel like the token minority student, and express themselves freely.

We found that the family/significant other and advisors/mentors were similar as far as percent abundance. Family/significant others comprised between 18-31% of their support network; however, they valued and interpreted this support very differently than what they found with friends and peers. Family support was a necessity, even a non-negotiable, for Black/African American and Hispanic/Latino/a/x students alike. Many discussed that they knew their parents, aunts, or spouses were proud of them, loved them no matter what, were always supportive, and even talked to them daily, but that they simply did not understand graduate school, what they would do with their degree, or what they were going through. Many ended up choosing not to burden them with worry.

Advisors and other faculty mentors made up 17-30% of support networks, a similar proportion as family/significant others. Black participants, in particular, discussed the importance of having a minority advisor or mentor that could empathize with their experiences, struggles, and challenges while making their way through programs at a PWI. This was not always achieved, as there are not many URM faculty at PWIs, and those that are there are often overloaded with responsibilities. Advisors were valued in general as an integral part of their support network through validating their work, making them feel that they were meant to be there, helping them feel accepted, and providing positive feedback. Advisors and faculty mentors

provide the mentorship, guidance, and support needed for students from underrepresented minority groups to have a successful graduate school experience (Allen, 1985; Dika, 2012; Tinto, 1975; Waldeck et al., 1997). Much of our interview data supported the existing literature with many students showing appreciation and gratitude toward their advisors, similar to Leslie, McClure, and Oaxaca (2016), who said that students who complete their science and engineering degree typically emphasize the role of a faculty member as instrumental to their persistence and success.

Chapter IV investigated the tendency toward and importance of homophily when looking at the racial/cultural/ethnic identity and gender attributes for Black/African American and Hispanic/Latina women. Previous literature has shown that ethnic origin is one of the strongest homophily attributes that is sought (Kossinets & Watts, 2009; McPherson et al., 2001). Our data showed that on average Black/African American and Hispanic/Latina participants had negative E-I indexes across all three surveys, indicating that they had support networks with more URM alters than non-URM alters. Interestingly, Black women showed a more significant trend toward homophily in every social support category and were much more vocal and passionate as a whole about their need for other "people of color" in their support network. Mayra was an example that shared similar views by saying,

> But just having students of color in general whether they be like within my department or across campus, it definitely gives me a sort of a support system that I feel like I can rely on and also people who probably had similar experiences that I've had here at [university] and within [program]. We often talk about some of the issues that come along with being a person of color within the field of [study] itself, and so it's definitely good to have people who understand the struggle…we try to help each other navigate.

Other students echoed this idea and said that it was a point of conversation amongst them and noted how easy it would be to leave their program with the unwelcome, non-diverse environment that existed.

Some of the Hispanic/Latina students shared similar feelings, like Gabriela, who said,

> We sought opportunities to meet other Latino students. We go to all the events here. We keep an eye out. We do all the townie stuff…we decided if we're gonna do this, we have to do it completely. Otherwise, you're miserable.

However, as a whole, their average E-I indices were more heterophilous when it came to ethnicity in their support networks, especially with their friends and advisors/mentors. We noted that many of our Hispanic/Latina participants considered themselves "white-passing," which might have a role in what friends they choose and whether they feel the need to have advisors or mentors of URM status. According to McPherson et al. (2001), physical location greatly dictates who we are in contact with and, therefore, who we are likely to form relationships with based on availability. One challenge at a PWI is how few minority students there are compared to the number of white and Asian students. This creates an obstacle for students of color to form the connections they need to help them be successful throughout their programs. This supports prior findings that racial/ethnic minorities in an environment such as a PWI have a much more heterophilous support network than their non-URM counterparts (H. Ibarra, 1992).

The other attribute examined in Chapter IV was the tendency toward gender homophily. Despite a general desire to have homophilous relationships with respect to both gender and race/ethnic/cultural identity, McPherson et al. (2001) noted that gender homophily shows a "remarkable contrast" to that of race and ethnicity because race and ethnicity homophily is "dominated by the strong structural effects of category size and by category differences on many socially important features" (p. 422). Regarding gender, though, there are approximately equal numbers of men and women globally, making the general population as a whole heterogeneous. It has been found, however, that most settings that have studied social networks are not heterophilous with regard to gender, especially with minority populations (P. V. Marsden, 1987;

McPherson et al., 2001). According to our data, the Black women students had overall negative E-I indexes, meaning they had more women in their support networks than men. They were very passionate about having Black women, women of color, and a "rainbow of diversity" of women in their support networks. They experienced understanding, support, affirmation, belonging, validation, and comfort when having discussions that made them feel vulnerable. The Black women's E-I indexes showed the most homophily trends in the friends/peers and groups roles, which were both very highly valued according to interview data and aligned with literature supporting the notion that relationships involving socio-emotional ties of friendship, advice, and support are much more likely to be homophilous (H. Ibarra, 1992; McPherson et al., 2001).

The Hispanic/Latina women's data showed more heterophily tendencies than the Black women's data, especially in the family/significant other category. URM women seeking connections from other women is apparent in our data and is consistent with P. V. Marsden (1987), who noted that gender homophily was higher with African Americans and Hispanics than Anglos. One of our Hispanic participants noted,

> I think I would like to create a group of Latina women only because there's so few of us in graduate school or in the professorship at the university level. And I think it's hard to explain to other people and to men even, Latino men, the kind of pressure you have on being nurturing and taking care of your family and all those competing kinds of roles and identity. So, it would be nice to have—to be able to talk to other Latina women about that specific aspect of this journey.

She, as well as other women, was really looking for women who understand the struggles of being a woman in academia, an academic trying to navigate having a family and balancing roles and responsibilities. One participant noted that "I think it's worse with race and ethnicity than it is to the gender aspect of it. It's easier to be a woman than it is to be a Puerto Rican woman in this program." This reiterates that while the population is relatively split, even when it comes to gender and finding other women to be in your support network, finding others with shared

race/ethnicity/culture identities is substantially more challenging and burdensome when that identity is marginalized.

While there are many benefits to being surrounded by others with shared or similar attributes, there are also incredible opportunities for forming ties with those with different attributes. As discussed in Chapter IV, having relationships with those of another race opens an opportunity to learn from, interact with, and befriend racially and ethnically different people. While much of society has been divided since the days dating back to the slavery era and Jim Crow laws, systemic racism needs to be addressed. One of the most prominent aspects of systemic racism is implicit bias—prejudices in society that people are not aware they have. By forming relationships with others with different cultural backgrounds, one can understand and appreciate different ways of life (Axner, 2020). The big challenge of systemic racism is that there is no single person or entity responsible for it, making it very hard to solve. However, Feagin (2006) discusses the severity of doing nothing by noting,

> This planet will not survive much longer if we continue to rely so heavily on the white men now at the helm for key ideas, policies, and actions in regard to the world's ecology, economy, and politics. Systemic racism has killed not only people, but many important human values, scores of excellent ideas, and countless innovations and inventions. (p. 322)

At a predominantly white institution, having heterophilous relationships and being involved in diverse groups and organizations is one way to start the change toward equity and inclusion. Feagin (2006) also noted that systemic racism is severely rooted in society. However, in order to reduce or eliminate it, all Americans "must organize collectively and effectively to create more egalitarian social, economic, and political institutions, and thus to finally implement the longstanding U.S. ideals of freedom, liberty, and justice" (p. 323). Systemic racism has been ignored for decades, and the time to start the change is now.

