# STEM SUCCESS FOR ALL: HIGH SCHOOL TEACHERS' PERCEPTIONS AND PRACTICE OF CULTURALLY RELEVANT EDUCATION IN SCIENCE AND MATH CLASSES

by

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Dedication

This work is dedicated to my grandmother, Frances “Big Momma” Barton:

Your strength, tenacity, faith, and grace were a blueprint for my life.

I reach for higher heights because the strength of your shoulders lift me.

## Acknowledgements

To my father God from whom all blessings flow. You are the source of my strength, my provider, my peace, … my everything. I thank you for using me as a vessel to do your work. I am grateful and awestruck by your faithfulness to me and blessed do the hard work that must be done for the least of these.

To my husband, Christopher Boyce, your unconditional love and bottomless sacrifice are an indisputable reflection of God's love for me. You are my rock, when all else is sinking. You lift me up; you settle me down; you let me shine. I look forward to all of the adventures that are to come our way.

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To my friends and family: Thanks to each of you for your love and support during these four years. For every encouraging word and prayer you flung towards heaven on my behalf. Thank you for understanding when I didn't come, or couldn't stay long, or blew up, or shut down, or just cried. It takes a village to achieve greatness and you are mine!

To my ancestors and all those that paved the way for me to see the American dream realized. Thank you. Your sacrifice, strength, and fight have allowed me to stand here. I am your wildest dreams come alive!

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Abstract

STEM SUCCESS FOR ALL: HIGH SCHOOL TEACHERS' PERCEPTIONS AND PRACTICE OF CULTURALLY RELEVANT EDUCATION IN SCIENCE AND MATH CLASSES

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The lack of participation of historically underrepresented groups (i.e., Hispanics, Blacks, and women) in science, technology, engineering, and mathematics (STEM) is a serious issue in the United States. Despite the intentional efforts at increasing STEM participation, Black and Hispanic high school students graduate significantly less prepared for college-level mathematics and science than their White counterparts. As a result, they are more likely to underachieve in college and inadvertently continue the cycle of STEM underrepresentation in college.

Using an anti-deficit perspective, this study explored a single high school science and math department's teachers' perceptions about Culturally Relevant Education (CRE) practices as facilitating or hindering STEM interest and science and math achievement among students of color. The following four behaviors of culturally relevant educators were explored: (a) using culture as a bridge to

connect to academic skills and concepts, (b) facilitating students' critical reflection of their lives and society, (c) building students' cultural competence to take pride in their culture, and (d) critiquing of discourses of power to challenge the status quo. The study was conducted in a high school primarily serving students of color that has met and exceeded state expectations for the last four years.

The study found that CRE practices were, in fact, perceived by teachers to be key in promoting the interest and academic achievement of their students. The teachers cited meaningful relationships with students, connecting their students interest with math and science content, the incremental process of empowering students, and departmental collaboration as the key contributing factors to their overall success. Recommendations and implications for practice, research, and policy are included.

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# Chapter 1

## Introduction

The lack of participation of historically underrepresented groups (i.e., Hispanics, Blacks, and women) in the science, technology, engineering, and mathematics (STEM) fields is a serious issue in the United States (National Science and Technology Council [NSTC], 2013). This problem with representation can be traced back to high school, if not earlier. The 2016 ACT Corporation reported that Black and Hispanic high school students graduate significantly less prepared for college-level mathematics and science than their White counterparts. For instance, while half of the White graduates were prepared for college-level mathematics, the number decreased to 13% for Black and 27% for Hispanic high school graduates. There were similar differences in science with 47% White, 11% Black, and 21% Hispanic high school graduates with sufficient science skills (ACT, 2016b). This meant as many as 89% Black and 79% of Hispanic high school graduates were unprepared for college-level science. Table 1 illustrates the mathematics and science achievement disparities between Black, Hispanic, and White high school students across America as reported by ACT (2016a).

Table 1

*ACT-Tested High School Graduates Meeting ACT College Readiness Benchmarks by Race*

| Subject | Black | Hispanic | White |
|---|---|---|---|
| Mathematics | 13% | 27% | 50% |
| Science | 11% | 21% | 46% |

*Note.* Data retrieved from ACT (2016a).

In Texas, a similar disparity exists. While a majority of the White students achieve postsecondary readiness, only one-third or less of Black and Hispanic students attain the same level of college readiness. Specifically, in the academic year 2015-2016, Texas' Black students passed the statewide mathematics and science assessments measuring postsecondary readiness rates at 26% and 32%, respectively, and were 30% below their White peers (Texas Education Agency, 2016). When Black and Hispanic students graduate from high school ill-equipped to perform satisfactorily at the postsecondary level, they are more likely to underachieve in college and inadvertently continue the cycle of STEM underrepresentation in college (Aronson & Laughter, 2016; Beede et al., 2011; National Center for Education Statistics [NCES], 2015; NSTC, 2013). (See Table 2 for gaps in both mathematics and science achievement among racial groups on the state's standardized assessments.)

Table 2

*2015-2016 State Assessment Postsecondary Readiness Passing Percentages for Students by Race for Mathematics and Science in Texas*

| Subject | Black | Hispanic | White |
|---|---|---|---|
| Mathematics | 26% | 37% | 55% |
| Science | 32% | 40% | 61% |

*Note.* Data retrieved from Texas Education Agency (2015b, 2016).

Policy and educational leaders have begun to take notice and address the current shortage of Black and Hispanic Americans persisting in postsecondary STEM education to ensure that the future of innovation and creation in America is an inclusive endeavor (Arcidiacono, Aucejo, & Hotz, 2016; Bayer, 2012; Carpi, Ronan, Falconer, & Lents, 2016; Eisenhart et al., 2015; Foltz, Gannon, & Kirschmann, 2014; Kendricks & Arment, 2011; Renn & Lane, 2015). Since 2000, government programs and corporate partnerships have made concerted efforts to increase the participation of historically underrepresented groups in STEM (Landivar, 2013). Federal programs alone have spent upwards of $616 million in support of STEM education for these minoritized groups (National Science and Technology Council [NSTC], 2013). Colleges and universities have also developed interventions to support students of color in STEM fields such as mentoring programs and targeted financial incentives and scholarships (Arcidiacono et al., 2016; Bayer, 2012; Carpi et al., 2016; Foltz et al., 2014;

Kendricks & Arment, 2011; Renn & Lane, 2015). However, the NCES (2015) reported that the disparities persist. This is evident by looking at college graduation rates from 2008 to 2013 where Whites were awarded 68% of all STEM-related bachelor's degrees followed by Asians (13%), Hispanics (9%), and Blacks (8%) (NCES, 2015). Not surprising, these critical gaps extend into the workforce (Foltz et al., 2014).

In 2011, the U.S. Census's American Community Survey data showed 71% of STEM workers were White, 15% were Asian, 7% were Hispanic, and 6% were Black (Beede et al., 2013). These numbers were disproportional to the total national population with 13% of the population Black and 18% Hispanic (U.S. Census, 2016). This was particularly problematic because no occupational fields were projected to grow as rapidly over the next 20 years as careers in STEM fields (NSTC, 2013). The U.S. Bureau of Labor Statistics (BLS) projected that over 9 million STEM jobs would be created between 2012 and 2022 (Vilorio, 2014). These high-growth and high-salaried positions include: (a) mathematicians (median annual wage of $102,440), (b) software developers (median annual wage of $92,660), (c) biomedical engineers (median annual wage of $88,670), and (d) college biological science teachers (median annual wage of $75,740) (Vilorio, 2014).

The fact that Black and Hispanic students were less likely to seek employment in these areas is a challenge for three primary reasons identified by

the NSTC (2013). First, the NSTC (2013) determined the current number of STEM workers in the United States is insufficient to handle the demands of the growing jobs in STEM fields. Second, with underrepresented groups becoming the majority in many regions of the United States, the NSTC (2013) contended it is even more important to tap into this potential pool of professionals and equip them to work in STEM fields in the years to come. Third, NSTC (2013) concluded that the diversity of thoughts and ideas in the workforce strengthens America's innovation and contributes to the nation's competitiveness internationally. In order to combat this cycle of underrepresentation, Snively and Corsiglia (2001) argued for educators to make science and math relevant to Black and Hispanic students. They noted that these students of color are not members of the dominant, White group and may have learning styles that diverge culturally from traditionally Western contexts of learning (Snively & Corsiglia, 2001).

As a result of these varied cultural views, researchers have studied these cultural differences and found Black and Hispanic students benefit when teachers attempt to bridge the achievement gap by using *Culturally Relevant Educational* (CRE) practices (Aronson & Laughter, 2016; Gay, 2013; Ladson-Billings, 2014). With CRE, teachers actively make course content relevant to minoritized students and empower them to engage in the learning process (Aronson & Laughter, 2016). For instance, a non-CRE history or government teacher might ask students to stand and to recite the Pledge of Allegiance as a matter of habit; however, a

CRE history or government teacher might add an assignment requiring students to exercise their critical thinking skills and answer questions about how the Pledge applies to the lives of people in communities of color in America (Esposito & Swain, 2009). In an environmental science class, a non-CRE teacher may use examples from random rivers in America to make a point about the impact of pollution on communities; however, a CRE teacher might use a case concerning pollution in a river close to where the students live and have them take samples from that site to analyze and understand how that polluted river may, in fact, impact their own community (Dimick, 2012).

As seen in the above examples and derived from the multicultural education research produced in the 1990s, CRE allows teachers to combine two of the most well-known concepts in their lessons. These CRE concepts are *culturally responsive teaching* (CRT; Gay, 2010, 2013) and *culturally relevant pedagogy* (CRP; Ladson-Billings, 1995, 2006, 2014). In addition to these terms, researchers have long labeled the various tenets of CRE in many ways, including social justice education (Esposito & Swain, 2009), culturally relevant science pedagogy (Johnson, 2011), democratic science pedagogy (Basu & Barton, 2010), and social justice science education (Dimick, 2012).

For this research, I refer to culturally responsive education (CRE) as an umbrella term inclusive of social justice education and the ideas of CRT and CRP, as they are the two most commonly used approaches to CRE (Aronson &

Laughter, 2016). While CRT and CRP may seem similar at face value, there are nuanced differences (Herrera, Holmes, & Kavimandan, 2012). Gay (2002) defined CRT as "using the cultural characteristics, experiences, and perspectives of ethnically diverse students as conduits for teaching them more effectively" (p. 106). This approach enables teachers to focus on their teaching practices in the classroom in an effort to meet the needs of their students. CRP expands those teaching practices to include concepts of social justice that extend beyond the classroom. Ladson-Billings (1995a) defined CRP as:

> A pedagogy of opposition … committed to collective, not merely individual, empowerment. Culturally relevant pedagogy rests on three criteria or propositions: (a) Students must experience academic success; (b) students must develop and/or maintain cultural competence; and (c) students must develop a critical consciousness through which they challenge the status quo of the current social order. (p. 160)

CRP, then, requires teachers to enter the recursive process of acknowledging their own attitudes, dispositions, and worldviews, because teachers may hold beliefs that conflict with those of their minoritized students. By acknowledging their personal values and beliefs, teachers can attempt to reconcile their own perspectives with their students' values and viewpoints as they work toward bridging gaps in achievement for the students of color they serve (Aronson & Laughter, 2016). For example, non-CRP teachers may use language that devalues

minoritized students' preferred musical genre or academically irrelevant because it may clash with the teachers' own cultural inclination. Meanwhile, CRP-oriented teachers may challenge themselves to be open to and inclusive of the cultural differences they experience with diverse students by asking these students to discuss what they find appealing about their musical tastes (Milner, 2012). Despite their specific differences, both CRP and CRT are pedagogical tools used by CRE-oriented teachers to ground classrooms and promote social justice and educational equality (Aronson & Laughter, 2016).

