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Latinx Students in STEM Education Research: A CRT and LatCrit Analysis of NSF

Funded Projects

by

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Latinx Students in STEM Education Research: A CRT and LatCrit Analysis of NSF

Funded Projects

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This thesis used Critical Race Theory (CRT) and Latino Critical Race Theory (LatCrit) to conduct an in-depth analysis of whether literature funded through the use of National Science Foundation (NSF) research awards perpetuates race, racism, or other interacting systems of oppression in the research or if the investigators resisted inequalities against Latinx students in STEM research. This thesis examined how the investigators of twenty NSF-funded articles examined the experiences of Latinx students in STEM. From a CRT and LatCrit lens I analyze articles to see if and in what ways researchers are complicit with oppression and which ways they resist. I argue that investigators not acknowledging racism and sexism in their research is as detrimental to Latinx students as it is to educational research. I also argue that investigators resisted inequalities with the use of culturally relevant approaches and practices. I found that the use of culturally appropriate approaches and counterstories identified Latinx students as holders and creators of knowledge and brought their ways of knowing from the margins to the center of research. In contrast, I found that research articles that maintained dominant ideologies such as meritocracy disadvantaged Latinx students, perpetuated inequality in higher education, and negatively influences research.

ACKNOWLEDMENTS

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Chapter 1

Background and Overview of the Study

In the past decade, STEM education has gathered plenty of scholarly and media attention as President Obama, federal agencies, and private organizations such as the Gates Foundation and the Lumina Foundation have all brought attention to the need to better prepare students in Science Technology Engineering and Mathematics (STEM) fields while increasing diversity in STEM education and the workforce. As more jobs in STEM fields become available, the Latinx student population would be the next logical potential source of talent considered by national organizations and agencies. In 2015, Latinx students earned 11.49% of all bachelor degrees awarded in the United States (U.S. Department of Education, 2016b) and received 9.59% of all total bachelor STEM degrees (U.S. Department of Education, 2016c.). As majority minority these trends have a direct consequence on Latinx representation in the STEM workforce, national figures have Latinx making up only 8% of the science and engineering occupations (National Science Foundation (NSF), National Center for Science and Engineering Statistics (NCSES), 2017). Based on these statistics, calls for increased diversity in STEM education will continue in the hopes that Latinx and other underrepresented populations join the STEM fields.

Though Latinx students are generally underrepresented in STEM, enrollment trends show that Latinx representation varies depending on institution type and fields of study. *Excelencia* in Education. (2015) reported that in 2013 Hispanic Serving Institutions (HSIs) conferred 33% of all STEM degrees earned by Latinx students in the United States. This means that 2% of the nation's institutions of higher education

awarded a third of all STEM degrees earned by Latinx students (*Excelencia* in Education, 2015). In its 2017 edition of the *Women, Minorities, and Persons with Disabilities in Science and Engineering Report* the NSF reported that out of all science and engineering bachelor degrees conferred, Latinx earned the most in biological science fields (9.78%) and the least in Mathematics and Statistics (7.9%) (NSF, NCSES, 2017).

Currently educational research literature concerning Latinx students' attainment in STEM fieldshas revolved around four main research points; (a) demographic factors, (b) precollege factors, (c) environmental pull factors, and (d) college variables. In the literature, research studies conducted to investigate students' demographic variables (e.g. gender, class, race) make the connections between the student and their institution and how that relates to persistence and degree attainment (Cole & Espinosa, 2008). Often research studies investigating Latinx students precollege experiences (e.g. high school academic achievement, test scores, college-prep) look for connections between these precollege variables and students' experiences and academic success rates while in college (Brown, Tramayne, Hoxha, Telander, Fan, & Lent, 2008; Lee, Flores, Navarro, & Kanaguini-Muñoz, 2015; Tyson, 2011). On the other hand, research studies looking at the students' environmental pull factors (e.g. debt, financial aid availability, family responsibilities consider whether student attitudes and ability to remain in their program are influenced by variables outside of educational life (Martinez & Fernández, 2004; Longerbeam, Sedlacek, & Alatorre, 2004). Finally, studies on institutional variables demonstrate whether institutional variables (e.g. academic courses, institutional climate, teaching pedagogies) influence students' degree commitment and attainment (Brown et al., 2008; Johnson, 2012).

Statement of the Problem

Although there is a stated need for diversity in the United States STEM workforce and there have been numerous institutional and agency calls for proposals on diversity and STEM education research, there is a limited amount of funded literature conducted with the sole purpose of documenting Latinx students experience in STEM education. Federal agencies such as the National Science Foundation (NSF), the National Institutes of Health (NIH), the U.S. Department of Agriculture (USDA), and the National Institute of Food and Agriculture (NIFA) among others have all provided grants to support STEM education and research projects. Several of these grants focus on Latinx enrollment, engagement, degree completion, and Hispanic Serving Institutions (HSI) outcomes (White House Initiative, 2017). Private organizations like the Gates Foundation and the Lumina Foundation have also provided grants focusing on improving STEM education and increasing the number of students who graduate with STEM degrees. Collectively, federal grants and foundation grants have a tremendous influence on education practice and policy due to substantive dollar amounts distributed, the competition for those funds, and their role in institutional performance measures and researcher tenure decision. The literature that researchers produce shapes practice as well as the public perception of Latinx STEM students so it is important to understand the nature, along with the content, of the literature currently available and ascertain how research might best serve this growing population of students.

The nature of the literature matters since current research concerning Latinx student in higher education and in STEM focuses on identifying trends. For example Villafane, Garcia, & Lewis's (2014) study that investigate minority students self-efficacy

trends in Chemistry or Chang, Sharkness, Hurtado & Newman's (2014) study that examined the factors that contribute to the persistence of minority students. Research like this can be attributed to dominant perspectives in which the STEM environment is taken for granted as established and ideal. There is little acknowledgement that the environment has been shaped by white cultural norms that marginalize other cultural values (Bernal, 2002; Bernal, 2013). For example, Johnson (2007) explored how the culture of science is closely aligned with the cultural skills of White middle class men making it hard for women, in particular women of color, of to fit in. Success in STEM requires a single-minded focus on individual goals that can be in conflict with communitarian obligations that students of color may have. If institutions moved, away from the dominant ideologies and norms in STEM education minority groups would stop looking like special cases and White male traits would no longer be the baseline (Johnson, 2007). However, because the STEM environment is taken for granted as ideal by the researchers that author articles and studies concerning the STEM education, the students are positioned as variables under study and this leaves little space to analyze the context behind students in STEM. It is in situations like this where context is needed in order to determine whether researchers are complicit in existing societal oppression or resisting it to meet students' needs (Byars-Winston, 2014; Cantu, 2012; Ladson-Billings & Tate, 1995; Scheurich & Young, 1997). Without the context, researchers may not fully understand the problem. Information about the growing population of Latinx students in STEM programs, which is in need of more scholars and scientists, is sparse. Given that society has a significant need for Latinx scholars, some may argue educators and student affairs professionals have an imperative need to provide quality education to all students

regardless of the background (College Student Educators International (ACPA) & Student Affairs Administrators in Higher Education (NASPA), 2015). Additionally, as there is evidence that racism and sexism influence educational environments and student experiences (Solorzano, 1998; Sólorzano, 2005; Villalpando, 2004), researchers need to understand the experiences of Latinx students in STEM environments more comprehensively.

Purpose Statement and Research Question

The primary purpose of this study was to develop a greater understanding of the literature on Latinx students in STEM produced by investigators who earned NSF awards in order to make recommendations directed at researchers who seek to support the success of Latinx students in STEM through research. Utilizing Critical Race Theory (CRT) and Latino Critical Race Theory (LatCrit) I analyzed publications to see if and in what ways researchers are complicit with oppression and which ways they resist. The research question is In what ways are NSF funded researchers of Latinx students in STEM complicit in and resisting oppressive ideologies and practices as described in LatCrit and CRT?

Theoretical and Analytical Frameworks

The theoretical and analytical frameworks guiding this study are CRT and the related LatCrit theory. In education, CRT and LatCrit are critical race-gendered frameworks that challenge traditional Eurocentric interpretations of students of color as lacking the knowledge, skills, and abilities to succeed in higher education (Bernal, 2002). Privileging the Eurocentric values is problematic because they differ from those that Latinx students experience at home and in their communities and continue to "adherence

to Eurocentric perspectives that are founded on cover and overt assumptions regarding white superiority, territorial expansion and 'American' democratic ideals such as meritocracy, objectivity, and individuality." (Bernal, 2002, p.11). The prioritization of the Eurocentric perspective over Latinx perspectives reinforces the inferiority paradigm where Latinx cultural capital and viewpoints are characterized as less than that of the dominant white majority in higher education. Continuous prioritization of Eurocentric views attributes to Latinx students to be seen as "different" and contributing something "foreign" to American higher education (Johnson, 1997; Johnson, 2000). Adherence by Latinx student to attributes and norms considered to be "other" is viewed by the dominant group to be an assault on the normative American academic identity while also being seen as a defiance by Latinx students who fail to assimilate or even acclimate to America's Anglo-Saxon and Germanic education cores.

Often inequitable environments result in Latinx immigrant students facing issues of self-doubt, survivor guilt, impostor syndrome, invisibility, and hopelessness that may be experienced regardless if they find success or not and may contribute to feelings of being "less than" their peers (Solorzano & Yosso, 2001; Villegas, 2009). The characterization of students as "foreign" or "other" and the mismatches between the values of students' home culture (e.g. interpersonal connectedness, collaboration) and the values of university culture (e.g. individualism, competition) further enforces the inferiority paradigm by property rights. These mismatches create a barrier in Latinx students' support systems, increasing stress and leading students to struggle to see themselves as full members of the university community (Villegas, 2009). Policies in many institutions of higher education reflect Eurocentric norms and values, perpetuating

privileges for the dominant group and continuing marginalization or exclusion based on

Latinx membership (or lack thereof) (Delgado Bernal, 2002). Many students find it hard

accessing opportunities in higher education settings and this can be attributed to the fact

that universities and other institutions of higher education reward the culture of the

dominant White middle class (Horvat, Weininger, & Lareau, 2003). Researchers are now

attempting to understand the experiences of racial minority groups in STEM due to

federal initiatives like the Hispanic-Serving Institutions - Science, Technology,

Engineering, or Mathematics (HSI STEM) and Articulation Programs. The HSI STEM

program seeks to (a) increase the number of Latinx and other low-income students

attaining degrees in STEM fields; and (b) develop model transfer and articulation

agreements between two-year and four-year institutions and STEM curriculums (Higher

Education Act, 2008). In this study, I review articles using CRT and LatCrit lenses in

order to examine the ways that researchers are complicit with oppressive ideologies and

practices and the ways that they resist them.

     Solórzano (1998) outlined five defining elements of CRT in education and Bernal

(2002) further expanded these tenets to encompass elements of LatCrit. Bernal (2002,

pp.109-110) listed these five tenets of CRT and LatCrit :

1. The importance of transdisciplinary approaches (challenges ahistoricism and

    the unidisciplinary focus prevalent in education)

2. An emphasis on experiential knowledge (use of counter-stories and

    narratives)

3. A challenge to dominant ideologies (critique of meritocracy and color/gender

    blindness)

4. The centrality of race and racism and their intersectionality with other forms of subordination

5. A commitment to social justice

I used these five tenets in this study to analyze the articles produced through NSF funded studies.

Both CRT and LatCrit frameworks attempt to account for the contradictions and inconsistencies in legal thought, and later policy, which have shaped and continued to guide research, the development of institutional policies and practices, and the public perceptions of Latinx students (Villalpando, 2004). Often law and educational policy claim to be just, fair, and neutral but critical analysis based on the historical and legal background of the United States, the historical treatment of minority groups, and the prevailing views of Latinx student populations indicate that there is systematic inequality present that is ignored. Individuals who question or resist such a system are often dismissed or punished for not adopting the accepted social capital and norms.

CRT scholars Ladson-Billings and Tate (1995) identified three proposals that not only help explain inequities in education but also support race-based inquiries: (a) race continues to be a significant factor in determining inequity in the United States where the notion of race is still commonly utilized to explain the different economic and social classes; (b) The United States social structure, practices, and law are based on property rights. The legacies of slavery and early capitalism and their connection to property rights have created a paradigm where those with better property (i.e. more wealth) are entitled to better schools and those with less property are forced into inferior schooling; (c) The intersection of race and property rights can be examined to understand social inequities in

education. Inquiries at this intersection help us understand social inequities, they help explain the results of inequity as it is found in law, policy, and research.

Those propositions can help educators understand how law affects students of color in higher education. Examples can be found in outcomes of Supreme Court cases such as Regents of the University of California v. Bakke or Grutter v. Bollinger. In these cases, institutions argued the race-based admissions to be necessary to the attainment of a critical mass of students from minority groups. Such policies were deemed beneficial because minority students would not be isolated or tokenized while also providing the dominant group with opportunities to interact with student populations they typically would not have. In other words, the property rights of those in the dominant group (i.e. better education) entitle them to the benefits minority students can provide for them (i.e. diverse viewpoints). This results in an interest-convergence situation in which progress towards equality depends on whether such opportunities best serve the interest of affluent White society (Baber, 2015). In the case of admissions, interest-convergence occurs when admissions that look at factors beyond test scores (i.e. socio- economic opportunities or race) are accepted as long as the benefits gained by minority groups do not take away from the dominant group. CRT and LatCrit research conducted on the results of these cases or the results of race-based admissions policies at institutions will continue to look for the benefits the cases outlined.

According to CRT and LatCrit Latinx students might experience varying degrees of oppression at all points of their education (Solorzano et al, 2005; Villalpando, 2004). Therefore, this study will evaluate the ways in which researchers have accounted for race, racism, and other interlocking systems of oppression in their examination of students'

experiences. Additionally, CRT and LatCrit state that the recognition of Latinx students as holders and creators of knowledge should also be acknowledged, especially by those documenting their experiences (Bernal, 2002; Cantu, 2012). In this thesis, I examine the literature produced by NSF-funded investigators with these things in mind to determine in what ways researchers are complicit with oppressive ideologies and practices documented in CRT/LatCrit and to look for ways that they are resisting them by elevating the cultural values and perspectives of the Latinx students.

Definition of Terms

For this thesis, the following definitions will be used throughout the study:

CRT: Acronym for Critical Race Theory. A theory that challenged the dominant discourses on race and racism by examining how educational theory, policy, and practice are used to subordinate certain racial and ethnic groups (Solorzano, 2010).