While the need for both homophilous and heterophilous relationships is necessary, this can be a challenging endeavor at institutions such as PWIs. To have representation that reflects the American population in higher education, we need a critical mass of URM students. However, this has been difficult for many universities to achieve when it comes to even getting URM students to apply. Having a critical mass, according to Anderson, Daugherty, and Corrigan (2005),

> supports the creation of a learning environment that combats marginalization of underrepresented populations. The goal of admissions policies becomes an attempt to represent a microcosm of the community, thereby providing opportunities for students from different cultural backgrounds to engage one another without feeling as though any one of them represents the totality of his or her cultural identity. (p. 53)

A critical mass should also provide educational benefits of diversity for all students. Finally, one of the most powerful benefits to having critical mass and helping end systemic racism is that critical mass was

> meant to reduce negative stereotypes held by students in the majority group about students in the minority groups by showing them the wide range of diversity within racial and ethnic groups, which would help to disprove the idea that all members of racial/ethnic groups are the same. (Kalbfeld, 2019, p. 2)

This will help eliminate the implicit bias that people hold and start the much-needed progression toward accepting, valuing, and appreciating all cultures. According to Sidhu (2013), this ultimately benefits everyone and will extend well beyond the university setting as these students continue into the workforce, have families of their own, and continue toward the elimination of systemic racism.

In Chapter V, we explored the social support interview and open response data in greater depth. There is a substantial body of literature about URM students at PWIs experiencing feelings of loneliness and isolation in an environment where they feel alienated and purposefully excluded. This often leads to adverse physical and mental health effects and challenges with

academic achievement (Bernardon et al., 2011; DiTommaso & Spinner, 1997; Fisher et al., 2019; Graham et al., 2013). Having a social support network has been thought to help alleviate many of these negative feelings; however, the question becomes whether minority students can create the social connection needed to thrive in an environment such as a PWI. Our social network survey data showed robustly populated networks in most cases; however, the interview and open response data revealed that connections were deficient in certain areas, allowing feelings of loneliness, isolation, and doubt to emerge.

As discussed in previous chapters, social support comes from many different sources and plays varying roles. For example, familial support for URM graduate students was a vital source of support. However, when it came to the daily struggles of being in classes, on campus, in the lab, or immersed in their programs, they still felt an emptiness that supportive family members could not fill. The greatest solution to feelings of loneliness and isolation appeared through campus group involvement. Many participants discussed the desire to drop out of their programs because of these negative feelings; however, groups such as BGSA, BPA, SACNAS, SHPE, Bible studies, and soccer teams were what finally made them feel accepted. Finding support from people experiencing the same stressors, time restraints, and overall graduate school experiences made the biggest impact. At the same time, many participants mentioned that they were the only person of color in their program. While they also said that support from those in their program cohort was somewhat there, being in a space with other people of color provided a missing sense of comfort and support. They often listed cohort members in their social support network surveys but did not talk about them as much as others with shared identities during their interviews. Being in the presence of other students with similar backgrounds going through the same

challenges undeniably fought those feelings of loneliness and isolation by providing acceptance, support, and affirmations.

While these data were all collected longitudinally, this study proved to be unique compared to prior research as we followed our participants after graduation for one last social networking check-in. While there was no substantial network turnover from their social support survey 2½ prior (from the third to the fourth survey), the open response data showed overwhelming changes. Participants went from feeling like they had found a support network to feeling alone and isolated again, despite having listed an extensive list of supportive alters, most of which were identical to the previous survey. They still reported feelings of not having a support network, feeling like it was significantly reduced, or that their support networks were virtually gone. It was noteworthy that most of the participants had moved to a new geographic location to start a new position or post-doc, so it is possible that while they still relied on those support persons from before, they lacked support in their new physical space. Having people within the same physical space, understanding the challenges and experiences at that given moment, and empathizing and supporting one another seems to be a significant factor when it comes to feeling supported and combatting feelings of isolation and loneliness.

Limitations

There were several limitations present in the work presented here, despite methodological attempts to address these challenges. Depending on the selection criteria, we had modest participant pools that varied from 11 to 30 Black/African American and Hispanic/Latino/a/x graduate students, which is not an accurate representation of all URM students in all graduate programs at PWIs. Initial recruitment surveys were emailed from the registrars, so we were limited to whoever responded. Two reminder emails were sent, but there is the possibility that

students were busy and simply ignored them or were consumed with other responsibilities and could not spare the time. However, there was a monetary incentive to those completing the initial survey and for opting into the interview process, which was intended to gather more participation. This could have been improved if we could have offered a greater incentive for their time and effort. Despite our best efforts, it is hard to have a large participant pool when doing research with students from URM groups because there is a limited number of them to begin with.

Secondly, our participants came from three Midwestern universities, which may not reflect other URM students' views in different areas of the country. There might be more challenges for URM students dealing with systemic racism in parts of the country where URM groups are not as plentiful compared to where there are larger populations of URM groups. While we recognize the representation limitations, the value of qualitative research is presenting participant stories and experiences in a way that allows for authentic connection and empathy. Therefore, the depth and quality of data collected provide opportunities for readers to understand and authentically relate to the participants regardless of whether the participant pool is adequately representative of the variety of students and institutions that exist in the United States.

This study also relied on participants' self-identification as far as gender, race, and ethnicity, which is undoubtedly murky and continues to change as our conceptions of identity evolve. Names and identities have even evolved since the study started. Initially, we used *male/female* for ego and alter identification but changed the terminology to *man/woman* to reflect gender identity more accurately. URM status was another attribute that also evolved as we continued this research. Initially, we were sensitive to group Black and African American

students together but were guided to use *Black* when referring to this group of students as it is the more inclusive term. Similarly, we initially used the term *Hispanic* for the students in the study as a broad group to include everyone; however, *Hispanic/Latino/a/x* has been found to be more inclusive of those with a Spanish-language background or Latin American, South American, or Caribbean decent. Additionally, *Latino/a/x* has been found to be more inclusive of those identifying as men, women, gender-neutral, or nonbinary as opposed to simply the masculine *Latino.*

Response bias could be another limitation of this study, where participants deliberately respond inaccurately or falsely to questions on surveys or in interviews. However, we relied on the participants to give honest answers while having clear recollections of past and current experiences. I was solely in charge of all the survey distribution and participant contact concerning social networking clarification, so this was one way of maintaining consistency and establishing trust. We also tried to address these limitations by combining interview data as well as survey data to align alters named and have the most complete social network.

Five interviewers were on the project over the six rounds of interviews, leading to unavoidable inconsistencies during the semi-structured interviews despite utilization of a semi-structured protocol and interviewer training. Interviewer effects inevitably existed and were apparent when reading transcripts, as some interviewers may have encouraged or discouraged participants to share information or explain their responses more than other interviewers. We tried to limit this by holding research group meetings before every round of interviews and reviewing the interview protocol. We also sent probing emails after their social networks were compiled to ask if any alters were accidently left out or if they thought of anyone else that should be included in their support network that they would like to add.

Additionally, when the study initially started, the study's social networking aspect was not set in place. Therefore, the first social networking survey was sent out asking participants to recall and record all of those in their social support network when they first started graduate school. We compared these data to their interview data to validate them and emailed participants to verify the accuracy. However, there is still the possibility that their recollection was hindered when it came to their network from the prior year.