Thus, CRE-oriented teachers reject the idea of teaching any standardized, one-size-fits-all curriculum developed according to the dominant culture's values. Culturally responsive educators actively interact with diverse students based on the students' experiences to enable them to gain and apply new knowledge both in and out of school (Rychly & Graves, 2012). Nonetheless, Aronson (2016) and others contend that because many science educators believe the content area is fact-based and context neutral, teachers are less likely to use culturally responsive practices in science or math classrooms. Further, other researchers (e.g., Brown & Crippen, 2016; Johnson, 2011) note that this context-neutral philosophy has led to a uniform approach to teaching science and math and contributed to minoritized students' decreased interest in STEM fields, which may have perpetuated the achievement gaps in those areas.

To date, researchers have explored these concerns, but the bulk of that research has been conducted from a deficit perspective (i.e., what contributes to problems; Harper, 2009; Schmidt, 2008; Seymour & Hewitt, 1997). Harper (2009) advocated taking a new approach to these challenges by applying an anti-deficit achievement framework, (i.e., what supports success) and emphasized the importance of diversity and social justice in STEM education. Moreover, much of the previous work using the anti-deficit perspective was focused on elementary, middle school, and college with few studies of science or math at the high school level (Johnson, 2011; Laughter & Adams, 2012; Milner, 2011). Further, the state of Texas assesses the success of subject areas (English, Science, Math, and Social Studies) by the achievement of the whole department in high schools (and not the success of individual teachers' class results), so more research is needed from a departmental perspective. The current study aims to address both issues by focusing on the perceptions of teachers in the science and math departments within a high school primarily serving students of color that continues to exceed state standards. More evidence about how CRE can benefit students of color enrolled in high school science and math may lead to better strategies for closing the achievement gap.

## Orienting Conceptual Framework

For this study, there were two guiding theories: Harper's (2010) anti-deficit achievement framework and Aronson and Laughter's (2016)

characteristics for culturally relevant education. First, the anti-deficit approach contradicts the common method of studying the inequities in academic achievement between Black students and their White counterparts. Rather, it advocates looking at what has helped these students succeed. Therefore, instead of focusing on the challenges that students faced, researchers ask about what contributed to their achievement.

The second framework guiding this study is from Aronson and Laughter (2016). They identified the following teacher behaviors that characterize CRE classrooms: (a) using culture as a bridge to connect to academic skills and concepts, (b) facilitating students' critical reflection of their lives and society, (c) building students' cultural competence to take pride in their culture, and (d) critiquing discourses of power to challenge the status quo (Aronson & Laughter, 2016). Both theories were helpful because the study focuses on how high school science and math teachers describe and use CRE practices in their successful classrooms and their perceptions about how their pedagogical approaches may facilitate (or hinder) STEM interest and science and math achievement among their students of color.

## Statement of the Problem

A longstanding achievement gap between White students and students of color persists. This gap is particularly acute among the STEM fields, which reward innovative thinking and lead to highly lucrative careers. While much

research has been done to illuminate the disparities in STEM education in America (Landivar, 2013; NCES, 2016; Office for Civil Rights, 2016), little research has been conducted about teacher perceptions regarding the use and impact of CRE on closing the science and math achievement gaps, especially in public high school education.

Much of the CRE-based research has been done on how culturally responsive educational practices help students of color succeed academically in English and social studies because many educators view these content areas as easier for incorporating CRE practices in the classroom (Bui & Fagen, 2013; Choi, 2013; Nykiel-Herbert, 2010; Souryasack & Lee, 2007). The view that science and math are context neutral has produced a standardized approach to teaching these subjects, led to limited interest in the subject matter for students of color, and contributed to the dramatic science and math achievement gaps for those students (Brown & Crippen, 2016; Johnson, 2011). Due to this misconception and based on their findings, Laughter and Adams (2012) recommended that "science teachers should practice culturally relevant science teaching… otherwise they are bound to reproduce science as an exclusive field for the benefit of a few" (p. 1129). Understanding how CRE benefits high school students from multiple high school science and math teachers' perspectives offers the unique opportunity to fill a gap in the research that has mainly focused on

single teacher case studies (Brown & Crippen, 2016; Fulton, 2009; Johnson, 2011; Milner, 2011).

## Purpose of the Study

Using an anti-deficit perspective, this study explored the perceptions of teachers from the science and math departments in a Texas high school that primarily serves students of color and has met or exceeded state expectations for standardized testing pass rates for the last four years. The goal was to discover the teachers' perspectives on the role of CRE practices as facilitating or hindering STEM interest and science and math achievement among students of color. The following four behaviors of culturally relevant educators were explored: (a) using culture as a bridge to connect to academic skills and concepts, (b) facilitating students' critical reflection of their lives and society, (c) building students cultural competence to take pride in their culture, and (d) critiquing discourses of power to challenge the status quo (Aronson & Laughter, 2016), because these elements of CRE may help explain the science and math teachers' successes with students of color in this specific high school.

## Research Questions

The research questions guiding this study are:

1. How do science and math teachers at a successful high school describe and demonstrate the use of culturally relevant education (i.e., using culture as a bridge to connect to academic skills and concepts,

facilitating students' critical reflection of their lives and society, building students cultural competence to take pride in their culture, and critiquing discourses of power to challenge the status quo) in their classrooms?

2. Do high school science and math teachers at a successful high school perceive CRE practices as promoting or hindering *the achievement of* their students of color and, if so, in what ways?
3. Do high school science and math teachers at a successful high school perceive CRE practices as promoting or hindering *the interest* of their students of color and, if so, in what ways?

## Position of the Researcher

Attending schools in low-income, minority majority areas as a child, I quickly came to realize that some teachers had the ability to connect with and help improve the lives of students like myself in powerful ways. I also watched other teachers come to our schools with low expectations of their students. They seemed to use the low-income schools serving students of color as a means to get the experience they needed so that they would be able to move to other districts. Understanding this made us feel like our school was disposable and, by extension, so were we.

After I finished college, I taught in the same low-income schools populated, primarily, by at-risk, students of color. I quickly learned that the way I

interacted with the students I taught was a big part of their success. Instead of exclusively teaching from the textbook, I scoured the internet for texts that appealed to my students' cultural interests and heritage. Tailoring the instructional experiences to the students enabled me to maintain high expectations for my students.

When I was a few years into my teaching career and in the early stages of my masters' degree, I discovered an entire body of research called "culturally responsive education" (CRE) that labeled, explained, and advocated for the strategies that were working for me in the classroom. At that point, I wanted to see if other teachers serving students of color found these practices led to positive results as well. If this was the case, it was my hope that policy makers and educational leaders would come to understand the power of CRE in classrooms, as opposed to the constant focus on standardized, one-size-fits-all instruction and assessments for student success.

## Definition of Key Terms

The terms that follow were used in the development of this study.

*Anti-deficit achievement framework*: According to this framework, research is driven by students' assets, models of success, and traits associated with persistence. In other words, researchers focus on the proliferation of what works for successful students, rather than what explains students' failures (Harper, 2010).

*Culturally responsive teaching*: This teaching strategy uses the cultural knowledge, prior experiences, and perspectives of diverse students to ensure learning is more appropriate and effective for the students in the classroom (Gay, 2002).

*Culturally relevant education*: This social justice pedagogy identifies four behaviors used as a cultural bridge by teachers to students. These behaviors are: (a) using culture as a bridge to connect to academic skills and concepts, (b) facilitating students' critical reflection of their lives and society, (c) building students' cultural competence to take pride in their culture, and (d) critiquing discourses of power to challenge the status quo (Aronson & Laughter, 2016).

*Minority-majority school:* A school in which the majority of students are students of color, such as Black, Hispanic, and/or Native American.

*STEM*: This term refers to fields related to science, technology, engineering, and mathematics (NSTC, 2013).

*Students of color*: As operationalized in this study, this term is used to collectively refer to the Black and Hispanic students as defined by the United States Census Bureau (Landivar, 2013).

## Significance of the Study

This study provides an anti-deficit point of view about one public high school's culture of success with the students of color in its science and math classes. Harper (2010) explicated:

> Most empirical studies amplify minoritized student failure and deficits instead of achievement. As such, we know little about those students who, despite all that we know about what complicates and undermines achievement for their particular racial groups, manage to successfully navigate their ways to college and through the STEM postsecondary pipeline. (p. 64)

Harper (2010) explained the anti-deficit approach as offering opportunities to answer questions about what students of color need to become prepared for college-level science and math and to narrow the academic achievement gap between White students and students of color.

Following Harper's (2010) assertion, this study's findings inform high school educators about what aspects of CRE have been most effective in the science and math classrooms at one successful high school primarily serving students of color in Texas. Further, this research may provide high school science and math educators with insights for understanding and generating best practices in their own classrooms. Finally, the study added to the body of knowledge regarding the use of culturally responsive practices in the science and math classrooms of a successful high school.

## Conclusion

Although leaders in various industries, government, and academia generally agree about the importance of STEM jobs in the workforce of

tomorrow, current disparities in STEM education have led to limiting access to those fields for students of color. This chapter has explained the current gaps in high school STEM achievement, STEM degree attainment in college, and the need for a more diverse STEM workforce, as well as an introduction to CRE as a possible way to bridge the gaps that persist.

# Chapter 2

## Literature Review

Many studies on the impact of Culturally Relevant Education (CRE) have explored the role of CRE in facilitating positive outcomes with students of color, specifically Black and Hispanic students, in schools. Because the research is limited on the use of CRE with high school students in math and science, this chapter includes the use of CRE at various grade levels and in many subject areas in an effort to illustrate its effectiveness in general. Thus, this literature review is divided into two main themes: CRE and teachers and CRE and students. The chapter concludes with the CRE and anti-deficit theoretical guides.

### Culturally Relevant Education and Teachers

Much research has been done to examine the link between teachers' pedagogical approaches and the role culturally relevant education has in improving teachers' instructional effectiveness in the classroom with students of color, in particular (Esposito & Swain, 2009; Johnson, 2011; Milner, 2011; Bonner & Adams, 2012; Brown & Crippen, 2016). Based on the findings from these studies, educators are encouraged to focus on four things in order to effectively adopt CRE practices: (a) rejecting deficit perspectives to build cultural competence, (b) aligning culture and academic standards, (c) cultivating consciousness, and (d) promoting culturally proficient learning communities. The section synthesizes the research findings that are specifically centered around

these items, which researchers consider essential when studying teachers' implementation of culturally responsiveness in their classrooms.

**Rejecting Deficit Perspectives to Build Cultural Competence**

In order for issues of achievement to be addressed, it is necessary to redefine the paradigm educators use to assess students of color. Irvine (2010) suggested that the idea of an achievement gap is nothing more than the manifestation of other gaps that have gone unaddressed by educators. One such gap is the low expectations and deficit mindsets many educators may have concerning students of color. With this assertion in mind, Milner (2012) explained that while most teachers attempt to teach all students, they sometimes lower expectations with students who resist or show opposition to the mainstream culture. In these situations, many teachers allow students to sit in their classrooms without providing engaging educational experiences for them.

CRE teachers reject such deficit mindsets and work to better understand the cultural capital their students already possess. Cultural capital refers to the knowledge, values, and ideas developed across generations in families and communities (Al-Fadhli & Kersen, 2010). By failing to recognize the benefits of cultural capital, teachers may inadvertently devalue their students' "culture, knowledge, language, tastes, and dispositions" (Saltman, 2014, p. 7) as a form of *symbolic violence*. In the classrooms of students of color, symbolic violence of this sort is a phenomenon experienced too often. Studies conducted by Ladson-

Billings (1995a), Milner (2012), and Irvine (2010) illustrated how teachers' use of CRE helped to shift the perspectives of the teachers and help them better understand students of color.