Eurocentric: A network or grid of broad assumptions and beliefs of the dominant Wester/European/Anglo-Saxon culture and the way it constructs the nature of the world and one's experiences in it (Bernal, 2002)

Epistemologies: The nature, status, and production of knowledge i.e. ways of conducting and understanding research (Bernal 2002)

HSI: Acronym for Hispanic Serving Institutions and defined by the Higher Education Act as degree-granting institutions with at least 25% of full time undergraduate student enrollments being of Latinx decent (Hispanic Association of Colleges & Universities (HACU), 2017)

LatCrit: Acronym for Latino Critical Race Theory. A theory that illuminates on Latinx multidimensional identities and can address the intersectionality of racism, sexism, classism, and other forms of oppression (Bernal, 2002)

Latina: Term referring to females of Latin American origin or descent who live in the United States (Latina, n.d.).

Latino: Term referring to males of Latin American origin or descent who live in the United States (Latino, n.d.).

Latinx: Term that refers to a person of Latin American origin or descent who live in the United States. Utilized as a gender-neutral/non-binary alternative to the collective term Latinos (Latinx, n.d.). I will utilize this term throughout the paper.

MSI: Acronym for Minority Serving Institutions and defined by the Higher Education Act as degree-granting institutions with at least 50% of its full time undergraduate student enrollments being of a single minority group as defined by the HEA or of a combination of those minority groups (United States Department of Education, n.d.)

Oppression: Prolonged cruel or unjust treatment or exercise of authority

S&E: An NSF acronym for science and engineering.

STEM education: Term referring to STEM curriculum at institutions of higher education.

STEM: Science, Technology, Engineering, and Mathematics. The NSF definition of this acronym includes natural sciences, computer and information sciences, engineering, mathematics, and the social and behavioral sciences.

Significance of the Study

With the current lack of NSF-funded literature concerning the experiences of Latinx students in STEM, this study aims to provide a critical analysis of the literature resulting from NSF awards. As a major federal funding source for the country, the NSF received a $7,472 billion budget for the 2017 year of which the agency directed $880 million to the Directorate for Education and Human Resources (EHR) (NSF, 2017b), the NSF directorate which produces the majority of grants and awards for research concerning learning and STEM education. The NSF has built a reputation as go-to resource for funding regarding scientific research; however, throughout the decades the NSF has expanded its interest to include the improvement of STEM education. Along with a reputation as an elite funding source, the NSF has published clearly outlined plans and goals for the improvement of STEM instruction and the enhancement of STEM experiences for undergraduate and graduate students. In its yearly financial report outlines plans to better serve groups historically under-represented in STEM field, improve STEM graduate student preparedness for entering the workforce, and to integrate education and research to support the development of a diverse STEM workforce with cutting-edge capabilities (NSF, 2017a). The NSFs interest in only accepting the best research proposals submitted is reflected in the quality and rigor of its merit review process. In order to be accepted research proposals must met the intellectual merit and the broader impacts criterions of the NSFs merit review process, criterion that are designed to communicate to the potential investigators the importance the NSF places on a proposals potential to benefit society or advance societal outcomes (i.e. social benefits) (NSF, 2017a). By earning an NSF award these investigators are provided substantial amounts of money that allows them the opportunity to collect notable data

sets and expand their research sites while the prestige of having passed the NSFs rigorous review process often adds to the studies' prestige, even if the investigators are not representing the NSF.

By conducting an analysis of the articles utilizing CRT and LatCrit lenses the goal is to better understand NSF funded studies and the literature they produce by using CRT and LatCrit to identify and critique oppressive research practices towards Latinx students as well as practices that might resist dominant norms. By analyzing the articles utilizing CRT and LatCrit tenets it will be possible to better understand NSF-funded literature. From this understanding, I will make suggestions with the hopes of creating a transformative change in the way STEM education research is conducted. Current research practices have studied the Latinx experience in higher education through a Eurocentric perspective resulting in research findings that maintain the dominant narrative making a study like this necessary in order to identify issues with current literature (Bernal, 2002). When investigating the experiences of students in higher education researchers often utilize theories and models developed by different fields of study, like CRT was initially created for use in law but is now used in education. If improperly applied, this transdisciplinary use of theories and models can preserve hegemonic methodologies, epistemologies, and ideologies that are harmful not only to Latinx students but all underrepresented students in higher education (Bernal, 2013). Due to the According to Scheurich and Young (1997) one of the negative consequences of epistemological racism is that epistemologies and research that arise out of other histories (e.g. African American or Latinx social histories) are not considered legitimate within the mainstream research communities. Finally, dominant epistemologies implicitly favor

White people because they accord most easily with their (i.e. White) social history (Scheurich & Young, 1997). In this critical analysis of NSF-funded articles, I hope to illuminate dominant norms, which may perpetuate oppressive practices, and ways researchers are resisting norms by analyzing some of the more influential research present in current literature. Since institutions are seeking increasing numbers and diversity of STEM students, the goal of this study is to recommend research strategies that will resist dominant norms of oppression of Latinx people.

Chapter 2 will provide a review of literature of Latinx in higher education, Latinx students in STEM, and an overview of CRT and LatCrit. Chapter 3 will describe the methodology of this study utilizing CRT and LatCrit. Chapter 4 will provide the results of the analysis utilizing CRT and LatCrit tenets. Finally, Chapter 5 will conclude the study by discussing the results and implications of the findings and include the recommendations that emerge as a result of the article analysis as well as suggestions for future research.

<center>**Chapter 2**</center>

<center>**Literature Review**</center>

This literature review explores two main themes through the lenses of Critical Race Theory (CRT) and Latino Critical Race Theory (LatCrit). First, a brief overview of the results of research shaped by dominant epistemologies is reviewed. Second, literature that discussed the application of CRT and LatCrit on research conducted concerning Latinx in higher education.

<center>**Literature on Latinx Students in Higher Education and STEM**</center>

Prior research has attempted to explain why Latinx students are underrepresented in higher education and in specific fields however literature examining specifically Latinx student in STEM is still quite limited. Based on the CRT and LatCrit lens employed in this study I theorize that some of the limitations are a result of Eurocentric epistemologies shaping research practices in the United States. Therefore, in order to understand how researchers are conducting research on the educational experiences of Latinx in STEM, it is important first provide an overview of the known factors affecting Latinx academic success. In Chapter 1 I stated that current educational research on Latinx students and their experiences in higher education revolve around four main research points (a) demographic factors, (b) pre-college factors, (c) environmental factors, and (d) college variables. In this section I will elaborate on what researchers learned about Latinx student success when they focused on these key points.

Factors Affecting Academic Success

Pre-college factors. Researchers investigating Latinx student experiences while in STEM programs have attributed a significant part of Latinx successful persistence to

the characteristics and skill sets they accumulated and brought with them to college. Pre-college experiences such as mathematics and science high school coursework (Heilbronner, 2001; Tyson, 2011), college-prep (Villafañe, Garcia, & Lewis, 2013), high school grade point average (Lee, Flores, Navarro, & Kanaguini-Muñoz, 2015; Brown et al., 2007), and test scores (Brown et. al., 2008) are utilized to predict student success. Having prior high school classroom experience in science and mathematics that is challenging and interactive may lead to students becoming interested in STEM majors and the possibility of the field being a career option (Heilbronner, 2001). While high school coursework introduces students to the possibilities in STEM, college-level preparation courses have the potential of increasing Latinx students' self-efficacy (i.e., confidence in one's ability to accomplish academic tasks successfully) concerning higher level STEM courses (Villafañe et al., 2013). High school grade point averages and standardized admissions tests are often utilized to predict future college grade point average potential (Brown et al., 2008) and Latinx students' persistence (e.g., retention) in STEM (Lee et al., 2015). In many studies, high school GPA and test scores are taken as measures of pre-college academic preparation (Moakler & Kim, 2014).

Transfer programs. In research, successful transfer programs are viewed as vital in recruiting and retaining Latinx students. They also help community college transfer students succeed in STEM. In Reyes' (2011) study, transition programs were found to facilitate the transition between community colleges and STEM programs in four-year institutions are vital in retaining Latinx students. After the transfer into their new institution, students often have to deal with feelings of isolation and invisibility because many enter small STEM departments or into programs with cohorts. Because STEM

departments or programs are often small, transfer students report feeling like outsiders who don't fit into the established culture developed in the prior school year(s) (Reyes, 2011). Students can feel excluded from established study groups and face difficulties developing the social networks and social capital same-year peers had semesters to build (Reyes, 2011). These feelings of isolation were increased when the student had off-campus responsibilities to family and employment; these time restrictions further limit the opportunities to initiate social networking within student groups and activities (Reyes, 2011).

While transfer programs may not eliminate students' feelings of isolation they do provide resources that are vital to STEM students' successful transfer into a new institution. These programs often include mentoring, paid undergraduate research, and workshops that help students learn to balance personal, professional, and demands (Bensimon & Dowd, 2009; Suarez, A. L., 2003). Transfer programs often target known factors of retention and degree completion and without the institution providing these tools transfer students would have to gather information on career choices and opportunities for research and graduate school own their own (Bensimon & Dowd, 2009). Transfer programs can help ease students' transition into new institutions, can limit students' isolation, and can make climates feel more welcome. While transition programs may not be able to make STEM climates feel entirely welcome to transfer students, such programs when paired with educational factors (e.g., faculty-student interactions, research opportunities) can help minority students adapt to STEM programs and may make STEM climates seem less hostile (Bensimon & Dowd, 2009).

Undergraduate Research Experiences. Research opportunities have been shown to encourage STEM participation for Latinx student and students receive multiple benefits from their participation. Chang, Sharkness, Newman, and Hurtado (2014) found that underrepresented students who participated in undergraduate research programs increased their chances of obtaining or continuing to progress toward completing a STEM degree by 17.4 percentage points (Chang et al., 2014). Latinx students that take part in a well-structured undergraduate research programs receive benefits such as an enhancement of their knowledge and comprehension of sciences (Hunter, Laursen, & Seymour, 2006). Well-designed research programs clarify graduate school or career plans in STEM (Eagan et al., 2013; Hurtado, Cabrera, Lin, Arellano, Espinosa, 2009) and offer professional opportunities that develop students' scientific self-efficacy (Carpi, Ronan, Falconer, & Lents, 2017). Participating in research gives Latinx students an opportunity to engage in a practical application of their coursework while improving their STEM performance and competence. Improved self-efficacy results in Latinx students feeling more connected to their STEM programs because they begin to consider science as part of their identity (Carlone & Johnson, 2007; Espinosa, 2011). Latinx students who feel connected to their STEM department are also more likely to persist in their field (Carlone & Johnson, 2007).

Finances. The issues of funding higher education are a major cause of concern for Latinx students. High-achieving low-income Latinx students enroll in less selective colleges because they view their attendance at elite institutions as unviable (i.e., undermatching), a perspective shaped by limited knowledge of financial aid opportunities available to them and familial economic situations (Rodriguez, 2015). The ability to

finance their college education has remained a significant barrier and source of stress for many high-achieving Latinx students and can be a cause of departure because Latinx students view their education to be too costly for them or their families to afford (Rodriguez, 2015; Suarez, 2003). Longerbeam, Sedlacek, and Alatorre (2004) reported to that Latinx student are more likely to work, work longer hours, and to drop out of college for financial reason than non-Latino students.

Climate. In many studies Latinx students are often found to arrive on campuses with various levels of preparation resulting from uneven precollege education experiences. Any disconnect they experience in the academic environment at college is heightened and affects the students' sense of belonging (Johnson et al., 2007). Entering STEM programs Latinx students often experience negative racial climates and are confronted by racial and sexist stereotypes that question their academic abilities (Brown et al., 2008; Tate & Linn, 2005). As Johnson (2012) states, such a negative racial climate holds Latinx students back from identifying with their STEM fields. When a Latinx student feels marginalized, the students' sense of belonging in the institution is affected, which can ultimately influence a Latinx students' intent to persist and can lead to the possibility of student departure (Flores, 2011).

Faculty Influences and Support. In literature, faculty-student relationships are found to be critical to student success. Faculty share insight accumulated through experience, giving the student a more personalized account of the educational and career paths from a trusted source. Beyond helping students overcome barriers created by institutional bureaucracy, faculty members also help facilitate the students' sense of belonging to the institution and helps students develop the cultural capital needed to

succeed in STEM (MacLauchlan, 2006). Faculty will continue to play a role in student experiences and success mainly through their courses, formal and informal mentoring, and their research agendas (Turner, Gonzalez, & Wood, 2008). Faculty committed to nurturing students often chose to do so by involving the students in research projects. In particular, faculty of color are more likely mentor marginalized students but include students of color their research project and promote an equitable climate in their classrooms (Contreras & Contreras, 2015). Positive faculty-student interactions help curve a students' feelings of isolation, limit the students' marginalization in the department, and introduce opportunities for Latinx students to gain the skills needed to succeed in STEM.

Mentorship and Role Models. In research concerning Latinx students' cultural capital, many low-income, first-generation, Latinx students navigate higher education without the guidance and mentorship that parents with degrees often provide (Wilson et al., 2012) making mentorship vital in promoting Latinx in STEM fields. Research shows that, when appropriately done, mentoring can be a primary source of emotional support, confidence, and guidance that positively promotes academic engagement and achievement (Martin & Dowson, 2009). Mentoring can occur in a variety of environments and situations but is identified as formal (e.g., in-class and set up by the institution) and informal (e.g., outside of class and happening organically) in either situation, mentored students were reported to have higher grade point averages and showed increased rates of persistence and degree completion (Crisp & Cruz, 2009). A lack of consistent mentorship does the opposite, Latinx students find it hard adjusting to

collegiate culture, have a harder time finding resources and opportunities, and are less motivated to stay in STEM (Taningco, 2008).

Role of Family. Family has always been considered to play a crucial role in Latinx students' academic success and persistence. In 2000, Hurtado published about the important role family has on retention of students while Gandara (2005) found that maintaining family relationship is an important factor impacting the adjustment of full time students when entering college. Latinx students' decisions to live off campus during the first year of college can be explained by familism as well. In a survey conducted by Johnson, Elder, and Stern (2005) students expressed their belief that it was important to live near their parents. The emotional and financial support that influence these decisions are significant when considering that a large portion of Latinx students are first-generation students with limited knowledge of U.S. academia and no established support networks in higher education institutions.