This study also lacks adequate representation from Black men, as there was only one Black man who participated in the study. While he did participate in all of the interviews, he did not complete all social networking surveys, therefore excluding his data from some of the chapters presented. There were also more women in this study than men, so women's experiences and perspectives were overrepresented. Lastly, we had a large portion of our Hispanic/Latino/a/x participants identify as "white passing," which may make their experiences different from other Hispanic/Latino/a/x populations. Because of these limitations, it cannot be assumed that the social support factors that contributed to students' persistence in this study are representative of the experience of all underrepresented minority students within the larger graduate context. However, we would never expect all URM students to have a singular, monolithic experience. Therefore, having the variety of experiences guides our understanding of their social support and their social networks. There is value in having a diverse participant pool, even if it is small and limited.

Despite these limitations, we sought to account for them in order to conduct a valid, reliable, and credible study. This research team had multiple interviewers as well as a large research team to help establish trustworthiness and address the limitation of interviewer effects. Member checking on social networks was done for each social networking survey as well as

after it was combined with interview data to ensure that response bias, survey fatigue, and burnout were accounted for. When the data analysis was conducted, intercoder agreement was reached to ensure that social networking codes, as well as those of social isolation and loneliness, were accurately interpreted while going through interview data. This method helped to alleviate any questions about misinterpretation and to ensure consistency throughout the coding process. Other team members and I engaged in much discussion to be sure we aligned on the data analysis process. Additionally, all participants in each study were given a draft of the manuscripts and allowed an opportunity to comment or express concern if they felt misrepresented at all, which did not occur. Participants were asked if there was anything they felt should be excluded or that they were uncomfortable with, and no one expressed that need.

Suggestions for Future Research

This research can help researchers and institutions move toward a more diverse, inclusive, and equitable student body and pool of future faculty, but there is much more research that can still be contributed. Future research should conduct a similar longitudinal study of students from URM groups in STEM and SBE programs at PWIs around the country where there are above average numbers of successful degree completions. Another avenue would be to study students that were not successful in their STEM or SBE programs at PWIs to understand why they left their programs, what they felt was lacking, what they needed that they felt was unavailable, and what their next educational endeavors were. There is a need to understand the perspectives of students who did not complete their degrees, as they are often not included in research on degree attainment.

Another avenue for future research would be to do a similar study involving URM students at PWIs in other regions of the country where there might be a more diverse student

population as well as surrounding population to see if similar outcomes are found. Future research could also examine the role of different campus programs, groups, and organizations on the experiences of graduate students from minority groups. A few students were not aware of how to find groups that they would fit into, while some students were involved in so many groups that they were overwhelmed. Some students dropped out of groups because of time restraints when they were in dissertation mode or had taken on too many groups, so it would be worthwhile to see which groups are viewed as most beneficial for students to join.

Recommendations and Implications

Today, with what we know from the literature and this study, there are some recommendations for departments and PWIs as a whole that may help minoritized graduate students succeed in completing their programs. It is valuable for institutions to better support URM graduate students before they even come to campus by connecting them with a diverse group of new students to foster relationships. The university and individual departments need to assume the responsibility of helping students from underrepresented groups by surrounding them with an immediate support network as they begin their graduate education. This could also include a mentorship program in which they have the support of older graduate students who can share their experiences and help them through trials of their own. This is also true when it comes to potential advisors. Students currently must seek out advisors, but if they were more available or there was an easier way to connect with them, this might help students feel more supported by faculty. Non-URM faculty would greatly benefit from cultural competency training to better assist, support, and understand URM graduate students throughout the trials they encounter.

Many universities have chosen to have faculty go through “active bystander” training described by Scully and Rowe (2009) to make the university a more welcoming environment.

Graduate students could benefit from this as well. In this training, one is taught to encourage the positive by "fostering productive behavior from all managers and employees, and other members of the organization, to improve morale and collegiality; to build community and to foster inclusion" (p. 1). Additionally, they are conversely taught to discourage the negative, which is meant to curtail discriminatory, destructive behavior. This is monumental for bystanders, especially when witnessing cross-racial interactions that are undesirable, to "react, and then act appropriately, when they see unsafe, unprofessional, offensive, discriminatory" behavior (p. 2). Some of these negative interactions could significantly affect URM graduate students, leading to feelings of exclusion, loneliness, and rejection, and may ultimately persuade them to leave their programs. However, if active bystanders were to intervene and address the unacceptable altercation or situation, that could be a powerful experience by giving students from URM groups immediate, positive reinforcement.

Conclusion

It is evident that we need greater diversity in STEM and SBE fields, including in the field of chemistry. This study has shown that at PWIs, Black/African American and Hispanic/Latino/a/x graduate students are especially in need of a strong, robust social support network when working their way through STEM and SBE programs. This study has shown stories of URM students that persisted through these programs. Overall findings support and highlight the need for minority students to have actual and perceived support from people in different roles because different people provide different resources. URM graduate students need to have more availability for URM alters to add to their support network, which would be accomplished by reaching a critical mass of minority students in higher education programs. This

support helps fend off feelings of isolation and loneliness, allowing for a better experience in graduate school.

With greater successes in higher education for URM students, we can begin to increase diversity in the workforce, which will also help the United States as a whole to be more productive, credible, and creative while reflecting the different perspectives and the population as a whole more accurately (Gibbs et al., 2014; Hodapp & Brown, 2018; Powell, 2018; D. G. Smith, 2015). All of this is a means to continue breaking down systemic racism in our society that has been around for centuries. According to Feagin (2006), "This [major changes in the system of racism] will be true in the future only if concerned Americans of all backgrounds organize on a large scale for their, and their society's, liberation from racial oppression, but the task is long and arduous" (p. xvii).

This research has the potential to impact and benefit students from marginalized social groups and non-URM students alike. With the current attrition rates for URM graduate students over 50% (CEOSE, 2010), researchers and institutions need to take action. Our research looked at a small population of successful graduate students. Their support networks were vital to those successes as students faced moving away from home, creating new relationships, and adjusting to graduate school's heightened academic rigor. Without adequate support, graduate students of color face deleterious consequences when it comes to having decreased academic performance, feelings of belonging to the university, and social engagement (Gibbs et al., 2014; Hodapp & Brown, 2018; Powell, 2018; D. G. Smith, 2015). The anxiety experienced in graduate school at a PWI is more intense for students from marginalized social groups. They feel less likely to belong, feel unwelcomed, have decreased academic performance, and have decreased social engagement (Mendoza-Denton et al., 2002). This country is becoming more diverse, and it has

been projected that by 2055 there will not be a single racial or ethnic minority in the country (Feagin, 2006; Stebbins, 2020; Willie-LeBreton, 2011). Therefore businesses, organizations, and other facets of American society will become more diverse, with an even greater need for higher education to train the diverse future generation. One professor noted the benefits of having more diverse college campuses by saying, "When we bring in students from different geographical backgrounds, different economic classes, different races, different ethnicities, different faiths, we can approach real-world problems with more realistic solutions" (Stebbins, 2020, p. 1). It is essential to ensure that this diversity can be maintained at campuses by making sure the URM students are retained and appropriately supported.