Yosso (2005) extends the concept of cultural capital arguing that *cultural wealth* forms from the capital created by the shared experiences that occur in communities of color. She called this unique set of knowledge and skills, Community Cultural Wealth (CCW) and listed the six types of CCW capital as "(1) aspirational, (2) navigational, (3) social, (4) linguistic, (5) familial, and (6) resistant capital" (p. 244). Yosso (2005) originally defined these six forms of capital as follows:

1. *Aspirational capital* is directly associated with the capacity to hold on to hope even in situations that seem to create insurmountable obstacles. This capital equips people in communities of color to understand the real and perceived barriers that exist in society and continue to strive for more nonetheless.
2. *Linguistic capital* refers to the fact that many students of color "arrive at school with multiple language and communication skills" (p. 78). Being bilingual affords these students benefits their monolingual counterparts do not receive. Visual art, music, and poetry are also included as forms of linguistic capital.

3. *Familial capital* finds value in the communal relationships that exist in communities of color. From the rich histories, oral traditions, unity, and even the adopting of community members into pseudo families, these relationships and the resources tied to them are highly valued.
4. *Social capital* refers to the skills provided by others to help one navigate through various societal institutions. This capital manifests in the form of emotional or instrumental support. This obligation for people in these communities to "lift as [they] climb" is a big part of how social capital is accumulated (p. 80).
5. *Navigational capital* requires a certain level of mental dexterity to maneuver through institutions that were not created for people of color. While systematic racism is engrained in many of the institutions that exist in our country, navigational capital sheds light on the importance of independence when moving through various institutions.
6. *Resistant capital* denotes the "skills fostered through oppositional behavior that challenges inequality" (p. 81). This aspect of cultural wealth implies that individuals realize the bigger implications of racist institutions and they fight against them. Those who possess resistant capital seek to change the structures they resist.

When educators take time to reframe the way they perceive students' cultural capital and broaden that definition to include the experiences of their students,

they position themselves to better understand the strengths of the students they serve and to build upon those strengths.

In addition to teachers understanding students' cultural capital, one of the most respected authorities on culturally relevant pedagogy, Ladson-Billings (1995a, 1995b), highlighted the importance of educators committing to CRE in order to build student's cultural competence. She (1995a) studied eight highly effective teachers of African American students over the course of three years. These teachers were nominated as outstanding educators by parents or principals because of their lower numbers of office referrals, higher levels of student attendance, and higher standardized test scores. Ladson-Billings conducted interviews, observed classrooms, and videotaped classroom instruction to collect data.

Ladson-Billings (1995a) found that the participants worked to build the cultural competence of their students. The term, cultural competence, refers to one's ability to retain their authenticity while working to gain new learning. One way to understand this idea is to consider that assimilating into traditional school environments is oftentimes referred to as "acting White" (Ladson-Billings, 1995a, p. 160) and is socially frowned upon by many students of color. Additionally, everything from their preferred way of dress or speak can be misunderstood by teachers, who are often White in Texas (Texas Education Agency, 2017). For this reason, teachers have to be keenly aware of how they view the varied strengths

their students bring into their classrooms and work to build up their sense of pride in themselves and their communities. While expanding teachers' understanding of students is a step in the right direction, CRE teachers go a step further by overtly helping students of color foster a sense of acceptance and pride for their own culture (Ladson-Billings, 1995a). Otherwise, teachers might inadvertently devalue their student's potential.

Despite their campus adopting scripted lessons that made it difficult for teachers to make the content personally meaningful and relevant to their specific students, Esposito and Swain (2009) reported that the seven teachers they interviewed committed to using culturally relevant pedagogy in their classrooms as a means to ensure students saw their needs reflected in the classroom. For instance, one teacher ensured her students saw images of positive African-American role models on the walls of the classroom even if the school did not provide funds for such things. Another teacher took time to address stereotypes students had about Africa and, in turn, their own ancestry to challenge the misconceptions they held. These teachers illustrate the power of the CRE classroom to build students' cultural competence and transform their own conceptions of self in the process.

While this idea of building cultural competence includes students understanding their own culture, it also refers to educators taking time to understand the differences between the students and themselves and how those

differences play out in classrooms (Esposito & Swain, 2009; Milner 2012). For instance, one Black teacher in Esposito and Swain's (2009) study acknowledged that her middle-class upbringing meant she had different cultural experiences than the students she served in the low-income area. These differences have the potential to cause conflicts in classrooms if teachers are unaware of how their own cultural identities may affect their students and the pedagogical decisions they make on a daily basis. CRE teachers must commit to this type of continuous and recursive reflection to ensure they are always working to better understand and uplift the students they serve, no matter how similar or different their cultural backgrounds.

Another such teacher is detailed in Milner's (2011) two-year case study of a White male science teacher's classroom in a diverse, urban school in the southeastern region of the United States. After conducting classroom observations, analysis of unspecified documents and artifacts, and multiple interviews with the science teacher, Milner (2011) noted that as the teacher built cultural understanding of his students, he became more culturally responsive and more effective. For example, as he developed meaningful relationships with the students, he realized this gave him greater insight into their specific needs. He also found it necessary to also share more of his own story with them. As a result, he built a mutual trust with his students. In the end, this teacher came to a deeper knowledge of himself and how his worldview impacted his practice. While some

educators view their personal backgrounds and culture as irrelevant to teaching content, this study's findings indicated that educators who work to build their students' cultural identities through the use of CRE actually build their own cultural competence in the process.

Rejecting deficit perspectives enabled researchers to reveal how understanding the varied forms of cultural capital students possess and building up students' cultural competence, which are the key elements of CRE, are necessary steps to engage and uplift their students.

**Aligning Culture and Academic Standards**

In the studies that follow, authors argue that it is not enough for teachers to appeal only to the cultural interests of students of color, they must also ensure the rigor incorporated by the performance standards to increase student achievement (Bonner & Adams, 2012; Brown & Crippen, 2016; Ellis et al., 2017; Hernandez, Morales, & Shroyer, 2013; Johnson, 2011; Ladson-Billings, 1995a). More specifically, Saifer, Edwards, Ellis, Ko, and Stuczynski (2011) explained culturally responsive teaching addresses "the needs of students by improving motivation and engagement, and standards-based teaching provides all students with the opportunity for rigorous, high-level learning. Culturally Responsive Standards-Based (CRSB) teaching means doing both, together" (p. 4). The marriage of these two ideas is the key to teachers' effective use of CRE strategies.

Effective implementation of CRE in science and math requires that teachers reject the myth of context-neutrality in these fields and find ways to consider both their students' interests and the content standards (Bonner & Adams, 2012; Brown & Crippen, 2016; Ellis et al., 2017; Hernandez et al., 2013; Ladson-Billing, 1995; Milner, 2012). Milner (2012) explained the context-neutral mindsets of some teachers as potentially troubling because educators and students live in social contexts; therefore, there exists a need to consider issues through students' perspectives. When teachers attempt to remain impartial in their approach, they forfeit the opportunity to address the realities of their schools and communities.

Illustrating this idea, Brown and Crippen (2016) interviewed five high school science teachers, conducted classroom observations, and collected artifacts (i.e., lesson study reports) to gain insights into the implementation of culturally responsive science practices in their classrooms. After the teachers participated in a six-month long professional development entitled, Science Teachers are Responsive to Students (STARTS), in which a portion of the training was dedicated to teaching the teachers about the essentials of implementing CRE in their science classes, the teachers implemented the CRE lessons they created with a group of culturally diverse students. In the end, Brown and Crippen (2016) found that effective implementation of CRE in science required teachers to learn about their students in order to incorporate the students' experiences and interests

in the science lessons. These findings revealed the importance of teachers being intentional about cultivating a strong knowledge of students' cultural backgrounds and the need to tie those interests into the science curriculum.

Other researchers also found the importance of making these connections. For instance, Mensah (2011) conducted a qualitative study into how three pre-service science teachers planned and executed a culturally responsive pollution unit. Using observations, interviews, informal conversations, and lesson plans as data sources, Mensah (2011) concluded that the implementation of culturally responsive teaching in the science class depended on the teachers' ability to make real-world connections to the content (e.g., impacts of pollution) as well as to students' personal interests (e.g., how such pollution impacts their community) in the lessons they brought to the classroom. In order for these things to happen, she noted that teachers must be trained to align culture and content in deep and meaningful ways. Hernandez et al. (2013) also conducted a qualitative study focused on defining the essential practices in culturally responsive math and science classes. After observing 12 preservice teachers' implementation of their lessons, they found that one of the most impactful practices was the ability to successfully integrate the cultural interests of students with the course content.

While the previous studies focused specifically on STEM subjects, the following research explores the use of CRE in other subjects and further demonstrates the impact of aligning culture and content in CRE classrooms. For

example, Ladson-Billing (1994, 1995a, 2006, 2014) highlighted how important it is for students to see their backgrounds included as part of course content as a means of affirming the importance of their culture in the learning process. For example, in one study, Ladson-Billings (1995a) reported how several reading teachers accomplished this task. She noted how one reading teacher used student-selected rap lyrics to teach poetry while another instructor welcomed parents to come in and teach students different life and job skills. Another teacher allowed students to speak their home languages in class, but taught them how to speak standard English as well, because this ability might be important to their future success. This skill is referred to as "code-switching" (p. 161), a term used to explain knowing the appropriate time to use an idiom, colloquialism, or language as opposed to totally using academic English. This effort to align students' pre-existing knowledge and cultural experiences with the new knowledge provided by school curriculum is the quintessential essence of successful CRE teachers.

**Cultivating Consciousness**

Despite the restrictive educational reforms, culturally relevant education (CRE) requires teachers to equip students to become conscious combatants of the injustices that impact society (Esposito & Swain, 2009; Hernandez et al., 2013; Ladson-Billings, 1995a). *Critical consciousness,* explained Ladson-Billings (1995a), is the idea that culturally relevant pedagogy must empower students to operate "beyond those individual characteristics of academic achievement and

cultural competence, students must develop a broader … consciousness that allows them to critique … institutions that produce and maintain social inequities" (p. 162). Teachers who participated in this seminal study had their civics students write letters to officials about community issues. This type of activity promoted a sense of critical consciousness that moved students toward thinking of themselves as agents of change. Notably, before teachers could create these learning opportunities, they had to reflect and commit to implementing such practices that were not included in the standard lesson plans found in the textbooks. This is a practice shared by teachers committed to CRE, which sets the focus of the teachers' practices outside the confines of the classroom and into impactful change in communities.

Esposito and Swain (2009) similarly found that this appeal to sociopolitical consciousness is a commonly used teacher practice when studying culturally responsive educators. *Sociopolitical consciousness* refers to the teacher's ability to teach students to think critically about the curriculum and the world around them. One example, briefly mentioned previously, would be the Pledge Activity. Instead of just requiring the students to stand and recite the Pledge of Allegiance, one of the teachers in this specific study designed an assignment requiring students to analyze the declarations made in it and how "one nation under God, indivisible… and justice for all" apply to Black people in America (Esposito & Swain, 2009). Exercises like this required the teachers to

push themselves out of the confines of the scripted curricula and encourage students to think critically about themselves and the world around them.