The benefits of familism are many but students often report having to juggle two separate identities. A clear division is often pointed out by students who have to prioritize between their academic identity and the cultural identity shaped by their family and community (Saunders & Serna, 2004). Additional difficulties are felt by the Latinx students when familial obligations and needs come into conflict with the students' academic obligations (Saunders & Serna, 2004). Often, students of color describe the feeling of having to decide between family and culture and school success, leading students with higher levels of family struggles and needs to experience higher levels family achievement guilt (Covarrubias & Fryberg, 2015). Family achievement guilt is a term that explains the guilt experienced by student when the guilt is related to the student

surpassing the achievements of family members (Covarrubias & Fryberg, 2015). Students who report family achievement guilt are often distressed between the distance created between themselves and their families after time spent in higher education. Many first generation students chose a career in which they could not only provide for themselves but for their families as well, placing a high value in finishing and obtaining a degree. (Boden, 2012; White et al. 2008).

CRT and LatCrit in Latinx Education Literature

CRT and LatCrit are important lenses by which to analyze research practices and institutional structures as contexts that systematically marginalize Latinx and other non-dominant groups in STEM education and research. For example, institutions of higher education tend to reflect Eurocentric norms and values and, in doing so, perpetrate privileges and marginalization or exclusion based on Latinx membership (or lack thereof) (Delgado Bernal, 2002). Because educational standards are based on Eurocentric norms it makes sense that Eurocentric epistemological perspectives shape the practices of researchers as well. In order to understand how research practices can be influenced by the same Eurocentric norms it is important to provide an overview of how researchers can use CRT and LatCrit to analyze how Eurocentric norms influence the experiences of Latinx in higher education.

Application of CRT and LatCrit on Latinx Education Research

This study utilizes both Critical Race Theory (CRT) and Latino Critical Race Theory (LatCrit) as the lens of analysis in this study. Initially created as theoretical frameworks in the field of law, in education CRT and LatCrit both explore the ways that laws, policies, institutional structures, and practices that do not mention race (i.e., race-

neutral) perpetuate racial, ethnic, and gender subordination (Sólorzano, Villalpando, & Oseguera, 2005). Federal courts have established a rigorous standard of judicial review called *strict scrutiny* on laws or policies that (a) treat individuals differently because of their race or ethnicity and (b) that provide opportunities or benefits that are of consequence based on that different treatment (e.g., school admittance). While federal definitions are essential when considering educational policy, CRT and LatCrit go beyond what is and isn't race-neutral or race-conscience (Bernal, 2002). These theoretical frameworks challenge the notion of color blindness (Sólorzano, Villalpando & Oseguera, 2005) and race/gender neutrality (DeCuir & Dixson, 2004) as well as the myth of equal opportunity for all students (Solorzano & Yosso, 2001; Villalpando, 2004; Yosso et al., 2009). United States law has a historical background privileging property rights, shaped by Eurocentric perspectives (Ladson-Billings & Tate, 1995). These same perspectives have also informed institutions of higher education in the United States. With this history, CRT and LatCrit emphasize the importance of analyzing policies, laws, and the making of them within a historical and cultural context informed by the perspectives of people of color to deconstruct their racialized or otherwise oppressive meaning (Crenshaw, Gotanda, Peller, & Thomas, 1995; Solorzano, Villalpando, & Oseguera, 2005).

The laws and policies that regulate higher education do not exist in an environment free of outside influence. It makes sense that CRT and LatCrit scholars analyzing the educational inequities and racialized barriers Latinx students face in higher education consider variables that affect the underachievement and underrepresentation of Latinx in higher education. This type of analysis challenges the established ideas of neutrality, colorblindness, and meritocracy because it sheds light on how policy and law

oppress people of color while further advantaging Whites (Delgado & Stefancic, 2001). In American education, meritocracy is an ideal based on the social and economic power of hard work (e.g., "pulling one's self up by the bootstraps"), strong will (i.e., grit), and equal opportunity for all regardless of one's race, gender, or social standing in the United States. Neutrality and color blindness are informed by a belief in equal opportunity for all. Based on these ideals, some scholars argue STEM education law, policy, and practice should be deemed to be without political stances or position (Martin, Gholson, & Leonard, 2010) and thus should not treat individuals differently based on their race, ethnicity, or other salient identities (DeCuir & Dixson, 2004). According to CRT and LatCrit, institutions of higher education utilize dominant ideologies such neutrality, colorblindness, and meritocracy to buffer the institution from directly addressing the roots of inequality in STEM education that advantage the dominant group (Sólorzano, Villalpando, & Oseguera, 2005). CRT and LatCrit literature explain that dominant ideologies in higher education policy and practice create environments unfavorable for Latinx students. In these environments, institutions can implement a standardized system for selecting STEM talent that privileges students from particular backgrounds (Sólorzano, Villalpando, & Oseguera, 2005). They also maintain persistent stereotypes that require Latinx students in STEM to prove themselves to be capable. Further, the myth of meritocracy provides a rationale for maintaining the established status quo (Barber, 2015).

Both CRT and LatCrit scholars who have conducted studies analyzing the experiences of Latinx students in education (both STEM and non-STEM) have found that institutions utilize self-serving notions of meritocracy, colorblindness, and neutrality.

These ideas often oppress people of color while advantaging White and privileged students. They also serve to maintain the institution's status. In their CRT analysis of educational inequities and racialized barriers Sólorzano, Villalpando, and Oseguera (2005) state that intuitions adopt alleged meritocratic measures of academic potential that purposely maintain racially segregated educational environments. They describe how academic potential is often measured by institutions who use tools such as standardized admissions exams (e.g., SAT and ACT), which are deemed to be "objective" and "unbiased" by Eurocentric perspectives and norms but studies have shown favor Whites and the wealthiest students. Practices of meritocracy like using standardized test scores allow institutions to act on fears of enrolling students perceived to be underprepared and unmotivated (Sólorzano, Villalpando, & Oseguera, 2005). *De facto* segregation is achieved by institutions that place meritocratic importance on the predictive value of standardized admissions exams, scores are utilized as screening devices. Institutions that place distorted significance on standardized test score are then able to admit students whom they deemed capable (i.e. those that that possess property such as cultural capital resulting from wealth) and uphold the perspective that underprepared students (e.g., low income, first-generation, minority students) would be better served by less elite or rigorous institutions such as community colleges (Sólorzano, Villalpando, & Oseguera, 2005).

Based as it is on the tenets of transdisciplinary approaches, the challenge to dominant ideologies, and the centrality of race, racism and their intersectionality with other forms of subordination, Sólorzano et al.'s (2005) research findings on standardized admissions testing showed institutions of higher education use scores as a gatekeeper that

maintains racially segregated educational environments.Non-CRT/LatCrit literature by SAT/ACT critics also argue that the test serves as a significant barrier to college access for minority and low-income students. For example, Letukas (2016) study on social disparities and sociocultural factors and standardized testing asserts that in a capitalistic society institutions are "aligned with the social relations of production and help to reproduce and reinforce the inequalities within this system" (Letukas, 2016, p. 100) and the utilization of admissions testing archieves this due to the role social disparities have on test scores. Many Latinx students have different and considerably limited opportunities to learn (e.g., limited access to advanced courses and certified teachers) compared to their privileged counterparts, a factor that influences test scores and can account for the educational disparities between Latinx students and White students (Ladson-Billings & Tate, 1995; Letukas, 2016). It is through the concept of property rights that CRT and LatCrit can explain the fact that institutions are then able to select STEM talent that privileges students from particular backgrounds. A lack of property (i.e., wealth) from the onset forces large populations of the Latinx community into inferior education during their time in K-12 systems. Inferior education often results in Latinx missing or gaining limited quantities of the knowledge and skills obtained by their privileged peers (Ladson-Billings & Tate, 1995; Letukas, 2016). Institutions of higher education can then select students with the desired capital (i.e., middle-to-upper class, predominantly White, privileged students) and say that they based their choices on objective factors (e.g., standardized admissions exams).

CRT and LatCrit challenge the notions of ahistoricism that Eurocentric norms hold. This perspective illuminates the historical context (Delgado Bernal, 2002). CRT

and LatCrit scholarship reveals that the preeminent belief in education and research is that the perspective of Euro-Americans are the norm, making Eurocentric ways of knowing and understanding the world appear natural and appropriate. As the long-standing dominant perspective, Eurocentric norms shape the standards regarding ability, success, and failure in STEM. Individuals or knowledges that depart from these norms are generally devalued and subordinated because they do not conform. Due to nature of such a hegemonic epistemological perspective, Eurocentric norms and ideologies have subtly and not-so-subtly shaped the belief systems and practices of researchers, educators, and curriculum, often adversely influencing the experiences of Latinx and other students of color (Bernal, 2013). Educational law and policy enforced in the last century when things like school segregation existed and a colonized relationship was established between Mexicans, and the dominant society (Bernal, 2013; Sólorzano, Villalpando, & Oseguera, 2005; Tate, 1997) created stereotypes and viewpoints about Latinx that are still in use today. For example, early-20th-century White perspectives regarded Mexicans and other Latinx peoples as different, other, and inferior to Whites (Bernal, 2002; Bernal, 2013). These stereotypes led to a devaluation of the Spanish language and justified the prohibition of Spanish-language in primary education (Bernal, 2002; Bernal, 2013). Additionally, Latinx students have consistently been considered to be foreign, and as such, they have been treated as immigrants regardless of their generational status in the United States (Johnson, 1997). As a result of these dominant perspectives, stereotypes regarding Latinx in education have been established. Bilingualism on campus continues to be seen as un-American, and an obstacle to learning

and Eurocentric epistemology has continued to view Latinx as culturally deficient and their ways of knowledge as inferior (Bernal, 2013).

While racial discrimination is no longer legally permissible, the damage it caused to legal thought and educational policy and practice continues in the form of stereotypes. Dominant ideologies in education and STEM maintain an environment where Latinx students must prove themselves to be capable due to these persistent stereotypes prevalent in STEM education (Baber, 2015). Latinx students, like women and other minority groups, commonly experience situations where professors or advisors tried to discourage them from science by either blatantly recommending that the student finds another major or by ignoring their contributions in the classroom (Fries-Britt, Younger, & Hall, 2010). Once in STEM programs, many Latinx STEM students feel like they have to continue to prove to their professors that they can handle the work, that can prove themselves in the classroom, and feel the need to prove to their peers (e.g., friends, classmates) they belong (Fries-Britt, Younger, & Hall, 2010; Packard, 2016). Latinas often experience what is called the double-bind, which in simple terms means they face both racist and sexist stereotypes that question their intelligence, their ability, and their capability (Ong, Wright, Espinosa, & Orfield, 2011).

The last tenet of CRT and LatCrit challenges dominant ideologies by providing a critique of liberalism and the basic notions that make it up, colorblindness, neutrality, and meritocracy. According to CRT and LatCrit, the reason that the notion of meritocracy infiltrates STEM disciplines is because meritocracy is often considered a positive concept where people are chosen (i.e., rewarded) on the basis of merit, as defined by education and ability, rather than demographic factors such as wealth or social class (Johnson, 2007). As

it stands American society operates on the belief that there is equal opportunity for all students in the United States and students will obtain educational results proportional to their efforts, innate talent, and moral character (Liu, 2011). Based on this belief, researchers often attribute the lack of underrepresented minorities in STEM programs to be indicative of minority students' lack of ability, drive, or interest instead of the more likely inequitable environments and unevenly distributed opportunities Latinx students experience (Byars-Winston, 2014). As a result of these beliefs, the myth of meritocracy can justify a rewards system in STEM that maintains the established status quo. Assumptions on which individuals possess the merit, ability, and interest (e.g., those with resources and opportunity) to do well in STEM are embedded into the admissions processes of institutions and results in the selection of privileged students from particular backgrounds being awarded admittance to stratified STEM programs, reflecting legitimizing, and reproducing class inequalities in education (Byars-Winston, 2014; Johnson, 2007).

Conclusion

The purpose of this literature review was to explore the ways researchers have examined the experiences of Latinx students in STEM including CRT and LatCrit scholars. Previous literature on Latinx students in higher education and in STEM fields has primarily investigated this population with hegemonic epistemologies and ideologies shaping their perspectives. Research practices have been developed by the dominant culture that created the educational structures researcher work in. Therefore little attention has been paid to the fact that research practices are also shaped by dominant perspectives and Eurocentric norms.

In this chapter literature was reviewed on factors affecting Latinx academic success and on the application of CRT and LatCrit on educational research concerning Latinx students. In the following chapter I will outline my methodological approach in this study. In light of the evidence gathered during the literature review showing hegemonic norms in higher education and racism experienced by Latinx people, this study will explore the ways that research on Latinx students in STEM is complicit with that oppression or resists it, using CRT and LatCrit lenses. The next chapter describes the approach and methods for this study.

Chapter 3

Methodology

The purpose of this study was to develop a greater understanding of the literature on Latinx students in STEM so that recommendations can be made to researchers to support the success of Latinx students in STEM. I relied on a CRT and LatCrit analysis of NSF funded research articles to examine the ways in which they are they are perpetuating systems of oppression and inequity and the ways they are resisting oppressive norms in their research. The goal was to understand through the CRT and LatCrit lenses how research might be contributing to oppression even though stated aims are to support Latinx students. Then, the next goal was to make suggestions based on these finding in order to improve future research.

Transformative Paradigm and Basic Interpretive Approach

The research paradigm that I chose for this study is transformative, meaning my research was a "study of the power structures that perpetuate social inequities" in STEM education research (Mertens, 2009). This is important because the transformative paradigm applies to people who experienced discrimination based their race/ethnicity, immigrant status, gender, class, or other identities an individual may possess (Martens, 2009). For this study, the transformative approach was a good choice because I explored the research conducted to support the success of Latinx students in STEM, a field in which Latinx students have historically been an underrepresented student population in STEM and where they continue to experience "chilly" environments (Cole, 2008; Johnson, 2012). However, because I wanted to study the power structures that perpetuate the inequity in STEM education and research, I utilized a critical approach to examine

dominant norms and center Latinx perspectives. The critical approach attends to different experiences, values, and impacts on different groups of people, particularly minoritized groups like Latinx people, other people of color and women in STEM (Mertens, 2015).

Reflexivity Statement

In this qualitative study, I was not only the researcher but also the primary research instrument (Xu & Storr, 2012). As Creswell (2007) states, "how we write is a reflection of our interpretation based on the cultural, social, gender, class, and personal politics that we bring to research" (p. 36) and so I was careful to understand how my positionality and personal history would affect the study outcomes (Creswell, 2008). As a Mexican-born immigrant with a history in STEM, I describe my background and perspective next.

I am a first-generation, low-income, Latina graduate student currently finishing my Master of Arts in Educational Administration with a specialization in Student Affairs. I earned my Bachelor of Arts in Global Studies, however, for the first two and a half years I worked on a degree in Food Science and Technology specializing in Pathogenic Microbiology. As a food science student, I was part of professional organizations that promoted women and minorities in STEM. I also participated in laboratory research, was involved in the grant writing, and received grant money to conduct my research. As a student, I saw other women and minority students stop out, drop out, or transfer out of STEM like I eventually did. These observations piqued my desire to know the factors that lead to minority students leaving STEM. As a graduate student, being part of a marginalized community has lead me to continue to study and understand not only the factors for Latinx students leaving STEM but those that lead to degree completion.