By adding to the existing literature regarding the social support networks of URM graduate students attending predominantly white institutions, this dissertation should support the continued development of resources that serve the minority population in the STEM and SBE fields and help increase URM participation in the chemistry discipline. PWIs need to explore past failures and work toward better ways to recruit and retain more URM graduate students. Chang and Ledesma (2011) said that the

> failure to intervene at the basic remedial level not only reduces the chances of realizing the benefits associated with a radically diverse student population, but also can fuel racial alienation, antipathy, higher rates of departure, and students' dissatisfaction with their overall college experience. (p. 84)

The mental and physical health of students from minority groups is at stake if we continue to ignore the structural and institutional factors that contribute to accumulated disadvantage and perpetuate their exclusion from the STEM and SBE workforce.

REFERENCES

Adair, V. C. (2001). Poverty and the (broken) promise of higher education. *Harvard Educational Review, 71*(2), 217-239.

Aguirre, A. (2010). Diversity as interest-convergence in academia: a critical race theory story. *Social Identities, 16*(6), 763-774. https://doi.org/10.1080/13504630.2010.524782

Allen, W. (1985). Black student, white campus: structural, interpersonal, and psychological correlates of success. *The Journal of Negro Education, 54*(2), 134-147.

Allen, W. (1992). The color of success: African-American college student outcomes at predominantly white and historically black public colleges and universities. *Harvard Educational Review, 62*(1), 26-45. https://doi.org10.17763/haer.62.1.wv5627665007v701

Anderson, G. M., Daugherty, E. J. B., & Corrigan, D. M. (2005). The search for a critical mass of minority students: Affirmative action and diversity at highly selective universities and colleges. *The Good Society, 14*(3), 51-57.

Autenrieth, R. L., Lewis, C. W., & Butler-Purry, K. (2017). Long-term impact of the enrichment experiences in engineering (E3) summer teacher program. *Journal of STEM Education, 19*(4), 19-29.

Axner, M. (2020). *Building relationships with people from different cultures.* Retrieved from https://ctb.ku.edu/en/table-of-contents/culture/cultural-competence/building-relationships/main

Baird, M. D., Buchinsky, M., & Sovero, V. (2016). *Decomposing the racial gap in STEM major attrition: A course-level investigation*. Santa Monica, CA: Rand Corporation. Retrieved from https://www.rand.org/pubs/working_papers/WR1171.html

Baldwin, A., August, L., & Bennett, J. (2020). *College success*: OpenStax.

Barrera, M. (1986). Distinctions between social support concepts, measures, and models. *American Journal of Community Psychology, 14*, 413-445.

Baumeister, R. F., & Leary, M. R. (1995). The need to belong: Desire for interpersonal attachments as a fundamental human motivation. *Psychological Bulletin of Science, Technology & Society, 117*, 497-529.

Bell, D. A. (1995). Who's afraid of critical race theory? *University of Illinois Law Review, 1995*(4), 893-910.

Bernardon, S., Babb, K. A., Hakim-Larson, J., & Gragg, M. (2011). Loneliness, attachment, and the perception and use of social support in university students. *Canadian Journal of Behavioural Science, 43*(1), 40-51.

Blau, P. (1977). *Inequality and heterogenity*. New York, NY: Free Press.

Bonous-Hammarth, M. (2000). Pathways to success: Affirming opportunities for science, mathematics, and engineering majors. *The Journal of Negro Education, 69,* 92-111.

Borgatti, S. P., Everett, M. G., & Johnson, J. C. (2013). *Analyzing social networks*. London, England: Sage.

Brainard, S. G., & Carlin, L. (1998). A six-year longitudinal study of undergraduate women in engineering and science. *Journal of Engineering Education, 87*(4), 7.

Byars-Winston, A., Estrada, Y., Howard, C., Davis, D., & Zalapa, J. (2010). Influence of social cognitive and ethnic variables on academic goals of underrepresented students in science and engineering: A multiple-groups analysis. *Journal of Counseling Psychology, 57*(2), 205-218. https://doi.org10.1037/a0018608

Byrne, D. (1961). Interpersonal attraction and attitude similarity. *Journal of Abnormal and Social Psychology, 62*(3), 713-715.

Cacioppo, J. T., & Cacioppo, S. (2018). Loneliness in the modern age: An evolutionary theory of loneliness (ETL). *Advances in Experimental Social Psychology, 58,* 127-197.

Cacioppo, J. T., Fowler, J. H., & Christakis, N. A. (2009). Alone in the crowd: the structure and spread of loneliness in a large social network. *Journal of Personality and Social Psychology, 97*(6), 977-991. https://doi.org10.1037/a0016076

Campbell, P. (2018). Science benefits from diversity. *Nature, 558*(5). https://doi.org.10.1038/d41586-018-05326-3

Carlone, H., & Johnson, A. (2007). Understanding the science experiences of women of color: Science identity as an analytic lens. *Journal of Research in Science Teaching, 44*, 32.

Carter, D. (2006). Key issues in the persistence of underrepresented minority students. *New Directions for Institutional Research, 2006*(130), 14.

CEOSE. (2010). *Committee on Equal Opportunities in Science and Engineering [CEOSE]*. Retrieved from https://www.nsf.gov/od/oia/activities/ceose/

Chang, M. J., & Ledesma, M. C. (2011). The diversity rationale. In L. M. Stulberg & S. L. Weinberg (Eds.), *Diversity in American higher education; Toward a more comprehensive approach*. New York, NY: Taylor & Francis.

Charmaz, K. (2000). Grounded theory: Objectivist and constructivist methods. In N. K. Denzin & Y. S. Lincoln (Eds.), *Handbook of qualitative research* (2nd ed.). Thousand Oaks, CA: Sage.

Charmaz, K. (2005). Narrative inquiry: Multiple lenses, approaches, voices. In N. K. Denzin & Y. S. Lincoln (Eds.), *The Sage handbook of qualitative research* (3rd ed.; pp. 507-536). Thousand Oaks, CA: Sage.

Charmaz, K. (2006). *Constructing grounded theory*. London, England: Sage.

Chen, X., & Soldner, M. (2013). *STEM attrition: College students' paths into and out of STEM fields* (NCES 2014-001). Washington, DC: National Center for Education Statistics, Institute of Education Sciences.

Christakis, N. A., & Fowler, J. H. (2010). *Connected: The amazing power of social networks and how they shape our lives*. London, England: Sage.

Clewell, B. C. (1987). *Retention of Black and Hispanic doctoral students*. GRE Board Research Report No. 83-4R ETS Research Report 87 -10. https://doi.org/10.1002/j.2330-8516.1987.tb00214.x

Codjoe, H. M. (2010). Fighting a 'public enemy' of Black academic achievement—The persistence of racism and the schooling experiences of Black students in Canada. *Race Ethnicity and Education, 4*(4), 343-375. https://doi.org/10.1080/13613320120096652

Cohen, S., Gottleib, B., & Underwood, L. (2000). *Social relationships and health: Challenges for measurement and intervention*. New York, NY: Oxford University Press.

Cole, D., & Espinoza, A. (2008). Examining the academic success of Latino students in science technology engineering and mathematics (STEM) majors. *Journal of College Student Development, 49*(4), 285-300.