Further, Esposito and Swain (2009) argued that effective CRE teachers not only encourage students to become more conscious of the inequalities that surround them, but also these teachers instill a *sense of agency*, which refers to students' feelings of autonomy and self-efficacy when confronted with the truth of social injustice. The researchers stated that to achieve this goal, educators should not treat students as victims of their circumstances, but empower them to be change agents in their communities. When hearing students share stories of difficult life experiences, instead of responding with pity, the participating teachers challenged the students with questions, such as "How can we change this?" (Esposito & Swain, 2009, p. 42). By asking this type of question, teachers enable students to have a sense of autonomy not only for their own academic success, but more importantly the success of their communities.

The importance of instilling agency was an idea further supported by Hernandez et al. (2013), who studied 12 preservice teachers through their math and science classes to their final student teaching classes. They collected data through interviews, observations, and analysis of artifacts (i.e., lesson plans, teacher self-reflections, philosophy of teaching). The researchers determined that each teacher had illustrated evidence of implementing culturally responsive lessons. They did this by advocating for their students and constructing learning

opportunities that enabled students to challenge the systems and world views around them. The teachers also used real world examples of scientific and mathematical concepts, modeling, related their backgrounds to their students, built on students' background knowledge, hands-on activities, and incorporated the native language of the students (Hernandez et al., 2013).

While the approaches of teachers may vary, their ability to cultivate the consciousness of the students they teach is an essential characteristic of CRE classrooms. This consciousness allows students to better understand the importance of being good citizens, but also empowers them to understand how they may impact the world as well.

**Culturally Proficient Learning Communities**

Whereas, the earlier sections focused on what teachers can do in the classroom to contribute to student success, Lindsey et al. (2009) concentrated on teacher supports that can lay the foundation for more effective classroom pedagogy. They found, for CRE to be effective, teachers needed time to form communities with other teachers to discuss student data, plan lessons together, and engage in professional dialogue during the school day, such as through shared planning periods (Woodland, 2016). This view contradicts the traditional view that teachers are independent professionals, with autonomous control of their classes (Lortie, 2002) and having little time for collaboration with colleagues (Mayer & Phillips, 2012).

This perspective has gained popularity due to research on best practices in teaching (Colbert, 2010; Reeves, Hung, & Sun, 2017; Rinke, 2009; Woodland, 2016). In fact, despite the myriad names ascribed to this concept of teacher collaboration (e.g., team meetings, departmental meetings, collaboration time, professional learning communities), professional learning communities (PLC) have emerged as one of the most widely accepted strategies for teacher collaboration in PK-12 schools. While its implementation may look different in practice, the power of the PLC to impact student achievement has been the focus of many researchers (e.g., Lindsey, Jungwirth, Pahl, & Lindsey, 2009; Rinke, 2009; Vescio, Ross, & Adams, 2008).

For example, Woodland (2016) suggested that at the core of the PLC process teachers focus on the following essential questions to ensure effectiveness:

> (1) What should our students know, understand, and be able to do? (2) How will we know what and when our students have learned? and (3) What should we keep, stop, and/or start doing to ensure that students who don't learn, AND students who do learn, continue to make meaningful progress? (p. 507)

Put simply, Goodlad, Mantle-Bromley, and Goodlad (2004) suggested rigorous PLCs must include dialogue, decision-making, action, and evaluation. This four-step process offers a clearer path for PLC implementation in schools and allows

educators to engage in meaningful discussions focused on both student achievement and the instructional approaches created to help students reach learning goals.

While this structure is a strong start toward increasing teachers' intentionality and collective accountability, the strength of an effective PLC lies in the willingness of its members to participate in the process (Ronfeldt et al., 2015). For that reason, a team of teachers that fail to understand and/or connect to the culture of the students they serve could become accustomed to recycling ineffective teaching practices, if they fail to include the elements of cultural proficiency in their PLC process (Colbert, 2010).

Lindsey et al. (2009) regarded "cultural proficiency as a frame for communities of learners to intentionally focus on setting and reaching academic achievement goals for students who have historically not been well served by schools" (p. 4). Where many PLCs might place the focus on teacher collaboration and instructional strategies, adding a culturally proficient lens to these meetings requires teachers to reflect on contexts beyond the data and numbers and challenge their own thinking and approaches to pedagogy as a team (Lindsey et al., 2009). Lindsey et al. (2009) provided the example of a school district, Maple View School District (MVSD), working to incorporate the following five essential elements of culturally proficient practices: (a) assessing cultural

knowledge, (b) valuing diversity, (c) managing the dynamics of difference, (d) adapting to diversity, and (f) institutionalizing cultural knowledge.

As a part of its improvement plan, the district focused on using *culturally proficient learning communities* as a means to rethink how they approached matters of diversity and improving student achievement. This plan required "a shift from the language of blaming the students and their circumstances to the language of personal responsibility for teaching and learning" (Lindsey et al., 2009, p. 58). In addition to collecting and analyzing data in education, Lindsey et al. (2008) promoted connecting with students and their families and working to become more culturally proficient as the key to increasing the instructional effectiveness of professional learning communities.

Similarly, Ndunda, Sickle, Perry, and Capelloni (2017) found a positive impact on student learning when math and science teachers at a Title 1 urban school worked together to include culturally relevant approaches to instruction. Ndunda et al. (2017) noted that three themes emerged as essential: an ethics of care, teacher agency, and aesthetics of professional interactions. An *ethics of care* refers to the teachers desire to support each other in an effort to better serve students. When teachers saw a positive impact on their students, they were more likely to seek and try more strategies as a team. *Teacher agency* refers to the teachers' view of themselves as change agents. As the teachers experienced success in the classrooms, they began to feel more empowered as professionals.

*Aesthetics of professional interactions* refers to the PLC members being openly vulnerable with each other and willing to taking risks alongside each other. All three themes played an important role with the PLC team as they worked to be more culturally proficient in their math and science classes.

As a result of their efforts, the math assessments indicated 15% of the students had basic math skills at the onset of the study, and by the end of the PLC intervention, 50% of them had mastered the standards. Likewise, in science, after the 15-week PLC intervention 70% to 92% of students were passing the science assessment, as opposed to the 11% pass rate at the onset of the study. These outcomes showed how a focus on culturally responsive PLC implementation can be used to positively impact teachers' instructional effectiveness in their classrooms.

Consequently, from the seminal work of Ladson-Billings (1994, 1995a) to the more contemporary studies of CRE in recent years (Brown & Crippen, 2016; Ellis et al., 2017; Hernandez et al., 2013; Lindsey et al., 2009; Ndunda et al., 2017), research affirms the positive impact of CRE on teaching practices and student achievement. These studies postulated that CRE teachers working toward rejecting deficit perspectives to build cultural competence, aligning culture and academic standards, fostering the social consciousness of their students, and engaging in culturally proficient learning communities are essential partners in improving instructional effectiveness of students of color (Bonner & Adams,

2012, Lindsey et al., 2009; Yosso, 2005). While CRE practices can be beneficial to teachers' perceptions of practice and cultural understanding, the following section provides insight into students' perspectives concerning CRE and how CRE classrooms impacted their learning in specific subject areas.

## Culturally Relevant Education and Students

Although there is limited research that specifically investigates CRE in science and math classrooms, many studies have been done focusing on culturally relevant education and its impact on students of color (Basu & Barton, 2010; Boutte, Kelly-Jackson, & Johnson, 2010; Dimick, 2012; Laughter & Adams, 2012) in other subjects. This section discusses CRE and science, mathematics, social studies, and English/language arts classrooms. These studies shed light on the impact CRE has had on student engagement/motivation, empowerment, and academic achievement from the students' perspectives, primarily.

### Science and CRE

To better understand the impact of social justice science education, Dimick (2012) studied one White male environmental science teacher, Mr. Carson, whose urban high school class consisted of 24 Black students. Carson implemented culturally responsive, social justice projects in his classroom. For example, The Green River Project (GRP) was created to give students an experiential learning opportunity to study one of the most polluted rivers on the country and how "environmental pollutants disproportionately affect people of

color and poor communities" (Dimick, 2012, p. 999). This science project took students outside of the classroom to see how social injustices related to the science content were applicable in their own environment and then to research possible ways to combat such injustices.

Dimick (2012) acted as a participant observer in the classroom over one semester, reviewed the curriculum and texts used in class, conducted multiple interviews with the environmental science teacher, and facilitated five focus groups with nine students who represented the low to high range of academic ability found in the class. The focus group students reported the educational experiences in the environmental science class allowed them to link the things they learned in class to real events occurring in their community and raise their "consciousness about the environmental problems and, by extension, social injustices they experienced living near the river" (p. 999). Dimick (2012) concluded the nine Black students became more engaged in the science class and attained a sense of empowerment due to the class' projects that connected them to the community.

Basu and Barton (2010) came to similar conclusions when studying 21 students of color and their ideas about teachers using Democratic Science Pedagogy (DSP). DSP provided an opportunity to engage in a "less authoritarian, more democratic relationship between teachers and students in which students have increased choice, voice, and authority" (p. 74). One example reported by a

student included having options to read a science text that related to their own interests. The researchers noted this increased engagement as key to unlocking the potential of students of color in the classroom.

While engagement and empowerment matters, the following research studies explored academic achievement in culturally responsive science classrooms. For example, Laughter and Adams (2012) employed the use of qualitative methods to study the outcome of culturally relevant science teaching in an urban characteristic middle school science classroom. The term, *urban characteristic*, refers to a school that faces similar challenges as an urban school, although it is not necessarily located in a major city. Through semi-structured interviews, observations, and classroom artifacts (i.e. student-generated discussion lab questions related to the reading), Laughter and Adams (2012) studied one teacher's implementation of a culturally relevant science unit and its impact on the students[1].

Laughter and Adams (2012) found that students were more eager to grapple with the science curriculum and engage with the academic language in a meaningful way when the information was couched in their personal worldview. Students began to understand science as a means to combat social injustices around them. Laughter and Adams (2012) concluded that culturally responsive

[1] Readers are encouraged to refer to Chapter 1's Orienting Conceptual Framework discussion for additional details about the pedagogy employed in Laughter and Adams' 2012 study.

science is essential for the advancement of the equality in science agenda to which many educators claim to subscribe. Students relating to the content and viewing it as a vehicle to improve the communities they occupy is the true mark of academic achievement.

Similarly, Boutte et al. (2010) studied the instructional practices of a teacher implementing culturally relevant science instruction with Black students in a high school classroom in an effort to "bridge the distances between school instruction and ways of knowing and realities within the homes and communities of culturally diverse students" (p. 2). One example of a culturally responsive lesson required students to draw comparisons between cell structures and items they encounter in everyday life. Instead of giving all students the same teacher-generated terms to memorize, this lesson allowed students to make original analogies based on things that were memorable to them. After creating the analogies, the students created collages using visuals that related the science concepts to their everyday experiences. The teacher in this case study also exposed students to Black scientists who may not have been included in the curriculum to enable them to understand and identify with the broader contributions of non-White scientists. This intentional exposure to diverse scientists allowed the students to see scholars who looked like them. Through the analysis of several culturally responsive classroom science activities, Boutte et al. (2010) discovered that when the teacher implemented the culturally relevant

science instruction students had higher passing grades on vocabulary tests and gained the ability to use the academic vocabulary and concepts they acquired in science class in their everyday lives (e.g., considering which hair/skin products to purchase, understanding product safety testing procedures).