Although my experiences differed from those of other Latinx in STEM, my background

had the potential to affect how I collected and analyzed the data. Therefore, I took care to

be self-reflectively aware to prevent the experience from unduly influencing the data

found in my findings. I did this through the use of memos and discussions with my

advisor, both utilized in order to keep account of how my experiences might have

influenced my study.

In order for readers to understand my experiences and insights I brought to the

study, I describe them here. As a qualitative researcher, it was imperative to acknowledge

my positionality (Creswell, 2013). My parents only received an elementary education in a

poor, rural part of Mexico but wishing to give me better opportunities than those they had

they decided to immigrate to United States when I was very young. Due to their

background I found myself the first in my family to go to college. I arrived on campus as

an at-risk student at a PWI with no knowledge of how to navigate college and no support

network. I had chosen Food Science and Technology as my major because of my affinity

to science and because I was told that Food Science would be a stable field with high

entry wages for graduates. I spent two years in this STEM field before switching to a

liberal arts major. During my time as a Food Science major I had gained hundreds of

relevant lab work hours, had applied for research grants, had taken part in my

supervisor's research, and had joined several professional organizations. My identity as a

Latina in a STEM and the experiences I received while in pathogenic microbiology have

given me insider knowledge on the cultures and communities of STEM discussed in the

articles as well as a perspective on how researchers in highly specialized fields view

STEM. It is these perspectives that allow me to anticipate several outcomes appearing in

the research. As a STEM student, my advisors had explained why they wanted me to take certain actions in order to succeed. And as a graduate student reading STEM education research I have gained some understanding as to why my advisors made the choices they had when helping me through the STEM pipeline. While not all my experiences were like those described in the literature, I have first-hand knowledge on several of the environments and situations described and I have experienced many of the strategies employed to retain at-risk students like me. This experiential knowledge did aid me in identifying particular CRT and LatCrit factors such as the endemic nature of racism and sexism in and institution of higher education and the necessity to critique the notion of meritocracy in STEM.

Even through many of my experiences in STEM helped me connect the tenets of CRT and LatCrit to situations in the literature I often had to reflect on my position as the researcher and on how both my experiences and my identities may have biased how I analyzed the articles in this study. My identity as foreign-born US-raised student from a low socio-economic background often has led me to expect that research on Latinx students is focused on students with similar backgrounds. This is an unrealistic expectation that I had to watch because the Latinx student population is made up of individuals with various combinations of racial, ethnic, and generational backgrounds in addition to differing socio-economic states. This was a fact I knew but kept forgetting. Additionally, my experiences as a Latina in Food Science led to me expect research on Latinas in STEM to include the issues I experienced while in microbiology. Research on Latinas in STEM looks at the experiences of Latinx in all fields in STEM so this expectation would have caused me to find issues with articles because the investigators

conducted their research on issues or situations that I may have been inexperienced with. Throughout this thesis I had to remind myself that my experiences could be utilized as a tool but that this tool had to be utilized consciously so that I was aware of how I was using it to be able to communicate that to the reader without my experiences negatively influencing the of the findings. This was achieved through the use of writing memos whose sole purpose was to get me to sit back from the data, moving away from the coding system I applied to the articles, and forced me to have times I internally self-assessed the situation. The goal was to utilize CRT and LatCrit in order to find whether the research conducted in NSF funded articles effectively helped Latinx student or if it perpetuated inequality. My experiences are not the benchmark on whether this happened or not. Through constant self-analysis I limited occurrences where I would utilize my experience and bias as reference points.

Description of the Data Collection

The articles utilized in this study were selected based on the following parameters:

1. The Primary Investigator(s), and CPI(s) if any, must have received an NSF award to conduct the research utilized in the article.

2. Latinx students must be a primary student group under investigation.

3. The article must have gone through a peer review process.

4. The article was published on or after January 1, 2006 and before July15, 2017

Ultimately, twenty articles were identified for this study.

Studies were located though the NSF repository and awards search functions, the NSF was selected due to the NSFs role as a major source of funding in the United States,

the NSF has expressed a vested interest in investigating STEM education in order to increase diversity and enrollment. Currently there is a limited amount of literature concerning students in STEM, as published literature becomes available those articles that have been published though grants and awards often receive attention. After the rigorous review process that the NSF submit all research proposals to, the articles produced by PIs and CPIs as a result of NSF funding are viewed as significant. This feat by the PIs and CPIS is further established when the articles are published by journals that also maintain rigorous peer review methods, giving their work credibility. As the number of Latinx students in STEM continues to increase it is vital that we understand whether the research produced regarding their positions as students is effective. As mentioned before there is a limited amount of literature on the experiences and of Latinx students in STEM and published articles have a significant impact on future research and current practice. If current literature on Latinx students perpetuates systems of oppression it is important to recognize the sources because current literature is continuously referred to by scholars and practitioners making an analysis on recently published articles vital.

Utilizing NSF search functions I was aware of the fact that researchers may also be submitting proposals to study what they describe as the Latino, Latina, Latin@, Hispanic, Chicano, or Chicana student populations, so I modified the keywords appropriately. I did combine all these terms with additional keywords to help broaden my search; HSI, science, technology, engineering, mathematics, STEM, and STEAM (Science, Technology, Engineering, Art, & Mathematics).

I selected the NSF because of its influence and presence in the research conducted by public and private institutions of higher education. Surpassed only by the United

States military, the NSF provides a large portion of federal funding utilized in research

and development and is increasing its involvement in STEM education research. I believe

that as the Latinx population in the United States continues to grow, more investigators

will submit proposals for the study of the Latinx student population and their experiences

in STEM education. Continued calls for diversity from the federal government as well as

institutional interest in a fast growing population appearing on their campuses will

increase the publication of literature on Latinx student. And because of the NSF's

Education and Human Resources (EHR) goals, I believe that the NSF will continue to

call for proposals that address diversity and equity in STEM education therefore

examining this body of research has relevance to the future of research on STEM

students.

National Science Foundation

The data for this study was articles written about studies funded in part through

the NSF. Therefore, it is important to describe the NSF, and I make an argument why

NSF funded research was a good source of data for this research. The NSF has been

known as the gold standard for scientific research funding in the United States and

abroad. The research produced by an NSF-funded investigator is developed to be

innovative and competitive, awardees will often continue to apply for and earn other

prestigious awards and honors with the discoveries they make. By 2016 researchers

funded through the NSF had won 223 Nobel Prices and have gone on to pioneer

breakthroughs in science. Because of the prestige and credibility that an award from the

NSF, thousands of people respond to the NSF calls for proposals. In 2016 over 49,306

research proposals were submitted, but only 11,893 (24%) were selected by the agency

(National Science Foundation, 2017a., p. MD&A-15). Of all the grant proposals being submitted for evaluation by external experts and NSF program officer, only those which meet the set criteria of intellectual merit and a broader impact of the prosed research will earn an award. Merit review process is so strenuous that each year proposal deemed "very good or higher" are often declined (NSF, 2016). According to the NSF the projects that are selected are the best that the nation can offer, and the research produced is often anticipated to be exceptional (NSF, 2016). Once an investigator receives a NSF award, their work is not representative of the NSFs and the funds may not end up in the service of Latinx students, which creates a problem. Inefficient research and improper data collection can result in investigators taking federal money and not utilizing it as accurately and efficiently as possible.

In May 2017 the Trump administration approved the Consolidated Appropriations Act (H.R. 244) which proved funds for various federal operations through September of 2017 (NSF, 2017b). This bill provided the 2017 funds for the National Science Foundation (NSF) and other science agencies, with the NSF receiving $7.472 billion. Of this $7.472 billion, $800 million was earmarked for the EHR account (National Science Foundation, 2017b). Its allocation of grants is of particular interest because a large percentage of articles collected for this study gained their grants from the EHR. As the funding source of approximately 24% of all federally supported basic research conducted in American institutions of higher education, the NSF is the major source of federal funding for science research in the United States (NSF, 2017 a).

The NSF is an independent federal agency created in 1950 that supports fundamental research and education in all the non-medical fields of science and

engineering. The NSF's statutory mission is to "to promote the progress of science; to advance the national health, prosperity, and welfare; and to secure the national defense, and for other purposes" which it achieves by issuing grants to fund research proposals (NSF, 2017, p. i). As mentioned previously the EHR is of particular interest as its own mission is to "achieve excellence in U.S. science, technology, engineering and mathematics (STEM) education at all levels and in all settings (both formal and informal) in order to support the development of a diverse and well-prepared workforce of scientists, technicians, engineers, mathematicians and educators and a well-informed citizenry that have access to the ideas and tools of science and engineering" and this mission affects any NSF calls for proposals concerning education (National Science Foundation Education & Human Resources (EHR), 2017). As it stands NSF calls for proposals that concern education is shaped by the following EHR goals:

1. Prepare the next generation of STEM professionals and attract and retain more Americans to STEM careers.

2. Develop a robust research community that can conduct rigorous research and evaluation that will support excellence in STEM education and that integrates research and education.

3. Increase the technological, scientific and quantitative literacy of all Americans so that they can exercise responsible citizenship and live productive lives in an increasingly technological society.

4. Broaden participation (individuals, geographic regions, types of institutions, STEM disciplines) and close achievement gaps in all STEM fields. (NSF EHR 2017)

Based on these goals it is likely that any calls for proposal concerning higher education will be shaped by the EHR and this division will have a large impact on the research produced by investigators who earn NSF awards.

Research on STEM education will continue to follow certain guidelines on what meets intellectual merit and what does not (i.e. does it encourage transformative research (NSF, 2016)), and it is often prestigious funding sources like the NSF who shape these guidelines. The NSF has explicitly stated its goals regarding the production of relevant scientific breakthroughs and its efforts to increase the number of practicing scientist and engineers, goals that it aims to achieve through investments in STEM educational research. The strenuous Merit Review Process that all proposals have to go through has provided research resulting from an NSF award a sense of notability and the investigators who earn the award gain a greater standing as researchers. These awards do not only attribute a level of prestige, the investigators are able to amass copious amounts of significant data that other researchers view as relevant and vital to their own studies and findings. It is because of this that I find it necessary to analyze the research being supported by NSF awards.

Description of the Data

In order to give readers a sense of what ended up in the data, I have described the data here.

Articles

As mention previously all the articles included in this study are articles produced by investigators who received NSF funding. Six different NSF divisions awarded the awards earned by the investigators, this information can be found in table A1 in the appendix.

Nineteen articles were published in national/international journals or were submitted as conference papers and later published in the organization's online journal. One article was published though a university center. All twenty articles went through a peer-review process before being published, and they were all published after 2010. See Table 1 for a list of articles used in this study and some information about these articles. Articles are included in the reference list and noted with the asterisk. This delay in publication is due to the time the PI and CPIs took between earning an NSF award, conducting their study or implementing their program, and submitting their study for publication.

Table 1. Articles Analyzed in this Study

Authors	HIS/MSI	Method	STEM Focus
Camacho & Lord (2013)		Qualitative	E
Camacho & Lord (2011a)		Qualitative	E
Camacho & Lord (2011b)	HSI	Qualitative	E
Crisp, Reyes, & Doran (2017)		Quantitative	M
Dika, Pando, Tempest, & Foxx (2014)		Qualitative	E
Fleming, Burris, Smith, Bliss, Moore, & Bornmann (2014)	HSI	Qualitative	E
Fleming, Smith, Williams, & Bliss (2013)	MSI	Mixed	E
Flores, Navarro, Lee, Addae, Gonzalez, Luna, Jacquez, Cooper, & Mitchell (2013)	HSI	Quantitative	E
Gates, Hug, Thiry, Alo, Beheshti, Fernandez, & Adjouadi (2011)	HSI	Mixed	CS
Lord & Camacho (2013)		Mixed	E
Malcom (2010)		Quantitative	STEM
Malcom, Dowd, & Yu (2010)	HSI	Quantitative	STEM
Moller, Banerjee, Bottia, Strearns, Mickelson, Dancy, Wright, & Valentino (2015)		Mixed	STEM
Pando, Suarez,Rodriguez-Marek, Dika, Asimaki, Cox, & Wartman (2012)	HSI	Qualitative	E

Stokes, Levine, & Flessa (2015)		Qualitative	GS
Strayhorn, Bie, Long, & Barrett (2014)		Quantitative	STEM
Strayhorn, Long, Kitchen, Williams, & Stentz (2013)		Qualitative	E /STEM
Talley & Martinez Ortiz (2017)	HSI	Mixed	STEM
Villa, Wandermurem, Hampton, & Esquinca (2016)	HSI	Qualitative	E
Zimmerman, Johnson, Wambsgan, & Fuentes (2011)	HSI	Mixed Methods	CS

CS=Computer Science   E=Engineering   GS=Geoscience

M=Mathematics

There are a couple commonalities that I can describe about the studies selected for this study. I found that the majority of the articles either implemented a mixed methods approach or were qualitative in nature, however many PI and CPI had previously conducted qualitative studies and had written the articles based on the prior results. Out the twenty articles utilized in this study, ten of the articles involved HSIs or MSIs, where either the investigators investigated the role of HSIs/MSIs on Latinx student success and development or the investigators had utilized these institutions as the setting for the study. Additionally, a little over half (55%) of the articles focused in Latinx students but the other 45% of the articles often investigated Latinx along with other minority groups, the most frequent student population pairing was with African American students. Finally, the main STEM field of focus investigated in these articles was engineering. Out of twenty articles, eleven (55%) focused on engineering students, engineering education, or engineering environments.