Cornell Law School. (2003). *Grutter v. Bollinger.* Retrieved from https://www.law.cornell.edu/supct/html/02-241.ZO.html

Crenshaw, K., Gotanda, N., Peller, G., & Thomas, K. (1995). *Critical race theory: The key writings that formed the movement*. New York, NY: The New Press.

Creswell, J. W. (2013). *Qualitative inquiry & research design: Choosing among five approaches*. Thousand Oaks, CA: Sage.

Crossley, N., Bellotti, E., Edwards, G., Everett, M. G., Koskinen, J., & Tanner, M. (2015). *Social network analysis for Ego-nets*. London, England: Sage.

D'Augelli, A. R., & Hershberger, S. L. (1993). African American undergraduates on a predominantly white campus: Academic factors, social networks, and campus climate. *The Journal of Negro Education, 62*(1), 67-81.

Daftary, A.-M. H. (2018). Critical race theory: An effective framework for social work research. *Journal of Ethnic & Cultural Diversity in Social Work*, 1-16. https://doi.org/10.1080/15313204.2018.1534223

Davis, J. E. (1994). College in Black and White: Campus environment and academic achievement of African American males. *The Journal of Negro Education, 63*(4), 620-633.

DeFour, D. C., & Hirsch, B. J. (1990). The adaptation of Black graduate students: A social network approach. *American Journal of Community Psychology, 18*, 487-503.

Dika, S. L. (2012). Relations with faculty as social capital for college. *Journal of College Student Development, 53*(4), 596-610.

DiTommaso, E., & Spinner, B. (1997). Social and emotional loneliness: A re-examination of Weiss' typology of loneliness. *Personality and Individual Differences, 22*(3), 417-427.

Dixson, A. D., & Rousseau Anderson, C. K. (2017). And we are STILL not saved: 20 years of CRT and education. In A. D. Dixson, C. K. R. Anderson, & J. K. Donnor (Eds.), *Critical race theory in education: All God's children got a song* (2nd ed.). New York, NY: Routledge.

Elo, S., Kääriäinen, M., Kanste, O., Pölkki, T., Utriainen, K., & Kyngäs, H. (2014). Qualitative content analysis. *Sage Open, 4*(1). https://doi.org/10.1177/2158244014522633

Espinosa, L. L., Turk, J. M., Taylor, M., & Chessman, H. M. (2019). *Race and ethnicity in higher education: A status report*. Retrieved from https://vtechworks.lib.vt.edu/bitstream/handle/10919/89187/RaceEthnicityHighEducation.pdf?sequence=1&isAllowed=y

Estrada, M., Burnett, M., Campbell, A. G., & Campbell, P. B. (2016). Improving underrepresented minority student persistence in STEM. *CBE Life Sciences Education, 15*(3). https://doi.org/10.1187/cbe.16-01-0038

Everett, M., & Borgatti, S. P. (2005). Ego network betweenness. *Social Networks, 27*(1), 31-38. https://doi.org/10.1016/j.socnet.2004.11.007

Feagin, J. R. (2006). *Systemic racism: A theory of oppression*. New York, NY: Taylor & Francis Group.

Fisher, A. J., Mendoza-Denton, R., Patt, C., Young, I., Eppig, A., Garrell, R. L., . . . Richards, M. A. (2019). Structure and belonging: Pathways to success for underrepresented minority and women PhD students in STEM fields. *PLoS One, 14*(1), 14. https://doi.org/10.1371/journal.pone.0209279

Freeman, L. C. (2004). *The development of social network analysis: A study in the sociology of science*. Vancouver, BC, Canada: Empirical Press.

Frey, W. H. (2018). US white population declines and Generation ‘Z-plus’ is minority white, census shows. *Brookings Institute*. Retrieved from https://www.brookings.edu/blog/the-avenue/2018/06/21/us-white-population-declines-and-generation-z-plus-is-minority-white-census-shows/

Gage-Bouchard, E. A., LaValley, S., Panagakis, C., & Shelton, R. C. (2015). The architecture of support: The activation of preexisting ties and formation of new ties for tailored support. *Social Science & Medicine, 134,* 59-65.

Gardner, S. K., & Barnes, B. J. (2007). Graduate student involvement: Socialization for the professional role. *Journal of College Student Development, 48*(4), 369-387.

Gewin, V. (2019). Women can benefit from female-led networks. *Nature, 566*(145). https://doi.org/10.1038/d41586-018-07878-w

Gibbs, K. D., Jr., McGready, J., Bennett, J. C., & Griffin, K. (2014). Biomedical science Ph.D. career interest patterns by race/ethnicity and gender. *PLoS One, 9*(12), e114736. https://doi.org/10.1371/journal.pone.0114736

Gloria, A. M., Castellanos, J., Lopez, A. G., & Rosales, R. (2005). An examination of the academic nonpersistence decisions of Latino undergraduates. *Hispanic Journal of Behavioral Sciences, 27*(2), 202-223.

Gloria, A. M., Kurpius, S. E. R., Hamilton, K. D., & Willson, M. S. (1999). African American students' persistence at a predominantly white university: Influences of social support, university comfort, and self-beliefs. *Journal of College Student Development, 40*(3), 257-268.

Gloria, A. M., Robinson, K., Hamilton, K., & Willson, M. (1999). African American students' persistence at a predominantly white university: Influences of social support, university comfort, and self-beliefs. *Journal of College Student Development, 40*(3).

Gloria, A. M., & Rodriguez, E. R. (2000). Counseling Latino university students: Psychosociocultural issues for consideration. *Journal of Counseling and Development, 78*(2), 145-154.

Golafshani, N. (2015). Understanding reliability and validity in qualitative research. *The Qualitative Report*. https://doi.org/10.46743/2160-3715/2003.1870

Gottlieb, B. H., & Bergen, A. E. (2010). Social support concepts and measures. *Journal of Psychosomatic Research, 69*(5), 511-520. https://doi.org/10.1016/j.jpsychores.2009.10.001

Graham-Bermann, S. A., Eastin, J. A., & Bermann, E. A. (2001). Stress and coping. In J. Worell (Ed.), *Encyclopedia of women and gender: Sex similarities and differences and the impact of society on gender*: Elsevier Science & Technology.

Graham, M. J., Frederick, J., Byars-Winston, A., Hunter, A.-B., & J., Handelsman. (2013). Increasing persistence of college students in STEM. *Science, 341*(6153), 1455-1456. https://doi.org/10.1126/science.1240487

Grandy, J. (1998). Persistence in science of high-ability minority students: Results of a longitudinal study. *Journal of Higher Education, 69*(6), 589-620.

Griffin, O. T. (1991). Minority student education: Concepts and policies. *Western Journal of Black Studies, 15*, 235-240.

Griffith, A. L. (2010). Persistence of women and minorities in STEM field majors: Is it the school that matters? *Economics of Education Review, 29*(6), 911-922. https://doi.org/10.1016/j.econedurev.2010.06.010

Grossett, B. J., Cuyjet, M. J., & Cockriel, J. (1998). African Americans' perception of marginality in the campus culture. *College Student Journal, 32*, 22-32.

Guiffrida, D. A., & Douthit, K. Z. (2010). The Black student experience at predominantly white colleges: Implications for school and college counselors. *Journal of Counceling & Development, 88*, 311-318.

Halgin, D. S., & Borgatti, S. P. (2012). An introduction to personal network analysis and tie churn statistics using E-NET. *Connections, 32*(1), 13.