In the same vein, Stevens, Andrade, and Page (2016) studied a culturally relevant science program for Native American elementary and secondary students. While the Native American demographic is not the focus of my current study, this study similarly explored how CRE contributed to the academic achievement of another group of underrepresented students. This program made a point to construct science learning in a way that drew on students' prior knowledge and linked them to new concepts. For instance, when learning about earth, space, and soil, students were given opportunities to leave the classroom and text books behind and venture to a local agriculture center to study the practices of Native Americans' and desert farming (Stevens et al., 2016). This unit also included lessons on how to create edible soil, Native American soil paintings, and careers related to soil science in general. According to the researchers, these practices "led [students] to greater understanding… and the ability to re-teach others, thereby increasing their self-efficacy and their pride in their culture" (Stevens et al., 2016, p. 958). Intentional connections to the culture and heritage of this historically marginalized student group motivated them to

engage in the content, which resulted in improved academic achievement (Stevens et al., 2016).

These studies highlighted some of the success seen with CRE in science classrooms specifically. The research suggests that culturally responsive approaches to instruction left students of color more engaged, motivated, empowered, and/or achieving academically. The next section explores the research available on Math and CRE, another content neutral subject.

**Math and CRE**

Even though there is limited research available on CRE and science, more studies at all school levels were focused on CRE and math. Hubert (2013) conducted a case study in a high school mathematics class where the teacher employed CRE practices. Specifically, while the 37 students in the class were studying quadratic and exponential functions, the students were given opportunities to select lessons that covered a range of topics that were responsive to their interests and rooted in real-life scenarios. These topics included teen pregnancy, HIV, teen smoking, football and soccer, and saving money.

Hubert (2013) interviewed five of the students (i.e., two Black, one mixed race, one White, and one Hispanic student) two weeks after the conclusion of the 10-day CRE intervention to explore their perceptions of using culturally relevant pedagogy (CRP) in the class. He found the students appreciated having options to choose lessons based on their interests. For example, one student reported feeling

she "could relate to the teen pregnancy lessons because her sister is a teenager and has two babies" (p. 330). In all, Hubert's (2013) five participants reported improved attitudes and greater interest in mathematics because of the CRP-driven content. Creating these organic connections to the lives of the students increased their willingness to engage with the content of the math class and motivated students intrinsically (Hubert, 2013).

Fulton (2009) similarly discovered that middle school students reported having a deeper understanding of the math content as a result of their teachers' commitment to using culturally responsive teaching. In this qualitative case study, Fulton (2009) conducted classroom observations where she discovered teachers using specific practices (i.e. individual, small, and whole group problem solving; incorporating thinking strategies; and using problems that covered important content and were engaging) in an effort to create more culturally responsive classrooms.

In addition to teacher interviews, Fulton (2009) conducted focus groups with 12 participating students to get an understanding of their perspectives of the effectiveness of the practices their teachers used in the classroom. In the focus groups, students reported feeling a deeper connection to the math content in addition to gaining a better understanding of each other's perspectives. Fulton (2009) concluded, "through constant and deliberate uses of specific [culturally responsive] teaching behaviors… teachers in my study were able to produce

learning environments that allowed students who have expanded ideas about mathematics and healthy notions about their own ability to be successful as mathematical thinkers" (p. 107). This sense of empowerment described by the students in this study is quintessential for more students of color to experience academic achievement.

Likewise, Cholewa, Goodman, West-Olatunji, and Amatea (2014) found that as early as elementary school, culturally responsive practices positively impacted students of color in math. In their study of an outstanding fifth-grade math teacher, Ms. Morris, who was nominated by parents and the principal as an effective teacher at a school with majority Black students, they concluded her success was rooted in her commitment to "building on experiences and existing knowledge, integrating music and dance, and utilizing familiar communications styles" (Cholewa et al., 2014, p. 581). The researchers noted that students in Ms. Morris' classes exhibited positive characteristics that included "zest, empowerment, clarity, sense of worth, and feelings of connection" (Cholewa et al., 2014, p. 579). This study further illustrates how the CRE practices have the power to motivate and empower students of various ages when they are properly implemented.

The previous studies were focused on small case studies, but Langlie (2008) used the 1988 National Educational Longitudinal Study database to explore how Black and Hispanic 10th-grade students were impacted by their math

teachers' use of culturally responsive practices. In order to determine the relationship between CRP practices and student achievement, the researcher conducted standard multiple regression analysis. Based on the findings, Langlie (2008) concluded that teachers who emphasized math in the everyday lives of the students "encourage their students to become interested in mathematics and encourage students to understand the applications of mathematics… will achieve more in mathematics" (p. 6). Cultural responsiveness takes foreign content and connects it directly to the knowledge that students of color possess. This kind of connection is a major tenet of CRE and is a hallmark of academic achievement.

**English/Language Arts and CRE**

Though outside of the scope of this study and its STEM focus, the bulk of research on CRE has focused on context-driven subjects. Therefore, the next sections include literature on English/language arts and social studies, as they shed light on students' perceptions of their learning motivation and empowerment and the impact of CRE in the classroom. These studies illustrate that when teachers make concerted efforts to use culturally responsive instruction in their classrooms, students not only feel more connected to the content, but they also feel empowered to succeed.

Implementation of CRE has been linked to increased student motivation in ELA classrooms. Hill (2012) used a mixed-methods approach to study two teachers' culturally responsive practices and their perceptions of those practices

with 24 high school students on the South Side of Chicago. Through the teachers' use of specific methods, such as cultural metaphors and personally relevant examples, discussion circles, and teaching literacy skills from basic to complex, students reported feeling motivated in the English class. Further, they gained a sense of connectedness to the curriculum and how it applied to their personal lives (Hill, 2012). Christianakis (2011) reached similar results in a study that looked at the impact of a language arts teachers' use of rap music in a fifth- grade classroom. Using rap and poetry in conjunction with the language arts curriculum made students report feeling more engaged and motivated to do the work required of them.

In another study with elementary-aged students in a language arts classroom, Bui and Fagen (2013) explored if the teachers' use of culturally responsive teaching approaches (i.e. story grammar instruction, word webs, activating prior knowledge, prediction strategies, multicultural literature and cooperative learning) led to increases in student learning. The researchers (2013) reported one group of students moved from frustration level to being ready for instruction according to the data from the pretest and posttest provided by the 49 participants. While no one instructional practice claimed to fix all of the educational disparities with these students of color, the utilization of CRT practices helped them move pass their initial frustrations with the content and connected them with the learning in the classroom.

Duncan-Andrade (2007) studied four highly effective English teachers in elementary and high school over three years in southern Los Angeles. The teachers were selected to participate because they were recommended by their peers and campus leaders, their students attained good grades and test scores, and they utilized social justice pedagogy as is explained below. Their focus on social justice allowed for equalizing the voices of marginalized cultures with the voices of the dominant culture. Duncan-Andrade (2007) investigated teachers' use of social justice pedagogy. For example, instead of using the scripted curriculum's persuasive writing prompt asking students to write about choosing teams at recess, one of the teachers in the study created a prompt requiring students to write a persuasive letter to their principal discussing a problem they experienced in the school and why it was important to fix it. The project culminated with students writing letters to their superintendent, and one student-selected representative sharing his letter and voicing legitimate concerns for change in their schools and community.

In the end, Duncan-Andrade (2007) discovered five common practices that emerged as pillars for success with the participating teachers in urban school settings. First, *critically conscious purpose* refers to the teachers' ability to build "intellectually rigorous lessons that are relevant to the real and immediate conditions of their students' lives so that students can think and respond critically for themselves" (Duncan-Andrade, 2007, p. 627). Second, *duty* suggests teachers

have a sense of responsibility and connectedness to the communities in which they teach. Third, *preparation* means these teachers spend time preparing for classes, as they gather resources to supplement scripted curriculum. Fourth, *Socratic sensibility* describes the teachers' ability to exhibit great "balance between confidence in their ability as teachers and frequent self-critique" (Duncan-Andrade, 2007, p. 632). Fifth, *trust* refers to teachers' willingness to proceed with the notion that reliance must be established and maintained with students in urban populations, as students do not automatically bestow trust on educators. Duncan-Andrade (2007) found that the participating teachers' commitment to implementing these five pillars of effective practice in urban settings led to the students' academic successes. Although the curriculum may vary from science and math to language arts, this body of research suggests the same types of engagement, empowerment, and academic achievement can be possible when aspects of CRE are implemented with fidelity in the classroom.

**Social Studies and CRE**

Considered by many to be one of the more ideal subject matters for cultural responsiveness and cultivating social justice, social studies research also reported great benefits for student outcomes in classrooms. For example, Martell (2013), a White male, examined his own New York high school history class in which he incorporated culturally relevant teaching in several ways. For example, he included reading materials related to the backgrounds of his students, used

diverse accounts of history that included people of color, and required students write research papers where they reflect on their cultures in relation to American history.

In the study, Martell (2013) conducted interviews with three Hispanic students and one Black student regarding their perceptions of CRT practices in the class. In the end, he found the interview participants felt empowered by the way he used these culturally relevant practices to connect their racial backgrounds to the content taught in history class. Second, Martell (2013) administered a survey to all his students ($N$=74) and compared responses by race (Black versus White) with independent sample $t$-tests and found that both Black and White students responded similarly to the items, regardless of race. The survey data revealed 71.4% of the Black and Hispanic students liked learning about history as a result of the CRT pedagogy used, and 81.7% of the Black and Hispanic students reported recalling more historical information from this class compared to their recollection of what they learned in previous history classes.

Coughran (2012) also explored the impact of culturally relevant pedagogy in her elementary school social science classroom by incorporating students' lived experiences of race in society with her curriculum. Based on post-lesson discussions and student interviews, students reported feeling more connected to the curriculum and to each other. The ability to make standard curriculum more dynamic for diverse groups of students is evident in the responses of the students

who reported feeling excited about learning the content and engaging in the classroom activities.

However, even though Martell (2013) and Coughran (2012) reported positive findings about the use of CRP in their own classrooms, as self-studies their findings may be considered suspect (Gall, Gall, & Borg, 2003). On the other hand, Choi (2013) researched the effectiveness of an exemplary (as identified through snowball sampling and community nominations) social studies teacher, Mr. Moon, and his implementation of CRP at a public high school that served students from more than 50 countries. Choi (2013) gathered data for this case study through classroom observations, three one-hour interviews with Mr. Moon, and artifacts (i.e. handouts, quizzes, and homework) over six months. The researcher reported that Mr. Moon challenged the standard curriculum by including the history and experiences of the students he served. For instance, he designed a "month-long unit on China addressing the dynamic geographical characteristics of China… and he led group projects in topographical map making" (Choi, 2013, p. 14). Choi (2013) found that students' academic engagement and achievement increased "as evidenced and observed by their active participation in learning, critical thinking/analysis skills development, and cooperative knowledge construction" (p. 17). He credited the implementation of CRP in Moon's social studies class for the positive outcomes.

Durm (2016) conducted a study looking specifically at the experiences of Black male students in social studies classes at different schools. The teachers noted their intentionality in combating stereotypes by discussing historical figures that otherwise were not included in the school's traditional texts. The students reported feeling positive about their social studies teachers, as well as empowered by learning about their own history. The students also acknowledged that when they learned about the resilience demonstrated by their ancestors in history, it moved them from feelings of victimhood to agents of change (Durm, 2016). This is the power of cultural responsiveness in the social studies classroom.

In the end, the CRE researchers discussed here reported that culturally responsive practices helped increase students' motivation, engagement, empowerment, and academic performance. Also, CRE researchers noted that gaining cultural awareness caused teachers to learn about their students so that students and teachers could become partners in the pursuit of social justice. While the reviewed studies spanned a range of content areas, most research was conducted with individual classrooms with teachers teaching one specific course. Therefore, research that includes several secondary science and math classrooms within two departments that have been successful in teaching students of color is needed.