Data Analysis

Due to the scarcity of NSF-funded articles whose focus was on Latinx students in STEM the data analysis stage of this study overlapped with the collection of articles (data collection). Seeing as locating NSF-funded articles took a considerable amount of time I overlapped these two steeps in order to have more analysis timeline. This allowed me to apply CRT and LatCrit tenets in an ongoing basis rather than waiting for all the articles to be located, which was good for my research as it allowed me to focus on analysis over time. As soon as I verified that an article I obtained was within the research parameters, I began with open coding. At this stage I took notice of any information, I thought was useful, striking, or noteworthy. At this stage open coding led to notes indicating the type of institution discussed in the article, for example whether the article described a new research model or program, if the only student population being investigated were Latinx students, and whether the report only considered race/ethnicity or if other aspects of identity were considered. The coding was informed by CRT and LatCrit tenets, I located trends were consistently found in the articles such as identifying what demographic factors were the articles main focus or what forms of subordination were considered in each article. After conducting the open coding, I applied the tenets of CRT and LatCrit as the analytical framework. It was at this stage that I went back to the articles and color coordinated instantiations of each tenet I identified. Following tenets of CRT and LatCrit, I marked areas in which the authors perpetrated racism or discrimination (e.g. essentialized a group to a single characteristic or based results on Eurocentric standards of merit or ability), whether there were factors that indicated interest-convergence, and I noted where the experiential knowledge of students was acknowledged and whether the investigators challenged dominant ideologies or perpetuated them. I also created an Excel

sheet documenting the methods of study and kept notes on whether the researchers acknowledged occurrences of racism, sexism, or other forms of oppression in the students' experiences. Through the two stages of coding, I documented my version of "internal self-assessment" (Hesse-Bier & Leavy, 2006) to understand how certain concepts were related to each other or CRT/LatCrit. I wrote detailed memos concerning the CRT/LatCrit tenets identified in the article and how they connected to aspects such as institutional location, student population, or program/model description in an effort to move back from the data and the codes. The goal was to think reflectively on the connections I made and helped me conceptualize the findings and their importance. This internal self-assessment through memos allowed me to summarize the key points, their connections to CRT and LatCrit, and the relevance they had when put together with the findings gleaned from the other articles. This internal self-assessment was helpful in explaining how the investigators did or did not consider racism or other forms of oppression, whether their utilization of culturally appropriate methods was effective, or how they accounted for the role of HSI/MSI environment when looking at student engagement or identities. This internal self-assessment also helped me realize when I was making the wrong relationship between CRT/LatCrit tenets and key points in the data. For example, I may have assumed that the environment at HSIs may not have as many chilly environments because they were less oppressive than PWIs. This idea was influenced by my experience in a chilly, competitive field while at a PWI and not by the data. My memo help me disentangle the connection I had made between my experience and a positive application of CRT and LatCrit tenets regarding HSIs which I may have automatically considered to have better environments overall.

I utilized CRT /LatCrit as the analytical framework during focused coding. Both CRT and LatCrit were useful for focus coding because they provided the framework with which I can question, critique, and challenge the manner and methods in which race, racism, discrimination, colorblindness, and alleged meritocracy have shaped and undermined policy efforts for Latinx students participating in STEM education (Harper, Patton, & Wooden, 2009; Villalpando, 2004).

Goodness of Research

If asked "how do you know that your findings are true and accurate" I must be able to link my research findings with the evidence to achieve reliability. As the individual researcher and data collector, it was of great importance that I established credibility through the establishment of peer debriefing in my study. Impartial peers ideally identified overemphasized points, vague descriptions, and biases or assumptions I, as the researcher, would have made. I had two for this study. Their feedback enhances my study's credibility and ensured validity. Carefully selected, individuals not involved with the study reviewed and checked the data analysis process to ensure that the interpretations are plausible given the data collected (Lincoln & Guba, 1985). This provided a fresh set of eyes, drew my attention to specific biases, involved a mind not immersed with the data, provided a fresh perspective, and increased the likelihood of catching errors. In particular, the peer reviewer searched for researcher bias, appropriate themes, and ways to increase credibility after a briefing of the findings, conclusions, and analysis (Creswell, 2016). The peer debriefer selected for this study is a Latino with prior experience engaging at-risk students in STEM-based activities. The peer debriefer has a substantial knowledge concerning this population and asked relevant questions

regarding the major findings and whether certain tenets applied to particular articles. Adjustments to the findings were made after a careful consideration of the peer debriefer's comments, with the majority of the peer reviewer's comments revolving around researcher bias or on the researcher's interpretation of racism and sexism. Adjustments were also made to my memos were also made and a careful readjustment regarding the application of whether transdisciplinary approaches were used, how experiential knowledge was utilized, and whether dominant ideologies influenced researcher's methods. Additionally, these adjustments were carried over to the discussion section of this thesis, particularly regarding the implications sections.

Credibility is important in qualitative research because it reflects that the researcher is representing the issue well through prolonged engagement. This study was conducted over a period of a year where the researcher engaged regularly with the data and the NSF funding of similar projects over that time. This prolonged engagement gave me a strong sense of the context and the specific data collected for this project. Thick descriptions are another method utilized to establish credibility. Extensive and detailed descriptions are provided to enable the reader to understand what was done and evaluate the research as well as make the decision on whether the research findings apply to their situation (Mertens, 2015). I also have ensured that an audit trail is established and kept secure. All available raw data, notes, and documents are being scanned, and I have kept a list of the articles and a few notes that were not utilized. Through this audit trail, there will be clear documentation of the analytical steps taken during this research project.

Conclusion

In this chapter I have described my positionality within the research topic and how my experiences may affect the findings. I have included a description of the NSF, how it affects STEM research conducted in the United States, and the methods utilized to collect my data and how it was analyzed. Chapter 4 will describe the research findings.

Chapter 4

Findings

The purpose of this study was to develop a greater understanding of the literature so I am able to make recommendations designed to help researchers support the success of Latinx students in STEM through research. In this chapter I applied CRT and LatCrit tenets in my analysis of NSF funded research articles to examine the ways in which they are they are perpetuating systems of oppression and inequity and the ways they are being equitable in their research. The goal was to understand how NSF research might be complicit with oppressive ideologies and practices or if the research demonstrates elements of equity suggested in CRT and LatCrit.

Culturally Appropriate Methods and the Utilization of Counterstories and Narratives

In order to see if the articles produced by NSF funded research were complicit with oppression of Latinx students STEM it is vital to understand whether investigators met the CRT and LatCrit tenets of transdisciplinary knowledge and use of students' experiential knowledge. Transdisciplinary approaches pay attention to both the history and the context of Latinx students and the educational environment they are in. Experiential knowledge validates the importance of narrative and provides representation for Latinx voices that have existed on margins. In this study, I found culturally appropriate methods that met the requirement of the first tenet. Investigators who chose culturally appropriate methods considered the historical background of the methods and assessment and if they were not satisfied, they chose modified methods, frameworks, and instruments in order to better investigate a minority group in education. The use of

culturally appropriate methods often included data collection methods that placed importance on allowing students to express their experiential knowledge through counterstories and narratives, thus meeting the CRT and LatCrit tenet of privileging the experiential knowledge of Latinx students. Utilizing counterstories and narratives in the data collection process was one way that I identified researchers were using culturally relevant appropriate methods but it was not the only way. I will begin by explaining what evidence of culturally appropriate methods I found in the data.

In addition to seeking experiential knowledge and requesting counterstories, some researchers used approaches and questions that had been used in previous studies with Latinx people in a variety of settings. Investigators often looked at the research outcomes of studies focused on racial minority students or studies conducted at minority serving institutions, and they incorporated those approaches and questions in their research. When choosing their methods, several researchers relied upon instruments, interview protocol, and theoretical frameworks that had been successfully utilized in the past to understand the experiences of Latinx or other racially minoritized groups. For example, Camacho and Lord (2011a)* utilized the interdisciplinary theoretical framework of "microaggressions" in order to investigate subtle and covert racist and sexist acts which occur in the lives of marginalized groups. Seeing as women of all races are severely underrepresented in engineering the investigators applied the "microaggressions" framework in order to demonstrate how microaggressions in academic settings against women of color can have a profound impact on perceptions of inclusion. Some researchers adapted frameworks and methods applied in other studies to fit the context of their own research. In the Camacho and Lord (2011a)* example, the investigators applied

the framework in order to investigate how microaggressions are processed differently depending on race/ethnicity.

In these articles, culturally appropriate methodology took into account the culture, ethnicity, and race of the students or the historical context in which they exist. In order to do this, investigators had to take into account socially desirable behaviors in order to interact genuinely with Latinx students and would have to take the time to understand Latinx students' ideas and assumptions about the world. Additionally investigators would have to consider the moral standard that was perceived as esteemed by students when inquiring into their experiences. For example, one study describes how Latinas form counterspaces within engineering education environments. The researchers incorporated rich, detailed perspectives by listening to Latina students as they described their realities of existing in the segregated spaces of engineering. Lord and Camacho (2013)* challenged the assumption that all women or all African Americans and Latinx student share the same educational experiences and separated the groups to look for differences in their lived experiences. The researchers were intentional to choose research and interview questions that reflected the students' cultures and backgrounds and moved away from aggregating minority group experiences. Data collection methods such as storytelling also reflected cultural traditions. Several of the investigators who utilized culturally appropriate instruments stated that they chose instruments due to the relevant content of the questions as they applied to the Latinx student population in education or Latinx students in STEM (Dika et al, 2014; Fleming et al, 2014; Fleming et al., 2013; Lord & Camacho, 2013)*. In several articles the investigators provided sections in which the explained the history of the questionnaire they used as well as the results of previous

studies, citing favorable outcomes as a reason why it was appropriate for their study (Flores et al., 2013; Talley & Martinez Ortiz, 2017; Villa et al., 2016)*. Authors like Talley and Martinez Ortiz (2017)* and Strayhorn et al. (2014)* selected instruments and models because they were used at other institutions and/or with other student populations with success. In those studies, the questionnaires included probing questions relevant across race and cultural experience. Or they considered factors such as collegiate environments (Crisp, Reyes, Doran, 2015; Dika et al., 2014; Lord & Camacho, 2013)*. Environmental factors are included in this category of culturally appropriate methods because they are not consistently considered in methodology developed to study a dominant student population like men or white students however, studying the environment can help researchers understand any racism and sexism, which may shaping their experiences. Racism and sexism as described in Chapter 2 have been well-documented in education.

Culturally appropriate methods allow for participants to talk about their experiences within a framework that acknowledges and values their racial and cultural heritage. Rather than beginning with a dominant frame often held by researchers, expecting students to fit within normalized discourses of what it means to be a student, to be a Latinx, or to be a woman, researchers allowed for students to express themselves within a culturally appropriate framework. For example, a culturally appropriate framework for Latinx students in STEM might acknowledge the importance of family, the desire to give back to their communities and to their families (Talley & Martinez Ortiz, 2017)*, and the importance they place in affinity groups because these have been shown to be important to many Latinx students (Villa et al., 2016)*. Talley and Martinez

Ortiz (2017)* implemented this approach by identifying Latina students' unique set of standards and values as they appear when the student volunteers to share their opinions and experiences. In this study investigators revealed how they considered the ways Latina students describe their experiences, treating their unique views and opinions as valid data all while viewing it as important in their search to deduct emerging themes. In other words, the investigators created focus group sessions where they listened to the students describe what they (a) believed to be intrinsic sources of motivation (e.g. strong drive, curiosity), (b) knew to be external sources of motivation (e.g. family, family duty/pride), and (c) recognized to be internal self-concept of motivation (e.g. insecurities, isolation, need for support) and utilized this information as data (Talley & Martinez Ortiz, 2017)*.

Villa et al. (2016)* implemented the culturally appropriate methods similarly, their attention to what their Latina students considered to be socially desirable in engineering education and their identification of what Latinas view to be as estimable cultural capital assets worth obtaining was noted in their study. After listening to Latinas' narratives concerning their experiences in engineering, the investigators considered more than the students' race and ethnicity. They also considered the students' gender, language, generational status, socio-economic status. Researchers analyzed these as part of an examination into how Latina students shape and describe their engineering identity and negotiating their positions as students in the face of adversity.

Some investigators included qualitative elements where participants could tell their own stories in their own words. In order to get rich descriptions Lord and Camacho (2013)* used focus groups of students shared experiences. This approach allowed participants to reveal their real human experiences and feelings to come through the data

collection and analysis stages, making it ideal for investigators who want to meet the needs of Latinx students or who what to drive home the issues that are concerning students. In another example Villa et al. (2016)* stated that they "employed naturalistic approaches to understand, illuminate, and interpret the multiple realities of individuals in particular context" (p.115). Through this naturalistic approach, the authors sought to make sense of engineering education through Latinas' experiences in it. In particular, they wanted to analyze Latinas' narrated experiences by interpreting what the experiences meant to the students. If a investigators used mixed methods in their study qualitative methods were employed in order to explore the relationships found in the quantitative data, often complimenting findings found in the qualitative data (Lord & Camacho, 2013: Moller et al 2015; Talley & Martinez Ortiz, 2017)*.

Qualitative research is generally accepted practice in most academic spaces. The semi-structured interview protocol which allows participants some latitude to speak about things important in their lives is one of the most common approaches to qualitative research. This finding suggests that the culturally appropriate approach may include more semi-structured protocols but the data also reflected elements of a more specific concept described in CRT and LatCrit literature – counterstories.

Counterstories and other forms of personal narratives are tools that express the importance of voice and the centrality of the lived experiences of people of color. The reality of STEM education is socially constructed primarily by one dominant voice and this reality is often considered legitimate in education literature (Bernal, 2013). The utilization of students' stories is a powerful tool that has the power to change people's ideas and perspectives on the established notions and mind sets. For example, the concept

that success in STEM is due to merit and grit is challenged because Latinx students' lived experiences indicate otherwise, a finding that is supported by CRT and LatCrit literature (Solorzano & Yosso, 2001). When interviewing Latinx students individually or in a group session the sharing of narratives helps build community and the participating members are often provided with self-preservation and coping tools. In research, counterstories are important because students can share their lived experiences in a way that is not shaped entirely by the researcher, instead discussions are shaped by the students' ideas, opinions, and world views. In this way, narratives and counterstories build on the students' cultural capital base and create different means with which to respond. They are different from many semi-structured approaches because they specifically are framed in a way that challenge dominant norms, like the norms based on middle/upper class, white, male, experiences. Counterstories create opportunities in which Latinx students can explain how they experience race, class, gender, sexuality, as well as issues of immigration status, language, ethnicity, and culture in their respective departments and universities. While interview and focus groups responses are invited and perhaps guided by the researcher by their choice of wording, the participants' responses are what they felt, saw, and determined from their perspective allowing the student to tell a story often ignored or dismissed in other situations. Counterstories also allow the student to explain why they felt what they felt and why they interpreted what happened the way that they did. Questions that create the opportunity for counterstories to occur allow the students to feel like they can speak about things that many people might dismiss as misinterpretations, overreactions, unimportant, or flat out wrong.

Counterstories are a way to explain why things are the way they are. Students can talk about how the things a department is doing are not as helpful as the institution might want or the climate is not as welcoming as the department may want. For example, in being one of three women in a class one Latina student said "I feel like I have to be smarter because you are being looked down upon and judged." (Talley and Martinez Ortiz, 2017, p. 10)*.Often being one of a few racially minoritized and/or women or low income students makes some students feel like they not only need to represent their groups well, but they also have to demonstrate that the stereotypes attached to their groups are incorrect. In this quote, the student holds herself accountable to do more to feel like they are doing well in a male-dominated environment and to displace the stereotype that women and Latinx people are not smart enough to be in science or engineering.