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

Harper, S. R. (2006). Peer support for African American male college achievement: Beyond internalized racism and the burden of "acting White". *The Journal of Men's Studies, 14*(337-358).

Hatch, L. R., & Mommsen, K. (1984). The widening racial gap in American higher education. *Journal of Black Studies, 14*(4), 457-476.

Hawkley, L. C., & Cacioppo, J. T. (2010). Loneliness matters: A theoretical and empirical review of consequences and mechanisms. *Annals of Behavioral Medicine, 40*(2), 218-227. https://doi.org/10.1007/s12160-010-9210-8

Hernandez, J. C. (2000). Understanding the retention of Latino college students. *Journal of College Student Development, 41*, 575-586.

Hernandez, J. C., & Lopez, M. A. (2004). Leaking pipeline: Issues impacting Latino/a college student retention. *Journal of College Students Retention, 6*(1), 37-60.

Hiraldo, P. (2010). The role of critical race theory in higher education. *The Vermont Connection, 31*, 53-59.

Hodapp, T., & Brown, E. (2018). Making physics more inclusive. *Nature, 557*, 629-632. https://doi.org/10.1038/d41586-018-05260-4

Holding a four-year college degree brings Blacks close to economic parity with Whites. (2005). *Journal of Blacks in Higher Education*. Retrieved from http://www.jbhe.com/news_views/47_four-year_collegedegrees.html

Huang, G., Taddese, N., & Walter, E. (2000). *Entry and persistence of women and minorities in college science and engineering education* (NCES 2000–601). Retrieved from https://nces.ed.gov/pubs2000/2000601.pdf

Hurtado, S., Eagan, K., & Chang, M. (2010). *Degrees of success: Bachelor's degree completion rates among initial STEM majors*. Los Angeles, CA: Higher Education Research Institute at UCLA.

Ibarra, H. (1992). Homophily and differential returns: Sex differences in network structure and access in an advertising firm. *Administrative Science Quarterly, 37*(3), 422-447.

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

Johnson-Bailey, J., Valentine, T., Cervero, R. M., & Bowles, T. A. (2016). Rooted in the soil: The social experiences of Black graduate students at a southern research university. *The Journal of Higher Education, 80*(2), 178-203. https://doi.org/10.1080/00221546.2009.11772138

Johnson-Bailey, J., Valentine, T. S., Cervero, R. M., & Bowles, T. A. (2008). Lean on me: The support experiences of Black graduate students. *The Journal of Negro Education, 77*(4), 365-381.

Jones, W. H., & Moore, T. L. (1987). Loneliness and social support. *Journal of Social Behavior and Personality, 2*(2).

Joseph, J. (2012). From one culture to another: Years one and two of graduate school for African American women in the STEM fields. *International Journal of Doctoral Studies, 1*, 18.

Kadushin, C. (2012). *Understanding social networks: Theories, concepts, and findings*. New York, NY: Oxford University Press.

Kalbfeld, J. (2019). Critical mass for affirmative action. Retrieved from https://www.jessicakalbfeld.com/blog/2019/11/22/critical-mass-for-affirmative-action

Kalmijn, M. (1994). Assortive mating by cultural and economic occupational status. *American Journal of Sociology, 100*(2).

Kandel, D. B. (1978). Homophily, selection, and socialization in adolescent friendships. *American Journal of Sociology, 84*(2), 10.

Kao, G., & Joyner, K. (2016). Do race and ethnicity matter among friends? Activities among interracial, interethnic, and intraethnic adolescent friends. *The Sociological Quarterly, 45*(3), 557-573. https://doi.org/10.1111/j.1533-8525.2004.tb02303.x

Kaufman, D. R. (1978). Associational ties in academe: Some male and female differences. *Sex Roles, 4*(1), 9-21.

Kimbrough, R. M., Molock, S. D., & Walton, K. (1996). Perception of social support, acculturation, depression, and suicidal ideation among African American college students at predominantly Black and predominantly White universities. *Journal of Negro Education, 65*, 295-307.

Kong, F., Zhao, J., & You, X. (2012). Emotional intelligence and life satisfaction in Chinese university students: The mediating role of self-esteem and social support. *Personality and Individual Differences, 53*(8), 1039-1043. https://doi.org/10.1016/j.paid.2012.07.032

Korstjens, I., & Moser, A. (2018). Series: Practical guidance to qualitative research. Part 4: Trustworthiness and publishing. *European Journal of General Practice, 24*(1), 120-124. https://doi.org/10.1080/13814788.2017.1375092

Kossinets, G., & Watts, D. (2009). Origins of homophily in an evolving social network. *American Journal of Sociology, 115*(2), 405-450.

Krackhardt, D., & Stern, R. N. (1988). Informal networks and organizational crises: An experimental simulation. *Social Psychology Quarterly, 51*(2), 123-140.

Lee, C. Y., & Goldstein, S. E. (2016). Loneliness, stress, and social support in young adulthood: Does the source of support matter? *Journal of Youth and Adolescence, 45*(3), 568-580. https://doi.org/10.1007/s10964-015-0395-9

Lee, S., Chung, J. E., & Park, N. (2018). Network environments and well-being: An examination of personal network structure, social capital, and perceived social support. *Health Communication, 33*(1), 22-31.

Leslie, L. L., McClure, G. T., & Oaxaca, R. L. (2016). Women and minorities in science and engineering. *The Journal of Higher Education, 69*(3), 239-276. https://doi.org/10.1080/00221546.1998.11775134

Lin, N., & Dumin, M. (1986). Access to occupations through social ties. *Social Networks, 8*, 14.

Lincoln, Y. S., & Guba, E. G. (1985). *Naturalistic inquiry*. Thousand Oaks, CA: Sage.

Lumino, R., Ragozini, G., & Vitale, M. P. (2016). Investigating social support patterns of single mothers from a social network perspective. *International Review of Social Research, 6*(4), 182-194. https://doi.org/10.1515/irsr-2016-0021

Malcom, S. M., & Malcom-Piqueux, L. E. (2013). Critical mass revisited. *Educational Researcher, 42*(3), 176-178. https://doi.org/10.3102/0013189x13486763

Marsden, P. (1988). Homogeneity in confiding relations. *Social Networks*. Retrieved from https://doi.org/10.1016/0378-8733(88)90010-X

Marsden, P. V. (1987). Core discussion networks of Americans. *American Sociological Review, 52*(1), 122-131.

Martinez, A., & Christnacht, C. (2021). *Women making gains in STEM occupations but still underrepresented*. Retrieved from https://www.census.gov/library/stories/2021/01/women-making-gains-in-stem-occupations-but-still-underrepresented.html.

McClain, K. S., & Perry, A. (2017). Where did they go: Retention rates for students of color at predominantly white institutions. *College Student Affairs Leadership, 4*(1), Article 3.

McPherson, M., & Smith-Lovin, L. (1987). Homophily in voluntary organizations. *American Sociological Review, 52*, 10.

McPherson, M., Smith-Lovin, L., & Cook, J. M. (2001). Birds of a feather: Homophily in social networks. *Annual Reviews of Sociology, 271*(1), 30.

Medina, C. N. (2015). *Graduation rates of URM students in STEM disciplines: An examination of institutional differences at selected four year campuses within a large system of public higher education* (Doctoral dissertation). St. John Fisher College.