## Theory

Two theoretical frameworks serve as the lens in this study: (a) Harper's (2010) anti-deficit achievement and (b) Aronson and Laughter's (2016) culturally relevant education. Harper's (2010) anti-deficit theory focuses on seeing the strengths rather than the challenges of underrepresented groups while Aronson and Laughter's (2016) CRE theory details ways teachers can incorporate the cultural backgrounds of their students in their classrooms. Both theoretical approaches have been found to benefit students of color. I discuss these theories in more detail in this section.

Most researchers do not seek out information about assets, models of success, and traits associated with persistence when studying students of color (Harper, 2009, 2010; Schmidt, 2008; Seymour & Hewitt, 1997; Yosso, 2005). However, Harper's (2009) anti-deficit line of inquiry offers the opportunity to proliferate anti-deficit, or more importantly, asset-oriented educational innovations, such as culturally relevant education. This approach provided guidance for investigating a campus where students of color were achieving success to shed light on what teachers do to support the students' achievement, which is the goal of this study. In the anti-deficit approach, the inquiry is based on examples of what practices work rather than on what problems are overcome.

Culturally relevant education has been the subject of several theorists (e.g., Aronson & Laughter, 2016; Delpit, 1992; Dover, 2013). Based on the work

of Delpit (1992), Dover (2013) labeled four "constructivist methods" for using CRE in a classroom: (a) use of culture as a bridge for academic skills and concepts, (b) critical reflection, (c) cultural competence, and (d) the critique of discourses of power (p. 6). The first behavior is related to teachers' ability to *use of culture as a bridge to connect to academic skills and concepts*. CRE teachers incorporate their students' cultural backgrounds in their classrooms and connect the students' ways of understanding to the academic skills and concepts mandated by the curriculum (Aronson & Laughter, 2016). For example, when the discussion lab teacher, Ms. Adams, designed the lesson[2] for her culturally diverse students, she wanted to choose a book that would interest the students (Laughter & Adams, 2012). However, she had to consider what book could address the academic skills and concepts as her state's standards required as well. Ms. Adams identified three state standards addressed in the selected text that she believed would also engage her culturally diverse students. This choice is an example of how she linked the students' backgrounds and the curricular demands.

The second behavior is evidenced by the teachers' *facilitation of students' critical reflection of their lives and society*. CRE teachers employ classroom activities and opportunities for students' critical reflection of their lives and

[2] The science lesson was based on Derrick Bell's (1992) short story titled "The Space Traders" (TST) and the TST discussion lab taught by co-author Adams (Laughter & Adams, 2012).

society (Dover, 2013). In the discussion lab, Ms. Adams selected a book in which a group of space aliens arrives in the United States unexpectedly. This story line allowed her to facilitate conversations about the parallels between beings from outer space and immigrants new to this country as well as how race relations impact social, political, and economic interactions in society under the umbrella of science. This subject matter encouraged the type of critical reflection CRE teachers hope to foster in their classrooms (Laughter & Adams, 2012).

The third behavior is teachers' capability to *build students' cultural competence to take pride in their culture*. CRE teachers equip their students with the cultural competence necessary to understand and take pride in their own cultures while also learning and appreciating the cultures of others (Dover, 2013). The discussion lab in Ms. Adams' science class offered all students the opportunity to learn about the cultural experiences of students who are immigrants. Some non-CRE teachers limit the idea of cultural competence in science to tasting the foods of other cultures during holiday celebrations because of the physical and chemical reactions involved in cooking and surface activities that are similar in nature. CRE teachers, like Adams, provide lessons that allow students to develop a deeper sense of cultural competence by planning discussions that require students to hear and understand each other's varied experiences and perspectives about life (Laughter & Adams, 2012).

And, lastly, CRE teachers use *critique of discourses of power* with intentionality. CRE teachers expose oppression among institutional systems and facilitate understanding of the presence and functioning of power structures within their environments (Aronson & Laughter, 2016). For example, in Adams' math lab, students discussed questions such as: (a) "Black Americans make up about 30% of the population. If we lost that many people what do you think would happen to the economy?" (Laughter & Adams, 2012, p. 1125); (b) "Do you think having a Black president means the U.S. is not racist?" (p. 1124). This approach coupled math concepts (e.g., figuring population percentages in varying situations) with a social context that connected with the students in the classroom (i.e., the impact of black people on the economy). While this line of inquiry may be uncomfortable for some people at first, CRE teachers understand how using unsettling topics and moments to facilitate a conversation is necessary to help students understand the nature of power within institutions.

Therefore, both CRE and Harper's (2009, 2010) anti-deficit approach provide novel tools to better understand high school science and math teachers' perceptions of what contributes to the success of their department's success with students of color. The current study and these theoretical perspectives help fill the gap in the literature regarding the use of CRE in successful high school science and math department's classrooms. This is significant because of the importance

of science and math education and the dearth of research into CRE practices within this field.

# Chapter 3

## Methods

The purpose of this study was to examine the perceptions and practices of a successful high school's science and math departments' teachers primarily serving students of color. I sought to capture the teachers' perceptions about how CRE practices facilitated or hindered interest and achievement among students of color. Qualitative research methodology was used because it captures the experience of science and math teachers within their natural settings, while simultaneously exploring "the complexity of social interactions as expressed in daily life and with the meanings the participants themselves attribute to these interactions" (Marshall & Rossman, 1999, p. 2). This research is also a case study, because it highlights the perceptions of subject-focused teachers at one Texas high school serving students of color. It does not claim to represent the experience of teachers at other schools in the district, state, or nation. Yet, it provides insights within this bounded context (Yin, 2014). The research questions guiding this study were:

1. How do science and math teachers at a successful high school describe and demonstrate the use of culturally responsive education (i.e., using culture as a bridge to connect to academic skills and concepts, facilitating students' critical reflection of their lives and society, building students cultural competence to take pride in their culture,

and critiquing discourses of power to challenge the status quo) in their classrooms?

2. Do high school science and math teachers at a successful high school perceive CRE practices as promoting or hindering *the science achievement of* their students of color and, if so, in what ways?
3. Do high school science and math teachers at a successful high school perceive CRE practices as promoting or hindering *an interest in science* by their students of color and, if so, in what ways?

The sections that follow detail the study site, research design, participants, data collection, data analysis, limitations and delimitations, and the strategies used to ensure trustworthiness.

## Study Site

The study site for this research was a public comprehensive high school referred to with the pseudonym North Woods Academy (NWA). It was the only high school serving a small school district, located in a suburb in Texas. Even though NWA was located in a suburban town, it had urban school characteristics (Milner, 2012) by serving a population of about 2,000 students, of which the majority were students of color in Grades 9 through 12 and 80% were economically disadvantaged. The ethnic distribution of the student population was 78% Black, 18% Hispanic, 1% White, and 3% Other (Texas Education Agency, 2016). The high school's success was shown through its accomplishments with

meeting state standards of accountability on their campus report card and cutting-edge academic programs in STEM as well as Advanced Placement (AP), International Baccalaureate (IB), and dual high school and college credit course access (Texas Education Agency, 2016).

Since 2013-2014, the state required all high school freshman to take the State of Texas Assessment of Academic Readiness (STAAR) End-of-Course (EOC) exams for the courses of Biology I and for Algebra I. Spring of 2013 was the last time Algebra II was a required EOC course. However, as of May of 2016, school districts could choose to offer the Algebra II EOC to their students strictly for purposes of testing for college readiness and not as an accountability tool (Texas Education Agency, 2015a).

NWA met the state's required standards for ensuring the majority of students pass high school science and math (Texas Education Agency, 2017). The 2016-2017 school report card issued by the Texas Education Agency indicated NWA exceeded the state's target passing scores in all four performance indices: Index 1: Student Achievement, Index 2: Student Progress, Index 3: Closing Performance Gaps, and Index 4: Postsecondary Readiness Score. By these state standards, the campus met standard. Due to the holistic assessment of the performance indices, the school is considered successful, thereby making it the ideal site for a study taking an anti-deficit approach to studying students of color.

Tables 3 and 4 show the passing percentages for students who took the Biology I and Algebra I tests at NWA between 2013 and 2017. Notably, the highest passing percentage for Biology I was 88% in 2014-2015. The highest passing percentage for Algebra I was 68% in 2016-2017. Both subjects yielded the lowest passing percentages for NWA in 2012-2013, as the first year of the STAAR era of accountability.

Table 3

*2013-2017 State Passing Percentages for Students by Race for Biology I EOC*

| Year | All | Black | Hispanic | White |
|---|---|---|---|---|
| 2012-2013 | 73% | 71% | 79% | 63% |
| 2013-2014 | 81% | 81% | 78% | 82% |
| 2014-2015 | 88% | 87% | 90% | * |
| 2015-2016 | 82% | 79% | 92% | * |
| 2016-2017 | 80% | 78% | 88% | 91% |

*Note.* Data retrieved from Texas Education Agency (2017). * indicates masked data due to few students included in this category and in an effort to protect student confidentiality.

Table 4

*2013-2017 State Passing Percentages for Students by Race for Algebra I*

| Years | All | Black | Hispanic | White |
|---|---|---|---|---|
| 2012-2013 | 49% | 50% | 51% | * |
| 2013-2014 | 61% | 63% | 56% | * |
| 2014-2015 | 61% | 60% | 68% | * |
| 2015-2016 | 56% | 54% | 65% | 71% |
| 2016-2017 | 68% | 66% | 81% | * |

*Note.* Data retrieved from Texas Education Agency (2017). * indicates masked data due to few students included in this category and in an effort to protect student confidentiality.

As is evidenced by these scores, NWA has shown consistent academic success with students of color in math and science over the past five years, as their campus continues to meet and exceed state standards of accountability.

Lastly, the study site was also significant because the rubric used to evaluate classroom instruction included wording that focused on cultural responsiveness in lessons. Teachers were trained to understand this rubric and it had been used on this campus for more than five years prior to the study.

## Study Design

As a qualitative case study, multiple sources of information were used to gain a detailed understanding of one academically successful high school educating students of color in science and math (Yin, 2013). I conducted one-on-one interviews with science and math teachers, observed teachers' practices in

science and math classrooms, and collected classroom documents and artifacts (i.e., classroom handouts and images of textbooks) to gain a complete understanding of their classroom practices and their perceptions regarding their pedagogy.

The North Woods Academy science department consisted of 14 teachers total, including one master teacher. The math department consisted of one master teacher and 14 teachers. The master teachers were full-time instructional coaches that led each department and provided instructional support to their departments.

All 30 teachers were invited by email to participate in the study. The only criterion for inclusion was that the teachers taught any of the math and science classes offered at NWA (See invitation email in Appendix A). Nine math and science teachers agreed to participate: Three of six teachers of Biology I (50%), four of nine teachers of Algebra I and II (44.4%), these courses represent the content areas for the EOC state-tested subjects. In addition, both departments' master teachers (100%) were included because they work with every teacher in their department as well as leading the PLCs for their department, therefore they offered different perspectives about the use of CRE in the classroom than the other teachers in the study. Master teachers are department leaders that work as instructional coaches to the department's teachers after having success as classroom teachers and earning advanced degrees in education. Pseudonyms were used for the participants' names to protect their identities and ensure

confidentiality (Creswell, 2013). Participants received a $10 Starbucks gift card for their participation in the study. See participant information in Table 5.