Students also talked about how they exist and persist within the environment when researchers present the opportunity via counter-storytelling. For example, in Stokes, Levine, and Flessa's (2015)* study a Latina student described that she felt that it was challenging for her to fit the geoscience culture by stating "You really don't see five foot inch little Hispanic girls going out into the field and wanting to collect rocks. It intimidates me because everyone else in Caucasian, taller, or has more scientific experience" (p. 258). The counterstory opportunity allowed this student to share her perspective on why she felt she did not meet the stereotype of what a geoscientist looks like. This gives both the investigator and the reader insight into how a Latina student may have internalized the struggle to fight multiple stereotypes based on her intersecting identities (Lord & Camacho, 2013; Villa et al., 2016)*. It conveys where there is a

perceived cultural expectation on who geoscientists are by prior enrollment trends.

Students can describe the things that they are doing on their own, within student groups,

or what they would like the institution to do that might better serve them. In one of Villa

et al.'s (2016)* narratives, a Latina student explains how their female study group

provides the academic support often missing in larger classes. She explained, without

feeling judged the groups can ask "well, do you understand this?" and whoever does

would explain it to the others (Villa et al., 2016, p. 118)*. They, in turn, would explain a

concept they knew whenever others would not understand. Examples like this show that

students take it upon themselves to build inclusive, welcoming, non-competitive, and

non-judgmental support groups. In both prior literature and in the articles used for this

thesis STEM classrooms are at times described by women and various minorities to be

negatively competitive, impersonal, or "chilly"/hostile where Latinx students are left

feeling alienated or invisible (Camacho & Lord, 2011a.; Lord & Camacho, 2013; Villa et

al., 2016)*. These environments often require students to seek out alternative approaches

and environments for support or leaving the program. Multiple investigators reported that

Latinx often feel the need to seek out affinity groups and support networks outside of

class or their department and that students consider these groups and networks as vital to

the development of motivating factors regarding success and their engineering identity

(Villa et al. 2016; Lord & Camacho, 2013)*. It is through counterstories and narratives

that investigators go beyond viewing membership in these types of groups as indicators

of success and instead find the environmental reasons shaping Latinx students ideas and

opinions regarding the necessity of these groups.

Examples like the ones given above are show the benefits of utilizing culturally appropriate methods in research concerning Latinx students in STEM. With counterstories students are given the opportunity to go into detail on the reasons why they feel they are experiencing different climates or treatments that their peers are not. Or they explain how they think the climate is welcoming or not welcoming without having their explanations be minimized or questioned. The counterstory framework begins with the expectation that there are realities that minoritized people often experience that are different from dominant norms. For example, when Latinas were asked about stereotypes in Lord and Camacho (2013)* Latinas reflected in terms of gender, not ethnicity, and were able to describe the stereotypes that emerged because of their low representation as women in engineering. There is no expectation for students to tell a story that fits within the master narrative. Students are not required to feel like institutions are acknowledging their concerns and providing them what they need, which can avoid having them attribute their negative experiences to be a result of their individual traits or lack of efforts (Moller et al., 2015; Villa et al., 2016; Talley & Martinez Ortiz, 2017)*. Open-ended questions often are viewed to be opportunities to explain situations or occurrences in greater detail but often fail to provide students the opportunity to explain their experiences as they see them through their salient identities if this opportunity is not explicitly stated. Additionally, counterstories afford students the opportunity to explain in rich detain how they interact with and survive inside institutions of higher education given the context and history of educational institution, which is that they have had few Latinx leaders and students in them. It is through the rich details that students provide in counterstories that investigators can better identify what students see as causing issues for them and other

Latinx students. Counterstories also help point to what the students are finding to be helpful, leading to well informed findings and discussions on the issues being investigated.

Discussions Regarding Racism and Sexism

Another tenet of CRT and LatCrit says racism, sexism, and other forms of oppression are endemic to everyday life. Further, CRT and LatCrit suggest that the history and context of any moment or space are important in analysis. STEM education has a documented gendered and racialized history (Byars-Winston, 2014; Flores, 2011; Metcalf, 2010; NASEM, 2016) a fact that correlates with the fact that higher education has always had such a history (DeCuir & Dixson, 2014; Ladson-Billings & Tate, 1995; Solórzano et al. 2005; Tate, 1997). In order to meet the CRT and LatCrit tenets of challenging ideologies it was important for the research to acknowledge and discuss race, racism, and the intersectionality with other forms of subordination as needed. During this investigation I have found that some investigators acknowledge the endemic nature of oppression and discrimination and its presence in the policies or practices that shape STEM education, however, most investigators were unlikely to address how such environments actively marginalize women and people of color. Investigators largely fail to examine the institutional environments and explain institutional factors that could be creating racism and sexism or perpetuating how these types of oppression operate in the larger society.

Universities' beliefs, values, and available resources differ from those experienced at home and in the communities of Latinx students. In this study only a select number of investigators explicitly acknowledged that there is a lack of connection

between the two. They are researchers focusing on Minority Serving Institutions' role on student success or who those look at the experiences of minorities and women in the realms of science and engineering education (Camacho & Lord, 2011b.; Camacho & Lord, 2013; Moller et al., 2014; Strayhorn et al., 2013; Talley & Martinez Ortiz, 2017; Villa et al., 2016)*. The cultural and structural barriers established by this disconnect in norms are rarely acknowledged by investigators, in fact the most consistent have been the investigators Michelle Camacho and Susan Lord. Instead, researchers' focus has been on the students ability to overcome such environmental barriers to succeed in the existing environment. When faced with educational barriers some students learned how to cope by adapting strategies such as learning to fail, asserting themselves by keeping a "sticking to your guns" mentality (Lord & Camacho, 2013, p. 4)*, separating their academic identity from their social/personal ones, and making accommodations to disengage and avoid hostile situations. These strategies are adopted as a type of resistance against the harsh climates and the macroaggressions some students face in STEM (Camacho and Lord, 2011a.; Talley & Martinez Ortiz, 2017; Villa et al., 2016)*. This approach fails to examine historical practices, policies, and ideologies, which may not serve Latinx students well. In one study the investigators state "leaders in the engineering community assert the need for a more diverse pool of engineering talent, the societal limitations grounded in historical inequities complicate the engineering pipeline for Latinos" (Camacho & Lord, 2013, p. 106)*, researchers want more minority students but often do not consider dismantling inequitable practices that exist in STEM education .

Additionally, only a handful of investigators acknowledge that racialized and gendered departmental environments have a negative impact on Latinx student experiences.

Investigators such as Strayhorn et al., (2014)* and Stokes, Levine, & Flessa (2015)*

called such environments a "chilly" and the results leading to "leaks" (Talley & Martinez

Ortiz, 2017)*, which filter out Latinx students, due to the competitive and unwelcoming

cultures.

Although racism being endemic is a central tenet to CRT and LatCrit, it is hard to

prove that racism is endemic to all STEM departments. Not all Latinx students

experience racism, sexism, or any other type of discrimination in their

departments(Talley & Martinez Ortiz, 2017)*. Another possibility is that students may

have experienced macroaggressions but dismissed them. Further, those who do

experience racism may be unwilling to tell investigators. The lack of readiness to disclose

racism and sexism may be due to various factors such as the perception that they may be

view as not having the strength or "grit" needed to persist, uncertainty on whether such

events happened due to the students having experienced prior invalidation when

discussing similar occurrences, or even an unwillingness to discuss such events to White

or professional investigators (Stokes, Levine, & Flessa, 2015)* The investigators may

face similar factors in not acknowledging racist or other discriminatory occurrences.

Some investigators acknowledged that they may not have implemented the proper

methodology or may have had too small of a sample size to determine whether overt

encounters with racial discrimination occurred (Stokes, Levine, & Flessa, 2015)*. Not

everyone experiences discrimination in academia and those who do may be unwilling to

attribute such practices to their departments or fields even when subvert acts of racism or

sexism (macroaggressions) are mentioned. For example in Strayhorn et al.(2013)*

mentions that participants indicated that they are rarely called upon by their name and

that the comments they make are often unacknowledged by the professors, unlike their White and Asian peers who are more often acknowledged by the same professors. In Villa et al. (2016)* there is narrative given in which the student does not interpret inequitable words and actions as inequitable. This Latina student explains her dismissal of a sexist occurrence in the following manner "But I mean, they never said that they kind of act like that. But since I already had experiences being in, like, a male-denominated environment, then I kind of just…… I was used to it." (Villa et al, 2016, p. 121)*. While the student does not interpret the situation as a macroaggression involving sexism, the fact that the student dismisses it because she is used to these situations is telling. Comments like this suggest that racism and sexism have a pervasive presence in Latinx students' college experiences.

The importance of acknowledging racism, sexism, and other types of discrimination in STEM programs and departments goes beyond the articles utilized in this study. By not recognizing or acknowledging discriminatory practices and views the investigators ignore the proverbial elephant in the room and instead shift the burden of proving inequitable practices on students. The structural issue is overlooked, and instead, the students are expected to survive and overcome all barriers. Those students who don't survive this environment are considered deficient and must account for their inability to do well in such a system. The departments and the institutions are then allowed to continue this cycle with no responsibility to change the environment to fit the needs of a changing student population.

The Roles of Hispanic Serving Institutions (HSIs) and

Minority Serving Institutions (MSI)

In this study there were ten articles, 50% of my sample, which either took place at a Hispanic Serving Institution (HSI) or investigated the roles of HSIs and impacts they had on Latinx STEM students' success. Of the ten articles, three went into detail explaining HSIs efforts for STEM student success, one explains the impact of HSIs on Latinx students engineering identities, and in the remaining articles the roles of HSIs were briefly mentioned. In four articles the roles of HSIs were discussed in detail (Fleming et al., 2014; Fleming et al., 2013; Gates et al., 2011; Malcom, Down, & Yu, 2010)*, with the main focus on programs and initiatives developed by HSIs. In this section I will describe how instigators wrote about how HSIs met the needs of Latinx STEM students by considering their identities and backgrounds, considerations that challenge to the dominant ideologies of meritocracy and neutrality in STEM education. This is an important finding in the current study because the analytical frameworks of CRT and LatCrit require researchers to examine how dominant ideologies can be pervasive at the expense of Latinx people and other minoritized people, their cultures, and their experiences.

Due to the limited budgets many HSIs have many investigators focused on the efficient and targeted use of funds this includes making financial aid resources available to students (Malcom, Down, & Yu, 2010)*. In several articles the investigators identified the generational and socio-economic status of the various populations in their institutions and developed strategic research opportunities that were often funded by assistantships, tuition waivers, and stipends (Gates et al., 2011; Malcom, Down, & Yu, 2010; Pando et al., 2012)*. Investigators then targeted student recruitment to the programs based on the specific Latinx student populations they are working with and their needs. For example if

the HSI identified that there were any low-income, first-generation minority students without the cultural capital nor the time to be in non-paying research programs the investigator and the institution would introduce programs that would meet the most pressing needs (e.g. mentoring, financial assistance to attend conferences) through avenues such as classes (Malcom, Dowd, & Yu, 2010)*. In another study, the investigators described how these strategies promote transfer, degree completion, career advance, and degree inspiration because the creators (i.e. the investigators) of the programs took into account student demographic traits, institutional climates, and field expectations being sensitive to the academic and cultural needs (Gates et al., 2011)*.

Investigators identified the reasons why students had a hard time at PWI and in STEM and investigated if these same educational barriers were in place at HSIs. Camacho and Lord (2011b)* found that HSIs hold the greatest promise for graduating future Latinx engineers and provide insight into the success of engineering education at HSIs and this may have to do with the different climates that HSIs provide students. In one article, the investigators found that the success of Latinx engineering students at HSI's relies on several factors. These included HSIs promoting engineering as a viable major to prospective students. To promote the field of engineering, the investigators suggested transforming the idea of what engineering is and who engineers are. Citing prior work, the researchers point to a shift in the language used to recruit Latinx students, a more direct approach involves community leaders and engages parents and other influential family members. By engaging the students' community, the investigators found that comprehensive approaches help Latinx students bridge their communities and the classroom. The direction of these inquiries moved away from the traditional route of

expecting students have developed a STEM interest early on in life with an idea of what a STEM degree entails and what a scientist does.

Most research involving HSIs, either as the location or as the main research focus, moves away from what the student brings to the field or instead focus on what STEM and HSIs can do for the student (Camacho & Lord, 2011; Gates et al., 2011; Malcom, Dowd, & Yu, 2010)*. While students are required to demonstrate the ability and willingness to do well, academically programing and pedagogies acknowledge that the students' intersecting identities will affect the students' experiences. Investigators focused on seeking out and developing talent, broadening students' knowledge of STEM career possibilities, increasing the visibility and enjoyment of STEM, and including the possibility of partnerships beyond the institutions (e.g. including industry as wells as civic organizations) (Gates et al., 2011)*. By providing welcoming environments, committed faculty, and specific culturally appropriate programming Latinx are given the opportunity to grow and succeed. The investigators leading the majority of these studies focused on how these institutions aim to create these environments for students, being intentional in their efforts and involving any partnership that may help students in any way.

Conclusion

In conclusion, most investigators did not discuss the presence of race, racism, and other systems of oppression in STEM education or how they create educational barriers for students. Additionally, the studies that applied culturally appropriate methodologies took into account Latinx students' backgrounds, cultures, and demographic factors, documented students' lived experiences, and considered Latinx students as creators and

holders of knowledge. Counterstories and narratives provided opportunities for Latinx students to be fully engaged and provided rich data. Finally, investigators that took into account HSI environments considered more than just institutional type, they researchers involved considered the whole students when creating programs and HIS research focused on what the institution and STEM fields could do for the student.

In this chapter I have described the results of my article analysis. Through the application of CRT and LatCrit I identified that many researchers did not acknowledge the centrality of race, racism, and other system of oppression in STEM education practices nor were there many cases of dominant ideologies (e.g. meritocracy, neutrality) being challenged . I did find that transdisciplinary approaches were used and that some articles did place an emphasis on Latinx students experiential knowledge. Chapter 5 will include a summary and discussion of the research findings, a discussion on the significance of the findings, recommendations for practice, recommendations for further studies, and concluding remarks

Chapter 5

Discussion

This final chapter consists of a discussion of the results of this research study. Included here are (a) the summary and discussion of findings, (b) the significance of the findings, (c) recommendation for practice, (d) recommendation for further studies, and (e) concluding remarks.