Melvin, L., & Ginsburg, S. (2018). *Constructivist grounded theory.* Retrieved from https://icenetblog.royalcollege.ca/2018/09/11/appliedmededmethods101-constructivist-grounded-theory/#:~:text=Constructivist%20grounded%20theory%20(CGT)%20is,participant%20interviews%20or%20focus%20groups.

Mendoza-Denton, R., Downey, G., Purdie, V. J., Davis, A., & Pietrzak, J. (2002). Sensitivity to status-based rejection: Implications for African American students' college experience. *Journal of Personality and Social Psychology, 83*(4), 896-918. https://doi.org/10.1037//0022-3514.83.4.896

Mendoza-Denton, R., Pietrzak, J., & Downey, G. (2008). Distinguishing institutional identification from academic goal pursuit: Interactive effects of ethnic identification and race-based rejection sensitivity. *Journal of Personality and Social Psychology, 95*(2), 338-351. https://doi.org/10.1037/0022-3514.95.2.338

Moreira, R. G., Butler-Purry, K., Carter-Sowell, A., Walton, S., Juranek, I. V., Challoo, L., . . . Spaulding, A. (2019). Innovative professional development and community building activity program improves STEM URM graduate student experiences. *International Journal of STEM Education, 6*(1). https://doi.org/10.1186/s40594-019-0188-x

Moren-Cross, J. L., & Lin, N. (2008). Access to social capital and status attainment in the United States. In N. Lin. & B. Erickson (Ed.), *Social capital: An international research program* (pp. 364-379). New York, NY: Oxford University Press.

Morris, J. E., & Parker, B. D. (2019). CRT in education. In J. T. DeCuir-Gunby, T. K. Chapman, & P. A. Schutz (Eds.), *Understanding critical race research methods and methodologies: Lessons from the field*. New York, NY: Routledge.

Murthy, V. H. (2020). *Together: The healing power of human connection in a sometimes lonely world*. New York, NY: HarperCollins.

Museus, S. D. (2008). The role of ethnic student organizations in fostering African American and Asian American students' cultural adjustment and membership at predominantly White institutions. *Journal of College Student Development, 49*, 568-586.

National Center for Education Statistics (NCES). (2020). Table 324.25. Doctor's degrees conferred by postsecondary institutions, by race/ethnicity and sex of student: Selected years, 1976–77 through 2017–18. Retrieved from https://nces.ed.gov/programs/digest/d19/tables/dt19_324.20.asp

National Girls Collaborative Project. (2013). The state of girls and women in STEM. https://ngcproject.org/sites/default/files/documents/ngcpstemstats_web.pdf

National Science Board. (2008). *Science and engineering indicators 2008*. Arlington, VA: Author.

National Science Foundation. (2019). *Women, minorities, and persons with disabilities in science and engineering*. Alexandria, VA Retrieved from https://ncses.nsf.gov/pubs/nsf19304/digest/field-of-degree-minorities#degrees-earned-by-underrepresented-minorities.

Ni, S., Yang, R., Zhang, Y., & Dong, R. (2015). Effect of gratitude on loneliness of chinese college students: Social support as a mediator. *Social Behavior and Personality, 43*(4), 559-566. https://doi.org/10.2224/sbp.2015.43.4.559

Nicolaisen, M., & Thorsen, K. (2014). Who are lonely? Loneliness in different age groups (18-81 years old), using two measures of loneliness. *International Journal of Aging and Human Development, 78*(3), 229-257. https://doi.org/10.2190/AG.78.3.b

Nokkala, T., Ćulum, B., & Fumasoli, T. (2017). Early career women in academia: An exploration of networking perceptions. In H. Eggins (Ed.), *The changing role of women in higher education*. Dordrecht, The Netherlands: Springer.

Okahana, H., & Zhou, E. (2018). *Graduate enrollment and degrees: 2007 to 2017*. Retrieved from https://cgsnet.org/ckfinder/userfiles/files/CGS_GED17_Report.pdf

Ong, M. (2005). Body projects of young women of color in physics: Intersections of gender, race, and science. *Social Problems, 52*(4), 593-617.

Ong, M., Smith, J. M., & Ko, L. T. (2018). Counterspaces for women of color in STEM higher education: Marginal and central spaces for persistence and success. *Journal of Research in Science Teaching, 55*(2), 206-245. https://doi.org/10.1002/tea.21417

Ong, M., Wright, C., Espinosa, L., & Orfield, G. (2011). Inside the double bind: A synthesis of empirical research on undergraduate and graduate women of color in science, technology, engineering, and mathematics. *Harvard Educational Review, 81*(2), 172-208.

Ozben, S. (2013). Social skills, life satisfaction, and loneliness in Turkish university students. *Social Behavior and Personality, 41*(2), 203-213. https://doi.org/10.2224/sbp.2013.41.2.203

Palmer, R. T., Maramba, D. C., & Dancy, T. E. (2011). A qualitative investigation of factors promoting the retention and persistence of students of color in STEM. *The Journal of Negro Education, 80*(4), 491-504.

Park, N., Lee, S., & Kim, J. H. (2012). Individuals' personal network characteristics and patterns of Facebook use: A social network approach. *Computers in Human Behavior, 28*, 1700-1707.

Peplau, L. A. (1984). *Preventing the harmful consequences of severe and persistent loneliness.* National Institute of Mental Health. Retrieved from https://psycnet.apa.org/record/1997-36496-000

Perlman, D. (1988). Loneliness: A life-span, family perspective. In R. Milardo (Ed.), *Families and social networks* (pp. 190-220). Thousand Oaks, CA: Sage.

Perry, B. L., Pescosolido, B. A., & Borgatti, S. P. (2018). *Egocentric network analysis: Foundations, methods and models.* Cambridge University Press.

Pidgeon, M. (2008). Pushing against the margins: Indigenous theorizing of "success" and retention in higher education. *Journal of College Student Retention: Research, Theory & Practice, 10*(3), 22.

Powell, K. (2018). These labs are remarkably diverse — Here's why they're winning at science. *Nature, 558*, 19-22. https://doi.org/10.1038/d41586-018-05316-5

Prell, C. (2012). *Social network analysis: History, theory & methodology*. London, England: Sage.

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 [Press release] Retrieved from https://eric.ed.gov/?id=ED541511

Robertson, R. V., & Chaney, C. (2017). “I know it [racism] still exists here”: African American males at a predominantly white institution. *Humboldt Journal of Social Relations, 39*(39), 260-282.

Rodriguez-Madrid, M. N., Del Rio-Lozano, M., Fernandez-Pena, R., Jimenez-Pernett, J., Garcia-Mochon, L., Lupianez-Castillo, A., & Garcia-Calvente, M. D. M. (2018). Gender differences in social support received by informal caregivers: A personal network analysis approach. *International Journal of Environmental Research and Public Health, 16*(1). https://doi.org/10.3390/ijerph16010091

Rothstein, M. G., & Davey, L. M. (1995). Gender differences in network relationships in Academia. *Women in Management Review, 10*(6), 20-25.

Sailes, G. A. (1993). An investigation of Black student attrition at a large, predominantly White, Midwestern university. *The Western Journal of Black Studies, 17*, 179-182.

Santos, S. J., & Reigadas, E. T. (2005). Understanding the student-faculty mentoring process: Its effects on at-risk university students. *Journal of College Student Retention: Research, Theory & Practice, 6*(3), 337-357.