Table 5

Participants' Characteristics

| Name | Content area | *Years Teaching* | Race | Gender |
|---|---|---|---|---|
| Angela Divine | Biology | 7 | Black | Female |
| Jasmine Smith | Biology, Anatomy | 3 | Black | Female |
| Anna Corinth | Biology | 17 | White | Female |
| Keisha Williams | Master Teacher Science | 9 | Black | Female |
| Tony Southall | Algebra II | 2 | Black | Male |
| Susan Brady | Algebra I | 28 | White | Female |
| Caleb Simpson | Geometry, Algebra I | 13 | White | Male |
| Cedrick Green | Algebra II | 12 | Black | Male |
| Ethal Brown | Master Teacher Math | 21 | Black | Female |

Note that six of the nine teachers were Black, which is unique in the state of Texas, where 60% of teachers are White (Texas Education Agency 2017). They range in teaching experience from two (Algebra 11 teacher) to 28 years (Algebra 1 teacher) , with an average of 12.44 years, in total. Within the science department, the participants average teaching experience was nine years; whereas the math department participants' average number of years teaching was 19 years.

## Data Collection

Yin (2013) described interviewing as the most important tool to use when gathering data in a case study, as it allows the researcher to gain meaningful insights from its participants. Therefore, I used semi-structured interviews (as seen in protocol of Appendix B) with each participating teacher and the departments' master teachers. The interview protocol intentionally focused on what contributed to student success as is advocated in Harper's (2009, 2010) anti-deficit framework. For example, I asked questions such as "To what do you most attribute the success of your students?" I did not concentrate on questions about the students' challenges. Interviews were conducted during the teachers' conference period, a 45-minute period, and interviews lasted about 20-30 minutes on average. Follow-up emails were sent to teachers, as needed, to clarify the contents of the interview. These interviews were also audio recorded to enable ease of transcription.

One classroom observation was conducted with participating teachers. Based on their selected availability, some teachers were interviewed prior to their teaching observation and some after. I sought to explore specifically how these teachers employed CRE in their science and math classrooms and how those practices connected to the information they shared during their interviews. Interviews and observations were scheduled in the same week, so that I was sure to have a fresh memory of both as I began data analysis. Creswell (2013)

described observation as involving the use of the senses to interpret the actions of teachers, interactions between students and teachers, and classroom activities in the physical setting of the classroom. During observations, I collected observational field notes to document all activities I ascertained and to reflect on my visits to the classrooms (Creswell, 2013). (See appendix C for observation guide.)

Lastly, I received classroom artifacts (i.e., classroom handouts, worksheets, and images from textbooks) from the participating teachers to establish a fuller understanding of the instructional strategies I observed the teachers use. By using multiple sources of evidence for corroboration and validation of data (Creswell, 2013), I gained a more complete and varied perspective of the educators' instructional practices at NWA.

## Data Analysis

First, all interviews were transcribed by a secure, online third-party company (www.gotranscript.com) within 24 to 48 hours of each interview so that analysis could begin promptly. After receiving each interview transcript, I reviewed them to ensure their accuracy and made corrections, as needed. Then, as Vogel (2006) explained, I began data analysis within 24-48 hours of receiving interview transcripts, which required "classifying, comparing, weighing, and combining material . . . to extract the meaning and implications, to reveal patterns, or to stitch together descriptions . . . into a coherent narrative" (p. 201). To

accomplish this, I began with open coding and chunking, which meant I read the first transcript without searching for any a priori codes (Saldana, 2010). Specifically, I labelled the content of each paragraph in the transcript with a single, broad code. After chunking the data, I reviewed the transcript again, this time coding it line-by-line to capture the nuanced perceptions of the participants (Maxwell, 2005).

After completing these steps with the first transcript, I took the next one and followed the same pattern until I had reviewed all nine transcripts. I used the constant comparative method of analysis, which meant that when new ideas emerged in the analysis, I returned to the previous transcripts in search of these codes/themes. This use of the constant comparative method helped me tease out the content from the interviews (Lincoln & Guba, 1985). I then took these codes and collapsed them into broader categories or themes so that I was able to ascertain patterns that emerged from the various interviews related to teachers' perceptions about student success. Some of the themes that emerged were: collaboration, teacher content knowledge, relationship building, and discovering student interest.

After using this open coding technique on all the transcripts, I then employed the lean coding approach and searched for the four tenets of CRE (Aronson & Laughter, 2016) (i.e., culture as a bridge for academic skills and concepts, critical reflection, cultural competence, and the critique of discourses of

power) to determine if the participants were guided by them in their pedagogical practice (Creswell, 2013). The same coding approach was employed when reviewing observation notes and artifacts where I also witnessed similar codes emerge. This process enabled me to review the same concepts and themes across the teachers' interviews, my observation notes, and classroom artifacts noting emerging patterns and themes.

## Trustworthiness

In order to circumvent my personal bias from impacting my findings, multiple processes were utilized during the analysis to ensure trustworthiness. According to Patton (2008), "the trustworthiness of the data is tied directly to the trustworthiness of the researcher who collects and analyzes the data" (p. 1205). For this reason, I engaged in the process of triangulation using data collected in interviews, classroom observations, and classroom artifacts to ensure validity in my analysis (Creswell, 2013).

Next, I worked with a current doctoral student to conduct peer debriefing (Lincoln & Guba, 1985) and coded data with this peer allowing them to challenge my interpretations, ask questions of my analysis, and provide an overall perspective that helped to ensure I remained objective in my analysis and interpretation of the data. This process was helpful in helping me stay objective when analyzing the data collected from my participants.

Finally, I conducted member checks to ensure the accuracy of my analysis. Lincoln and Guba (1985) refer to this step as "the most critical technique for establishing credibility" (p. 314) in a qualitative study. Member checks allowed the participants to provide additional details, if they deemed them necessary. Therefore, I emailed my preliminary findings to them to confirm that they agreed with my interpretations and had a chance to ask any clarifying questions. They had one week to respond if they had corrections and feedback regarding the findings. No feedback was received from any of the participants; therefore, I proceeded with finalizing my conclusions. Taken together, these efforts helped build trust in my study and its findings.

## Limitations and Delimitations

In spite of the efforts made to ensure trustworthy findings, this qualitative case study has three primary limitations. The first limitation is that the findings were not generalizable, as is the case with all qualitative research. This study's findings reflect the practices of a few science and math teachers at one successful high school in Texas primarily serving students of color. Other science and math teachers at this school or at other successful schools within Texas might have very different views, which could lead to different findings. Further, because the state of Texas requires its own unique curriculum and system of accountability, teacher perceptions in other states with different systems of accountability likely vary from the perceptions provided by this sample of Texas teachers.

Second, this study had the potential for bias. Being a former teacher and leader on the campus I studied, I established trust with my participants by ensuring them that I would not be disclosing information they gave me to their current supervisors, as some teachers may have seen me interacting with them on campus in the past. I reassured them that pseudonyms would be used to protect their identity. With the rigorous application of strategies to ensure credible findings, the certainty of anonymity, and because I had not been employed at this school for more than three years, I felt that the participants trusted me and were forthcoming.

The third limitation is that participants did not provide feedback through member checking, as requested. This strategy relies on participants providing feedback to the findings. My participants, however, did not respond with any feedback after receiving the preliminary findings via email indicating to me that they accepted the findings as they read them. Nevertheless, one cannot be certain that no contact meant they had no objections or questions. Still, the study begins to address a gap in the literature related to the role that CRE plays in the instruction of students of color in high school math and science departments.

## Summary

This chapter provided an overview of my research approach and methods. It includes my research questions, qualitative study design, approach to data analysis, and efforts to achieve trustworthy findings.

# Chapter 4

## Presentation of the Findings

Using an anti-deficit perspective, this case study focuses on the experiences of math and science teachers from one Texas urban characteristic high school that either met or exceeded state expectations for standardized testing pass rates for the last five years. The research explores the perceptions of teachers from the math and science departments about their culturally relevant education (CRE) practices and if they view them as facilitating or hindering STEM interest and math and science achievement among students of color. Harper's anti-deficit theory and the four elements of CRE provided a lens to help explain the science and math teachers' successes with students of color in this specific high school. These behaviors were: (a) using culture as a bridge to connect to academic skills and concepts, (b) facilitating students' critical reflection of their lives and society, (c) building students' cultural competence to take pride in their culture, and (d) critiquing discourses of power to challenge the status quo (Aronson & Laughter, 2016). The findings are organized according to the overarching themes presented in the following sections: (a) meaningful relationships with students, (b) bridging culture with standards, (c) empowerment as a process, and (d) departmental collaboration.

### Meaningful Relationships with Students

The teachers in both the math and science departments were committed to building meaningful relationships with their students. One way they did that is by getting to know the students' interests. Keisha, the master teacher for the science department, starts the year by surveying the students, so she can capture personal information that she can incorporate in the classroom throughout the year. She explained:

> At the beginning of the year, to me, it's very important to get that little survey going, trying to get to know your students a little bit more, what they're interested in, and things of that sort. Throughout the year, you're able to tie in some of the things that they like or that they're interested in. Current events that they can write about, just anything to connect with them, to let them know that you care about their interests.

Likewise, Ethal, the math master teacher and 21-year veteran teacher, would ask the students early in the term personal questions such as, "What is your favorite movie? What's your favorite candy?" She would then "go back and incorporate" the information in lessons she developed later in the term.

In addition to making efforts to learn about students in the classroom, many of the participants explained the importance of showing interest in students outside of the classroom, as a means for building meaningful relationships. Ethal stated, "I'm always there. I'm at games, and I'm the loudest, rowdiest person.

When they see you at their performances, they see you at their games, they're like 'Okay, she cares.' I want to be there for them." Similarly, Tony, a math teacher in his second year of teaching, said:

> I'm a coach [and] the girl [in my class]…, she's a track runner. We talk about track all the time. They see me over there supporting them when they play their sports… If you develop those relationships early on, it feels like it makes it easier for the kids. They may not like the [course] material, but they'll at least try for your sake.

In addition to assessing and understanding students' interest, Caleb, a math teacher of 13 years, explained how important it is for his students to know he cares about their individual wellbeing:

> When you hear them talking about their birthdays coming up this weekend, they have a quinceañera, or there's something going on at their church, or baptism, or something is going on in as far as grandmother is passing away or something like that… A couple days go by, check on that kid. You just stay in tune with your students, and if you don't stay in tune with your students, then you are not truly showing them you care about them.

He continued by mentioning other issues he considers that can have a huge effect on the student's in-class success:

> What if something happened that morning? What if they didn't have breakfast? What if the night before, mom got sick or the baby was sick, and everybody was up all night and they only got an hour of sleep? You have to take consideration of life, and when students see that I do that, they're more responsive in a positive way. They realize, "Okay, this guy actually kind of cares."

Caleb's point illustrates that caring was perceived by the teachers to be a key component to connecting to the students who they serve.

As a result of building meaningful relationships, teachers were able to use what they learned about students to motivate them in the classroom. Cedrick, who previously taught elementary and middle school grades, commented on a motivational tool he uses:

> One thing that I learned being in high school is that the kids, for the most part, still love the checks on their papers, they love for you to say a great job, they love to be acknowledged among their peers. They love the sticker thing. Even as simple as a pat on the back. It's a sign of motivation, but somewhere down the line in between middle school and high school we lose that, but kids still love that. It makes them feel proud of who they are.

Anna, a science teacher of 17 years, echoed Cedrick's sentiments when explaining the power of encouragement as a motivator:

> Praise, praise, praise… I'll say "Okay, we're going to get in groups and I need you to lead the group and make sure everyone's on task, doing what they're supposed to." Then all of a sudden, that kid that's not as good sometimes is like, "Oh, I was a group leader in science today." I've had parents come and say, "I don't know what you're doing but they came home talking about science class. I didn't know they took science until this class."

This type of engaging experiences were characteristic of NWA teachers and their commitment to building classrooms that were inclusive and engaging for students.