This qualitative research aimed to develop a greater understanding of the literature produced by investigators who have utilized funding from the National Science Foundation (NSF) to study Latinx students in STEM. With a focus on examining whether these investigators are perpetuating systems of oppression and inequity or resisting them, I applied the key tenets of CRT and LatCrit as a lens through which I analyzed the published studies produced by the investigators.

This research sought to answer the following question:

1.   In what ways are NSF funded researchers of Latinx students in STEM complicit in and resisting oppressive ideologies and practices as described in LatCrit and CRT?

Summary of Findings and Discussion

Culturally Appropriate Methods

Many of the investigators who produced the articles utilized in this thesis aimed to understand the needs of Latinx students in STEM and their experiences of a STEM curriculum. To accomplish these goals investigators employed various research and data collection methods and applied a broad range of theoretical frameworks to conduct their studies. After a thorough analysis utilizing the CRT and LatCrit tenets as scrutinizing critical lens, I found that the investigators who used culturally appropriate methods and

frameworks identified Latinx students as holders and creators of knowledge even when their experiences may not have fit into the dominant Eurocentric definition of what knowledge is (Bernal, 2013; Solorzano, 2005). The studies that utilized culturally appropriate methods more appropriate for Latinx students tended to address or mention more than one issue or concern facing Latinx students in STEM letting students respond to how they experienced, and dealt, with race, gender, and class inequality while in STEM (Solorzano & Yosso, 2001). CRT and LatCrit both explain that Latinx college students are constantly utilizing a double consciousness between their multiple identities and their roles as a STEM students (Bernal, 2002; Gonzalez & Morrison, 2016; Ladson-Billings, 1995) It was through the use of culturally appropriate methods that investigators highlighted Latinx students' experiences and brought their knowledge and ways of knowing from the margins to the center (Gonzalez & Morison, 2016). For example, students saw their home knowledge as a tool that helped them navigate through educational obstacles, get through college, and achieve their goals. However a failure to acknowledge these ways of knowing probably indicates that investigators are approaching the students situation from a Eurocentric lens, instead communicating that students' ways and experiences are not as important as dominant ones (i.e. they are lacking, limited, and "inferior" to the norm) (Bernal, 2013).

It was with the CRT and LatCrit tenets of (a) the importance of transdisciplinary approaches, (b) an emphasis on experiential knowledge, and (c) a challenge to dominant ideologies that I was able to make distinction on whether articles utilized culturally appropriate methods which articles did not. Additionally, the centrality of race and racism and their intersectionality with other forms of subordination was utilized by some

investigators but few articles explicitly mentioned or chose methods that indicated an acknowledgment to the centrality of racism or oppression in their studies. With these tenets as guides. I found that culturally relevant methods were used in some research studies and not others. Culturally relevant methods are important to Latinx students in STEM because as CRT and LatCrit scholars have documented failing to account for the cultural and racial background of racially minoritized students within a racist society perpetuates their oppression (Bernal, 2002; Bernal, 2013).

I found that articles that utilized counter-storytelling allowed students more opportunities to describe experiences and events as they understood them through their salient identities. It was though counterstory-telling that students shared their perspectives on events, offered detailed background information and details that helped explain their perspective on situations and events more thoroughly, and offered the feelings and ideas on the opinions of others involved. Both CRT and LatCrit recognize that the experiential knowledge of Latinx students is legitimate, appropriate, and critical to understanding, analyzing and researching about Latinx students and their experiences of oppressive subordination in STEM fields (Cantu, 2012; Solorzano & Yosso, 2001). This is a significant contribution to the literature because no analysis of articles on Latinx students in STEM has been published. This finding indicates to researchers that traditional research methods may not help them meet their goals of graduating more Latinx students from STEM majors. Latinx students may need opportunities to tell their stories in their own words to people who understand their lived experiences if educators want to push through the norms of dominant research and Eurocentrism to equity in STEM. Failure to employ culturally appropriate methods may position the student as

variable to be manipulated in order to increase retention and graduation because this is the dominant norm in research. While students may be part of the equation, this approach may not lend itself to understanding the impact of the environment on students.

In the articles analyzed in this study, some investigators combined counter-storytelling with data collection methods like focus groups, individual interviews, and culturally appropriate/adapted surveys. The combination of these techniques offered the researchers an opportunity to interact with students genuinely and respectfully, allowed for the students' complex identities to be reflected in the method and questions asked, and utilized proven cultural appropriate methods that aligned with students' values (Bernal, 2002). By utilizing elements of counter-storytelling as well as data collection methods such as focus groups the investigators get more information from the students' perspectives that lead to a better understanding of the students' existence in systems of oppression or discrimination. These methods are often seen as adaptive to the various subgroups and intersectionality within the greater Latinx population, often building community with others who exist in the margins of STEM education while also challenging the perceived wisdom of people of authority (e.g. researchers, professors, or administrators) transforming the established belief systems (Solorzano & Yosso, 2001).

Culturally appropriate research methods allowed students to express their lived experiences more deeply because the researchers were open to understanding the issues from the point of view of the students. Latinx students were able to utilize their own identities and experiences as knowledge; this knowledge was further used as the basis of their perspective on events and situations. Through counter-storytelling and culturally appropriate methods, Latinx students found a way to explain not only place in STEM but

how they are interacting and surviving within a system with a history of oppression and discrimination. In most of the articles, Latinx students found the opportunity to utilize their experiences as a way to steer the conversation to issues more relevant to them. For example, instead of feeling discriminated against because of her race a Latina student may have experienced more negative situations based on her gender or possibly have faced issues that a Latino student wouldn't due to her intersecting identities. These finding resembles those found by Ong, Espinosa, and Orfield (2011) and in CRT/LatCrit literature (Yosso et al. 2009). In cases like these, counter-storytelling provided the opportunity to explain her perspective based on her experiences. This is a significant finding because researchers have stated they want to support more Latinx and other racial minority students in STEM fields. However, Latinx students are not unidimensional. They have many different identities and even within those identities, they have differing experiences. This means that researchers need to utilize approaches that will capture those differing experiences. There is little published on the approaches used to understand the experiences of Latinx students in STEM so this is a contribution to the literature.

Educators can also understand this as important finding to take seriously because CRT and LatCrit scholars have documented the impacts on people of color when those around them fail to recognize their culture, backgrounds, identities and societal/institutional racism they encounter every day. Dominant group epistemologies tend to distort the lives of Latinx groups and these distortions are pass into the dominant STEM culture as "truth", thus becoming the basis of individual, departmental, and institutional attitudes, practices, and policy while invalidating the lives of Latinx students

(Scheurich & Young, 1997). Researchers must be aware of how they may be complicit with norms of ahistoricism, neutrality, and meritocracy if they want to "do no harm", a common ethical principle in research. Failure to address the fact that there are unchecked assumptions and myths in STEM research concerning the myth of meritocracy and the development of student scientific interests is harmful as standards have been shaped by the dominant population. For example, research on the development of students' scientific interests is based on a stereotype of a common male pattern (e.g. the attraction to STEM happens early in life). Stereotypes like this shape assumptions in research practices (e.g. that an early interest would allow students the opportunity to inform themselves about the STEM discipline) and inevitably harm students who do not follow a presumed pattern of STEM participation (Byars-Winston, 2014).

Lack of Discussion of Racism and Sexism

Through an analysis of the articles utilized in this study, it became apparent that racism, sexism, and other forms of oppression were rarely mentioned. When gender or race was mentioned, it was as the students' identity and how they learn to adapt to the environment in spite of these identities. What often happened in these articles when identity was a concern was that investigators were more concerned in developing the students' scientific or engineering identity by utilizing methods proven to work on the prevalent identities of other students in these programs (i.e., successfully acclimated students). In other words, the investigators often sought to find ways to make Latinx students adapt and acculturate to a competitive, often historically discriminative environment. This finding resembles those findings found in literature by Ong, Wright, Espinosa, and Orfield (2011) and Longerbeam, Sedlacek, and Alatorre (2004).

Research that does not discuss race, racism, and other systems of oppression and does not question or challenge dominant ideologies essentially places the responsibility on Latinx student for not thriving in inequitable environments (Johnson, 2007; Liu, 2011). Researchers do this by claiming that students do not having the right social and cultural capital and by possibly not assimilating fast enough to the department. The student is found to be lacking and typically the research conducted tends to look at what cultural capital factors attributes to achievement often disregarding individual characteristics, or finds what capital from a cultural group attributes to failure (Johnson, 2007). This lack of discussion can be a result of investigators ignoring the centrality of race, racism, and other forms of subordination its presence in STEM education policy and practice, their being unaware of it, as well as the fact that a critique of dominant ideologies (e.g. meritocracy, color blindness) is not conducted in most studies (Scheurich & Young, 1997).

Early on, departments like engineering were developed utilizing military and industry education models as templates and created to educate the people employed in these fields. With exceptions for breakthroughs in technological advancements, vague institutional goals, or compliance with federal mandates, this educational template has changed slowly over the decades. Inequitable practices have seen superficial changes but are often unchanged at their core, leading to minority groups to face "chilly" environments and eventually leaving through a "leak" in the system. CRT and LatCrit theories both indicate that racism and other forms of discrimination are endemic (Bernal, 2002; Bernal, 2013; Ladson-Billings & Tate, 1995), however many investigators rarely talk about it or acknowledge it, some may not even be aware that it shapes the

epistemologies they employ themselves (Bernal, 2013; Scheurich & Young, 1997). Even though numerous student populations from various backgrounds face such challenges in STEM and make up the vast population of students that do not consider STEM as a possible choice those investigating enrollment, attrition and experiences ignore the main question that should be asked. In literature if the researchers asked "What is it in STEM that discourages minority students?" the answers were often student disinterest, lack of motivation, lack of grit, or a lack of experience or knowledge (Byars-Winston, 2014, Martin et al., 2010) and the articles in my study reflect this attitude.

When asking about racism, sexism, and other forms of discrimination investigators often fail to discuss or ask about a few key factors. I observed that in various studies questions about racism and sexism seem to be point black, often disregarding that students may perceive discrimination differently. Due to the insidious, slippery, hard-to-name nature of macroaggressions the aftereffects of such actions are felt and identified differently by Latinx STEM students. There is literature that provides examples macroaggressions experienced by Latinx students (e.g. jokes, insensitive comments), how the students decipher macroaggressions (e.g. as a result of ignorance or an intentional attack), how they respond (e.g. contest the macroaggression or sidestep discussing the situation), and how their reactions/responses can be shaped by prior experiences (e.g. accusations of being too sensitive or paranoid, overreacting) (Minikel-Lacocque, 2013; Yosso, Smith, Ceja, & Sólorzano, 2009). For example Minikel-Lacocque (2013) may not be willing to label situations because Latinx students may have previously found certain actions and statements racist or sexist but those in positions of power have could have denied students the opportunity to define their reality (e.g. call an

action racist). By negating students' protest and claiming that their reactions (i.e. anger, offense) were invalid, those in positions of power or in the dominant group defined students' realities for them, exposing students to the possibility that any similar reactions by the student in future would be treated in a similar manner. This may shape the way Latinx students interpret situations and how they report them in research studies. Unfortunately this tendency can also happen within the research process, researchers can impose realities on students. Additionally, such questions fail to take into account that even if the students faced difficulty due to their race, gender, class, etc. many are unwilling to be perceived as lacking strength, aka "grit," in fields that uphold meritocracy and established cultural capital. Next, I discuss the implications of this study.

Implications

When analyzing my findings with the tenets of CRT and LatCrit several key points are apparent. Most investigators producing literature utilizing NSF funding follow STEM academic norms, norms that are centralized around the scientific identities and practices of the primarily White men occupying these fields (Johnson, 2007). STEM education privileges certain forms of speech and actions and if students do not adopt the technical terms and the acceptable language use in their secondary explanations (i.e. use proper English), do not engage in approved practices classroom practices such as group discussions and activities, and do not adopt the ways of knowledge as set by teachers and texts (i.e. Eurocentric ways of understanding science, nature and the environment) the student is seen as failing to understand STEM. If a student does not reconcile their cultural epistemological beliefs with those of mainstream STEM the student is not considered a "good" fit with STEM programs, limiting their opportunities to learn and

succeed (Brown, 2004). The general mindset is that individuals must adopt the established norms and assimilate to the academic STEM environment to be successful and those that do not fail and leave. Unfortunately, this is a mindset that disregards the possibility of a faulty system that is unyielding and hostile to those that do not acculturate fast and accurately enough. When acculturation is not accomplished by the individual student, the environment and the climates are not questioned, it is the individual who is perceived as lacking.

This habit of not questioning the system could be a result of the investigators' own history and experience within the academic system. Investigators would have had their own experience while in academia, and this experience would lead to a familiarity in which investigators view and identify certain policies and practices as central pillars of the scientific institutions they interact in. The normalization of practices and behaviors that contribute to exclusionary climates makes them seem ordinary and fair (Bernal, 2013; Johnson, 2007). Seeing as so many individuals from different groups can do well within the established norms, those questioning the exclusionary educational system are often seen in a negative light (Lui, 2011; Scheurich & Young, 1997). Studies that investigate minority students in STEM may examine the environment, but longstanding STEM tradition leads investigators to abandon questions of the environment and instead focus on the students' traits and their ability to adapt to a STEM curriculum.

By not questing the environments in STEM education, researchers maintain a vacuum around the discussion concerning exclusionary climates in STEM. The existence of racism, sexism, ableism, and other sources of oppression, as well as their effects on particular student populations, are compressed into soundbites like "chilly climates" and

"leaky pipelines." Researchers and practitioners avoid talking about oppression within STEM in their studies and, by avoiding these topics, discussions regarding the presence of racism and sexism not only in the classroom but the policies and histories of departments are sidestepped as well. Students joining departments adopt the practices of their departments and those students who do well never have to question the norm. It is the students who have difficulties within these environments suffer from such a pervasive social norm, and their options are whether to question the environment or to question themselves. With STEMs established views on objectivity, neutrality, and meritocracy, students reflections are directed on themselves. Because the environment is one in which individual merit and ability are the deciding factors for success, their failure to adapt and thrive is a reflection on their abilities and their "grit." Many students will see their failure as one attributed to only their traits and will maintain the norm of not questioning if aspects of the environment they were in had anything to do with the difficulties they faced.