Schrum, W., Cheek, N. H., & Hunter, S. M. (1988). Friendship in school: Gender and racial homophily. *Sociology of Education, 61*(4), 13.

Scott, J. (1988). Social network analysis. *Sociology*, *22*(1), 109-127.

Scott, J. (2017). *Social network analysis* (4th ed.). London, England: Sage.

Scott, J., & Carrington, P. J. (2011). *The Sage handbook of social network analysis*. Los Angeles, CA: Sage.

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

Sedlack, W. E. (2011). Using noncognitive variables in assessing readiness for higher education. *Readings on Equal Education, 25*, 187-205.

Sidhu, D. (2013, February 18). A critical look at the 'critical mass' argument. *The Chronicle of Higher Education*, 4.

Smedley, B. D., Butler, A. S., & Bristow, L. R. (Eds.). (2004). *In the nation's compelling interest: Ensuring diversity in the health-care workforce*. Washington, DC: National Academies Press.

Smith, D. G. (2015). *Diversity's promise for higher education* (2nd ed.). Baltimore, MD: Johns Hopkins University Press.

Smith, K. P., & Christakis, N. A. (2008). Social networks and health. *Annual Reviews of Sociology, 34*, 405-429.

Sowell, R., Allum, J., & Okahana, H. (2015). *Doctoral initiative on minority attrition and completion*. Retrieved from https://cgsnet.org/ckfinder/userfiles/files/Doctoral_Initiative_on_Minority_Attrition_and_Completion_2015.pdf

Stebbins, S. (2020). Despite growing national diversity, these colleges have the least diverse student bodies. Retrieved from https://www.usatoday.com/story/money/2020/02/13/these-colleges-have-the-least-diverse-student-bodies/41152235/

Suarez, S. A., Fowers, B. J., Garwood, C. S., & Szapocznik, J. (1997). Biculturalism, differentness, loneliness, and alienation in Hispanic college students. *Hispanic Journal of Behavioral Sciences, 19*(4), 489-505.

Sweitzer, V. (2009). Towards a theory of doctoral student professional identity development: A developmental networks approach. *The Journal of Higher Education, 80*(1), 33.

Tate, E. D., & Linn, M. C. (2005). How does identity shape the experiences of women of color engineering students? *Journal of Science Education and Technology, 14*(5-6), 483-493. https://doi.org/10.1007/s10956-005-0223-1

Terhune, C. P. (2008). Coping in isolation: The experiences of Black women in White Communities. *Journal of Black Studies, 38*(4), 547-564.

Thoits, P. A. (2011). Mechanisms linking social ties and support to physical and mental health. *Journal of Health and Social Behavior, 52*(2), 145-161. https://doi.org/10.1177/0022146510395592

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

Toven-Lindsey, B., Levis-Fitzgerald, M., Barber, P. H., & Hasson, T. (2015). Increasing persistence in undergraduate science majors: A model for institutional support of underrepresented students. *CBE Life Sciences Education, 14*(2). https://doi.org/10.1187/cbe.14-05-0082

Tullis, K., & Grunert Kowalske, M. L. (2020). *The composition of social support networks of URM graduate students at predominantly White institutions*. Under review.

United States Census Bureau. (2019). Population estimates. Retrieved from https://www.census.gov/quickfacts/fact/table/US/PST045219.

Unraveling the double bind: Women of color in STEM. (2011). *Harvard Educational Review, 81*(2), 157-161.

Urquhart, C. (2013). *Grounded theory for qualitative research: A practical guide*. Thousand Oaks, CA: Sage.

Utz, R. L., Swenson, K. L., Caserta, M., Lund, D., & deVries, B. (2014). Feeling lonely versus being alone: Loneliness and social support among recently bereaved persons. *Journals of Gerontology: Series B, 69*(1), 85-94. https://doi.org/10.1093/geronb/gbt075

Verbrugge, L. M. (1977). The structure of adult friendship. *Social Forces, 56*(5), 26.

Waldeck, J. H., Orrego, V. O., Plax, T. G., & Kearney, P. (1997). Graduate student/faculty mentoring relationships: Who gets mentored, how it happens, and to what end. *Communication Quarterly, 45*(3), 93-109.

Walton, G. M., & Cohen, G. L. (2007). A question of belonging: Race, social fit, and achievement. *Journal of Personality and Social Psychology, 92*(82-96).

Wang, J., Leu, J., & Shoda, Y. (2011). When the seemingly innocuous "stings": Racial microaggressions and their emotional consequences. *Personality & Social Psychology Bulletin, 37*(12), 1666-1678. Retrieved from https://doi.org/10.1177/0146167211416130

Wellman, B., & Wortley, S. (1989). Brothers' keepers: Situating kinship relations in broader networks of social support. *Sociological Perspectives*, 32(3), 273-306.

Wellman, B., & Wortley, S. (1990). Different strokes from different folks: Community ties and social support. *American Journal of Sociology*, 96(3), 558-588.

Williams, S. N., Thakore, B. K., McGee, R., & Price, R. (2017). Providing social support for underrepresented racial and ethnic minority PhD students in the biomedical sciences: A career coaching model. *CBE—Life Sciences Education, 16*(4). https://doi.org/10.1187/cbe.17-01-0021

Willie-LeBreton, S. (2011). HBCUs: Continued relevance in the new century. In L. M. Stulberg & S. L. Weinberg (Eds.), *Diversity in American higher education: Toward a more comprehensive approach*. Ney York, NY: Taylor & Francis.

Yanguas, J., Pinazo-Henandis, S., & Tarazona-Santabalbina, F. J. (2018). The complexity of loneliness. *Acta Biomedica, 89*(2), 302-314. https://doi.org/10.23750/abm.v89i2.7404

Zhao, J., Kong, F., & Wang, Y. (2012). Self-esteem and humor style as mediators of the effects of shyness on loneliness among Chinese college students. *Personality and Individual Differences, 52*(6), 686-690. https://doi.org/10.1016/j.paid.2011.12.024

Appendix A

Human Subjects Institutional Review Board Approval Letter

Date: June 19, 2014

To: Megan Grunert, Principal Investigator
Jocelyn Steinke, Co-Principal Investigator
Susan Stapleton, Co-Principal Investigator

From: Amy Naugle, Ph.D., Chair

Re: HSIRB Project Number 14-06-16

This letter will serve as confirmation that your research project titled "AGEP: BPR: Understanding URM STEM Graduate Students' Identity Integration and Assimilation into a Community of Practice" has been **approved** under the **expedited** category of review by the Human Subjects Institutional Review Board. The conditions and duration of this approval are specified in the Policies of Western Michigan University. You may now begin to implement the research as described in the application.

Please note: This research may **only** be conducted exactly in the form it was approved. You must seek specific board approval for any changes in this project (e.g., ***you must request a post approval change to enroll subjects beyond the number stated in your application under "Number of subjects you want to complete the study***)." Failure to obtain approval for changes will result in a protocol deviation. In addition, if there are any unanticipated adverse reactions or unanticipated events associated with the conduct of this research, you should immediately suspend the project and contact the Chair of the HSIRB for consultation.

Reapproval of the project is required if it extends beyond the termination date stated below.

The Board wishes you success in the pursuit of your research goals.

Approval Termination: June 18, 2015