As a minority group in STEM, Latinx students experience exclusionary environments in various fields but often left in situations in where discussing the issues they face result in a dismissal of the problem or misdirection by those in higher positions. Pointing out racial or gendered issues results in Latinx and other minorities students being told they are exaggerating issues or they are accused of "pulling out the race/gender/etc. card" to explain away their inadequacies. Often they are required to provide adequate proof that such occurrences happed even though certain events are not ones others are willing to name as racist or sexist. Students who do succeed despite educational barriers are seen as exceptional, put on pedestals, and used as examples of

how the system is working for all students. Established members tell Latinx students that it is not the environment that is deficient and causing issues. Instead, it is determined that students do not possess the traits, drive, and ability needed to survive in STEM and if that they cannot adapt to the environment that is what is causing the issues. STEM is perceived to domain that belongs to an elite few and will only accommodate the capable and the driven, a concept that distances those that are having difficulties (Byars-Winston, 2014).

Current literature maintains this stance on not questioning the environment and focusing on the fact that it is up to the student to adopt the established cultural capital and adapt to the STEM environment without question. Research today looks at what "successful" Latinx have done to succeed in this environment, what models lead to the successful acculturation of Latinx students, and what personal or cultural traits Latinx students may possess that lead them to fail. Research that only focuses on these factors point readers to the idea that the educational system is fine, most people in these environments if thriving, and those that don't won't because they are not assimilating and following the expected steps to success. Those students who are succeeding are continuously rewarded when they maintain the status quo and those individuals who go against the grain are regarded as distractions of anomalies within a well-functioning environment.

It is through the application of culturally appropriate methods and by focusing on HSIs and other MSIs that researchers begin to not only find proof of in inequitable practices, but they introduce the probability that it is these practices that are the sources of problems commonly faced by minority students. Without opportunities to discuss

racism and other forms of oppression, existing exclusionary norms remained

unquestioned, and students who face difficulties feel like they do not belong and that they

are the problem. The researchers who continue to utilize inadequate research methods to

study Latinx students in STEM fields created to educate a historic student population

comprising of White males will be unlikely to recognize forms of oppression that target

women and minorities.

Recommendations for Practice

The researcher conducting studies on the experiences of Latinx students in STEM

tend to conduct their studies following scientific protocols and an objective lens to find

what there is to be found without the influence of the researcher's bias. In this type of

research, researchers view themselves as a neutral observer rather than a social reformer,

a viewpoint that may conflict with the goals and reasons of their research study (e.g.

creating programs that increase student enrollment). Based on the literature produced by

the NSF funded investigators it seems that this is a common issue that keeps happening.

Many researchers attempted to produce research utilizing a scientific approach in which

they act as a neutral observer but were conducting the study to better understand the

issues surrounding retaining, recruitment, or educating a historically underrepresented

student population. They often provide suggestions or methods in how to solve these

issues at both the undergraduate and graduate levels of STEM education and base their

proposals to the NSF of theories surrounding these solutions. However, these goals are

the goals of a social reformer instead of a neutral creator of knowledge regardless of what

type of research or data collection methods the investigators utilize, a point that eludes

sometimes eludes the investigators and prevents them from introducing findings that

could do more for the goals they are attempting to reach. Social reformers do not just collect, analyze, and report data they, like the investigators who published many of the articles in this thesis, conduct research that seeks to create social change in education (Mertens, 2015). With the "scientific" models investigators employ they will find little room to introduce critical though that challenges the status quo and expose the fallacies that exist in scientific institutions with their findings. Instead, these investigators will continue to discuss the symptoms of inequitable practices instead of identifying the source of the symptoms.

This diagnosis can be the presence of racism, sexism, or a combination of oppression and discrimination in the educational system. As stated by CRT and LatCrit oppression is endemic, but many investigators will never point it out because they are stuck behind their view of objective and neutral observation. Researchers investigating Latinx student in STEM need to move away from this objective or "tourist" mindset where they view Latinx students passively without moving past the surface. As it stands most investigators view the scientific environment as a neutral field and Latinx students as an anomaly within STEM, even when they state otherwise. With this approach investigators fail to explore the environment thoroughly, often failing to investigate the historical background of the field or the history of Latinx or minority presence. By failing to include an investigation into the background and just investigating the present environment and Latinx presence, there is a failure to introduce the past as a possible answer to the issues being investigators. The issues faced by Latinx students are attributed to a failure by the student to acclimate and adapt to the STEM environment, and the successes are attributed to the Latinx student embracing status quo by adopting

the capital required by the environment. But at no point is their questions of why or how the climate was shaped to be what it is, if or how it has adapted to serve the Latinx population, or if the climate has anything to do with Latinx students experiences both positive or negative.

The researchers need to take into account the role of the environment when researching the students. STEM fields, academic research, and academia all place heavy emphasis on meritocracy, grit, and neutrality but no one person of group exists within a bubble. Investigators need to include the climate as a source of aid or hindrance to the student and include this in their research as it plays an important role in the development of Latinx students as scientist and students as well as how Latinx students react. Climates shaped by inequitable practices and policies need to be questioned and criticized as causes of difficulties and failures instead of the publishing Latinx students' individual and cultural traits as the reasons for lack of adaptation or reason to thrive. If the researcher embraces their role as a social reformer and includes the environment and its history as a major source of issues their work will identify oppressive policies and recognize that the status quo and the climate that STEM fields require Latinx students to adapt and acclimatize to rewards White privilege. Researchers ignore the fact that STEM field requires minorities to adopt traits of the dominant group (White men) and will only accept cultural capital that conforms to that of the dominant group. Researchers need to stop accepting and writing about the idea "grit, " and as a positive trait, Latinx and other disadvantaged students need to have to succeed in STEM. The idea of grit often is a crutch utilized by researches that allow researcher to avoid investigating the fact that the STEM educational system rewards the adoption of established dominant traits in science

and punishes the possession and application of cultural capital that does not conform to this narrative by stating that meritocracy is an important characteristic of STEM.

It is up to researchers to acknowledge that climate has a psychological effect on students and that these effects often explain Latinx students' success or failure in STEM. An example based on the findings found in both NSF funded studies and prior literature is the fact that Latinx and other minority groups in STEM often seek needed peer support when institutional or departmental support is inadequate or nonexistent. Often considered voluntary segregation, this practice of seeking peer support is often vital to many Latinx students to succeed in STEM but is resented and disapproved by the dominant group. The reasons to seek out peer support vary from student to student, but it is acknowledged that it is a way to supplement the lack of support Latinx and other minority groups find in STEM fields as well as resource utilized to find way to survive and succeed. What many investigators fail to acknowledge in detail when reporting these findings is that it is the STEM environment that causes Latinx students to seek support outside of the departmental support systems. Many investigators fail to identify the unique stresses Latinx students face in STEM, particularly if they attend PWIs, and that these stresses often differ from genetic adjustment problems faced by most students.

When discussing climate and its psychological effect on students researchers need to identify and discuss the stressed that Latinx students face in STEM. This can be achieved by acknowledging the intersecting identities of the Latinx students they are investigating and naming them as key factors in their study. In the studies utilized for this thesis, most investigators focused on the either the Latinx students racial or gender identity but failed to acknowledge that they were also utilizing other factors such as

socio-economic, generational, gender, ethnicity, or country of origin when conducting their study. By failing to acknowledge Latinx students intersecting identities when conducting their data collection investigators identification of stresses was off and their findings reflect the fact that they mainly asked their questions based on the students salient identities and received responses accordingly. When investigators are specific in detailing the intersecting identities they are investigating, their data collection methods reflect what they are looking for, and they receive the corresponding responses from students. These responses will be more accurate in detailing the climate stresses they student is experiencing, and the investigators are better able to identify not only what needs need to be met but the source of the stress.

It is through the employment of cultural appropriate methods that researchers can successfully study Latinx students in STEM (Bernal, 2012). Culturally appropriate research methods refer to methods that derivate from approaches developed to study traditionally aged, middle-class, White college students and instead utilize methods and theories that better accommodate the identities and experiences of Latinx students on campus. Through the use of culturally appropriate methods investigators can interact with students genuinely and respectfully and create the opportunity to gain the trust of a student population that has historically been studied through a deficit model (Bernal, 2002). Researchers who value Latinx students' experience-based knowledge and report these experiences as data relevant to the study often gain students trust. Latinx students will see the study as more equitable and respond accordingly. Researchers should consider the utilization of counter-storytelling and testimonials as these methods provide rich data that is often missed when solely relying on surveys or other quantitative data

collection methods. Culturally appropriate methods, especially counter-storytelling, will allow the investigator the opportunity to investigate student experiences through the eyes of the student instead just relying on the education and experience of the researcher. These methods create the opportunity to investigate issues with the climate and the environment as experienced by Latinx students and, through reverse engineering, allow the investigator to find the sources. Counter-storytelling will also detail how Latinx students view and identify racism and other forms of discrimination or macroaggression and what solutions they propose. Culturally appropriate methods are often adaptable to the intersecting identities being investigated and often address issues experienced by Latinx students as well as other minority groups.

Recommendations for Future Studies

Currently, literature on Latinx students in STEM is limited, and NSF funded studies are incredibly hard to locate. NSF grants are often hard to obtain and mainly are utilize to fund programs and initiatives to increase the enrollment, engagement, and degree completion of Latinx and other underrepresented minorities in STEM however only a few of the studies that utilized the money for programs and initiatives published the outcomes within 5-10 years of obtaining the award. A comprehensive investigation which program proposals receive awards would help create an understanding as what the NSF finds classifies to be impactful programs, would provide data as to the type of institutions where these programs will be implemented. Additionally, future research could investigate the impact and influence of researcher's positionality on the research they conduct. Researchers wield power, privilege, and status as the creators and production of knowledge and these positionalities have the potential to reproduce

inequalities in STEM education making this a good research topic as research studies have hard reaching affects.

Concluding Remarks

The purpose of this thesis was to examine if investigators who had obtained NSF funding to study Latinx students in STEM were perpetuating systems of oppression and inequity or resisting them through their research utilizing through a CRT and LatCrit lens. I found that many were. The NSF and this topic were chosen partially because the NSF is a major source of research funding in the United States and research produced by those awarded funding is influential due in part to the clout that the NSF has. Due to the influence these studies may have, the research by NSF when complicit in perpetuating systems of oppression and inequity has a significant possibility to influence future studies and the experiences of students in STEM. The literature on Latinx students in STEM is limited, and studies funded with NSF awards are often considered reputable. Additionally, the methods, approaches, and findings in these studies are often replicated, setting the tone for future research.

It was identified in this study that HSIs and MSIs were often the settings of the studies conducted by investigators due to the acknowledgment that the practices and environments of these institutions were conductive to Latinx student success in STEM. However, the main point of the findings is that racism, sexism, and other forms of discrimination in STEM is rarely acknowledged and that it needs to be addressed. The majority of investigators talk about issues that students face on campus or in the classroom (e.g. isolation) but never go beyond mentioning "chilly" climates. The studies that came the closest were the ones that applied culturally appropriate methods such as

counter-storytelling. Through the application of culturally appropriate methods, investigators and researchers are better able to identify present issues with the STEM environment and reveal the oppressive and inequitable practices that produce them.

The calls to produce research that addresses the issues of enrolling, retaining, and engaging Latinx students in STEM have long been present and the NSF has provided funding in order to find solutions that increase Latinx success in STEM education. However, researchers have often not met research goals to improve student experiences because the literature produced only describes symptoms that affect Latinx success but never address the fact that oppressive systems and the environments they create have a larger role than is acknowledged. If we consider that institutions most likely operating under a framework of interest convergence (e.g. institutions are run like businesses and won't hurt their own interests), diversity initiatives will more than likely encourage the enforcement of, and adherence to, assimilation of current norms (Barber, 2015). Limited approaches targeting underrepresented student groups will ignore structural and system changes because they do little to address the culture in STEM that contributes to the systematic inequalities (Barber, 2015). This will result in limited achievement of educational equity. Researchers conducting studies about STEM education continue to maintain scientific norms of objectivity and neutrality even when conducting research that calls for social reform. Research that fails to acknowledge that the current scientific climate affects Latinx student success will only produce findings that answer half of their questions. To answer the other half of the questions researchers will need to realize that students are instrumental as sources and creators of knowledge and that researchers will have to meet them halfway by adopting culturally appropriate methods (e.g. methods that

consider the historical context of Latinx students experiences in STEM) (Gonzalez &

Morison, 2016). Research that adequately addresses the needs and concerns of Latinx

students requires that the researcher adjust to the idea that they are taking the role of

social reformer.

Appendix A

Table A1. Articles Utilized, Awarding NSF Division, and Award Number

Authors	NSF Division	Award #
Camacho & Lord (2013)	Division of Human Resource Development	0734062 0734085
Camacho & Lord (2011a)	Division of Human Resource Development	0734062 0734085
Camacho & Lord (2011b)	Division of Undergraduate Education	0734062 0734085 0341127
Crisp, Reyes, & Doran (2017)	Division of Undergraduate Education	1340056
Dika, Pando, Tempest, & Foxx (2014)	Division of Engineering Education and Centers	1240299
Fleming, Burris, Smith, Bliss, Moore, & Bornmann (2014)	Division of Research on Learning in Formal and Informal Learning	1109121
Fleming, Smith, Williams, & Bliss (2013)	Division of Human Resource Development	1109598
Flores, Navarro, Lee, Addae, Gonzalez, Luna, Jacquez, Cooper, & Mitchell (2013)	Division of Human Resource Development	1036713
Gates, Hug, Thiry, Alo, Beheshti, Fernandez, & Adjouadi (2011)	Division of Computer and Network Systems	1042341
Lord & Camacho (2013)	Division of Human Resource Development	0734062
Malcom (2010)	Division of Undergraduate Education	0653280
Malcom, Dowd, & Yu (2010)	Division of Undergraduate Education	0653280
Moller, Banerjee, Bottia, Strearns, Mickelson, Dancy, Wright, & Valentino (2015)	Division of Undergraduate Education	0969286
Pando, Suarez, Rodriguez-Marek, Dika, Asimaki, Cox, & Wartman (2012)	Division of Civil, Mechanical & Manufacturing Innovation	1132373
Stokes, Levine, & Flessa (2015)	Directorate for Geosciences	0914401
Strayhorn, Bie, Long, & Barrett (2014)	Division of Research on Learning in Formal and Informal Learning	0747304
Strayhorn, Long, Kitchen, Williams, & Stentz (2013)	Division of Research on Learning in Formal and Informal Learning	0747304
Talley & Martinez Ortiz (2017)	Division of Undergraduate Education	1431578

Villa, Wandermurem, Hampton, & Esquinca (2016)	Division of Human Resource Development	1232447
Zimmerman, Johnson, Wambsgan, & Fuentes (2011)	Division of Research on Learning in Formal and Informal Learning	0737631

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