Various methods of external motivation were utilized by other teachers as well. While observing Susan, a veteran math teacher with 28 years of experience in education, she realized her students were answering her review questions slower than usual. Consequently, Susan walked to her file cabinet and announced to the class, "If I get my candy out will you magically remember? Y'all know this stuff!" After she had her candy bag in hand, the students immediately showed increased effort and began answering her questions more readily. When asked about this approach to externally motivating her students, Susan explained:

> I have suckers. I have cracker jacks. I have little miniature candies. Every once in a while, for instance, when somebody says something, I'll say "That's worth a blow pop!" [such as] if they make a conclusion that I just think was amazing. Everybody can do it, if you have the want to. As a

teacher, it is my responsibility to build that want to. When I'm planning lessons that's what I think about. What's the "want to" to win the kids to "want to" learn this today?

In fact, in almost every interview, participants explained the importance of forging meaningful relationships with the students at NWA as a preliminary necessity for being successful in their classrooms. Instead of diving into an exposition of what their students did not possess, these teachers took time to assess students' strengths and use those to motivate students in their classroom. The assessment of strengths is an example of Harper's (2009) anti-deficit theory as an integral approach to creating conditions for success with students of color. According to the teachers, their relationships with their students served as springboards for motivating them and, in turn, increasing their interest in science and math. Additionally, by learning about their students, the teachers demonstrated that their cultures and interests had value.

**Bridging Culture and Standards**

Although the teachers expressed different approaches to engage students in their classrooms, many participants emphasized the importance of understanding student interests and using those to "hook" or "reel in" the students' to learn the subject matter. Importantly, during their efforts to link content to students' interests, the teachers remained focused on the state standards they were required to teach. The interests they incorporated in their math and

science courses included current music, pop culture, video games, television programs, and even dance. Caleb shared one such approach:

> In geometry, we were doing coordinate plane geometry. So, what I decided to do was, hey, one of the new games my students, kind of, grew up playing was "Minecraft". So, I incorporated a "Minecraft" project and showed them how the developers of the game used actual math to do that. If I see an opportunity where something that's a fad in our social life or I see something that is going on, I will try to incorporate that, if it's something that I noticed that the culture that I'm around is more in tuned to, I will do that.

Instead of diving straight into the topics that he must teach in his math class, Caleb and the other teachers intentionally taught the content according to the real-world interests their students already had, representing what researchers (i.e., Bonner & Adams, 2012; Brown & Crippen, 2016; Milner, 2012) noted to be culturally infused approaches.

One science teacher, Anna, described integrating culture during a classroom project.

> I have a huge group they're into anime this year. I have an anime book that we're actually reading in class... The ones that aren't like really into science, they're really into anime so I just combined the two. It's a really good book…. [The authors] have all the [science] stuff, but they did it in

> anime. [The students are] seriously into it. The kids can now load it on their computer, and we can read it….It worked out really great.

Rather than using only the district-assigned text book, Anna had researched a text that connected the science content to the interests of her students. Providing this connection between what the students enjoy and the course content helped motivate the students to learn. After reviewing the artifact she described, it was evident that the biology content was clearly covered in the anime text.

In fact, most of the teachers explained the importance of peaking students' interest prior to directly teaching the content. For this reason, the teachers acquired outside resources beyond those used in the district-provided curriculum and sought new ways to increase student interest in the content and motivate them. Jasmine, a science teacher with three years of experience, stated:

> The most important thing, because it's science, is how am I going to reel my kids in? My first year of teaching, we had a book that's called "Teach Like a Pirate" and there were different hooks that you have just to get your students engaged and interested. [I ask myself:] How am I going to keep them invested from the beginning to end?

Jasmine provided the following specific classroom example:

> My anatomy and physiology students are doing a project over muscle building. If you just give them, "This is what you have to do"; then, it's like "blah." Instead, I showed them a video of P90X [a workout program

> video]. I used the same structure in the video to explain this is what you need to do in your project. It got them hyped up because now they want to create commercials, they want to do these videos where they're being trainers. It got them really, really excited about the project.

These examples represent how the science teachers found ways to connect student interests to scientific content.

This cultural infusion of content also occurred within the math classrooms. While students might not be drawn into a particular math concept, Ethal interested her students by leading the lesson with something the students all loved. For example, she explained her process when teaching parallelograms:

> I took advertisements, looking at commercials. And the kids had to decide if the slogans that the commercials were given would be true or false. All I had to do was put up McDonald's, and they were like "I'm loving it." It's stuff like that, "If I eat at McDonald's, then I'm loving it. Is that a true statement?" Just bringing in the real world. Something relatable to them. Well, if these two sides are parallel, then it is a parallelogram.

While her students may not have initially been interested in the concept of parallelograms, Ethal's approach allowed students to apply something with which they were already familiar, such as commercials, with the concept being covered for that day.

Some of the participants incorporated music and dance when they taught these context neutral subjects. Susan, a middle-aged, White, math teacher, found ways to "use a lot of music" and dance for teaching parent functions and slope in algebra as follows:

> Beyoncé is my favorite artist. I like to envision that I am Beyoncé in my mind. When we [were learning] all the parent functions, I had them create an eight-step dance. They had to find their music and absolute value quadratic. I brought in videos of Beyoncé and some of her dances, and I would freeze it and say, "Now what function is that?" I also [incorporated] Beyoncé about slope. When we talk about graphing of lines, it was always to the right. Up and over to the right, or down and to the right, if it's negative. Beyoncé says to the left [in the lyrics of one of her popular songs], but we go up and to the right [when determining slope].

The use of music and dance to connect students applied not only to mathematical concepts but also to science lessons. The science master teacher, Keisha, explained:

> For me, it was always, how can I connect with my students? How can I take a rap lyric and throw it in just to hook them to pull them up to where I needed them to go? How could I take a line step dance and incorporate that into a piece of content for chemistry? Line dance, just one step to the right, one step to the left, one step to the front, one step to the back. We

could put on a little *Step in the Name of Love* and play that at the beginning of the class period. I explain the steps, we all get up, and we do the little line dance. When we sit back down, that is basically teaching them about the electron configuration dot structure. So, just showing them where those electrons assemble around the atom. They're engaged with those type of things.

The teachers found that using the students' cultural interests, whether those were popular television commercials, cartoons, music, or dance, helped the students learn in-depth math and science content. Similarly, Basu and Barton (2010) concluded that engaging in a "less authoritarian, more democratic relationship between teachers and students in which students have increased choice, voice, and authority" (p. 74) increases student motivation and engagement. They note this empowerment as the key to unlocking the potential of students of color in the classroom. The current study also found that the flexibility, inclusion, and consideration of students' interests led to similar successes.

In addition to bringing students' interests into the classroom, Mensah (2011) reported that the implementation of culturally responsive teaching in the science class depended on teachers' ability to show students real-world connections to the content. Making real-world connections was also important to the NWA teachers who participated in the study. Angela described this approach:

> I'm learning to teach the content with real-life scenarios. If we're learning about the blood, I'm going to teach it through sickle cell anemia. My kids were real smart as far as content, but they did not understand how it connected. Every year, I'm trying to figure out…

Jasmine added to the importance of making real-life connections by providing a specific classroom example:

> I just want to show them how they can apply it [science] to their lives and get a gist of "how can I apply this to me?" . . . that goes into what we eat, getting enough sleep, exercise, just learning how to incorporate all those things to a healthy lifestyle and then that will help you with your purpose, what you want to do in your life. A lot of people really don't understand what you're putting into your body, how the environment actually affects our bodies, diseases, illnesses. When we go over the digestive system they do a project called The Biggest Loser, where they use an app to say this [food item] has this many carbs. Looking at how much you're supposed to take in in a day compared to how much they actually take in and they're like, "Oh, dang." Then, we'll watch the documentary where the guy ate McDonald's every day. We make those connections. They're like, "This isn't healthy."

This level of contextualization of the science content facilitates students' deep reflection and application of the learning to their own lives.

In line with those findings, Caleb provided a similar approach in his math classroom:

> With math, it's about logically thinking through problems [by asking,] "When am I going to use this in the real world?" "Did you have a flat tire this morning?" "Did your parents have a flat tire? How did they figure that out?" Those are steps in logical process of thinking. I can't just go and throw the jack underneath and pump it up, and then all of a sudden, I get to rip the tire off the thing. No. I had to go through a step process. There are steps and processes, and that's what math is. Math, it's just, "How do I logically think through a problem, a situation to be able to help me out?" That's how you see it in everyday math.

This approach to viewing the world and everyday problems through the lens of a math allowed the teachers at NWA who participated in the study to encourage their students to understand the content and practicality of their subject matter. Fulton (2009) also concluded that a teachers' use of culturally responsive instruction to contextualize content in math classes produced students who had expanded understandings of mathematics and "healthy notions about their own ability to be successful as mathematical thinkers" (p. 107).

The teachers in the study provided evidence both in their interviews and during my observations of being strategic about helping students see how their math and science content applied to events that happen in everyday life. Their

hope was that these lessons will have resonance in the students' lives after high school as well. This focus on the practicality of the content was also supported by Boutte et al. (2010) who found that students experienced increased academic achievement when they gained the ability to connect what they learned in science class to their everyday lives.

Yet, increasing the science and math interests of their students was only one part of the bridging culture and standards equation. While they spoke in much detail about making lessons to bridge students' cultures and the content taught, the teachers were very clear about their attention to ensuring students were exposed to the state standards. The participants' clarity about requirements was supported by Laughter and Adam's (2012) suggestion that focusing on subject-area standards is an essential part of successful CRE classrooms. Ethal explained how she explicitly connected her lessons to the math Texas Essential Knowledge and Skills (TEKS):

> When I'm planning lessons I'm thinking about, first the SEs--student expectations--that I have to cover, looking at the TEKS--Texas Assessment of Knowledge and Skills--from the state. How do I prepare those SEs over the course of that six weeks to be able to meet the achievement goal for that particular assignment?

Angela taught biology, a state-tested subject area and held similar thoughts shared by Ethal:

> Since I am a STAAR subject, I have to make sure I look at the SEs and see what the verbs are, and then from there, I figure out what is the most creative way to implement that. I don't want to get so off track doing my own thing that they don't pass the test, but I do want them to enjoy [learning].

These teachers work intentionally to connect state-defined learning objectives, which may otherwise be interpreted by their students as irrelevant, to student interests, to help their students succeed. Susan said it simply, "I first start with the standard, the TEK, then, I think about how I can relate it [to the students' interests]." Therefore, the teachers juggle a number of concerns when designing lesson plans to support their students' learning.

During my observations, I saw teachers, like Anna, build in assessment questions that came straight from the previously used and released state biology exams. Anna made this strategic move, as did the other math and science teachers, to ensure student mastery of content standards during their lessons. By knowing the test, Anna had the ability to purposefully make connections that would benefit students while taking the state's assessment of the content.

According to Aronson and Laughter (2016), CRE begins with the teachers' ability to use culture as a bridge to connect to academic skills and concepts. Saifer et al. (2011) described CRE as the process of serving students what they need by way of what they want. Even though NWA's math and science

teachers did not reference the term CRE or culturally relevant education, they actively and strategically bridged student interests, subject content, and state standards to engage the students in learning. This approach facilitated their efforts to empower their students both academically and personally.

## Empowerment as a Process

As stated, the participants focused on connecting students' interests to the material to aid student learning. This effort was critical, because the teachers' realized that the students may be coming to their classes already disliking the courses. The teachers seemed to perceive themselves as playing a vital role in the personal and academic empowerment of their students. Fostering students' empowerment, however, seemed to be explained as a process rather than an event or status. The empowerment process started with the acknowledgment of the resistance and negative attitudes students had toward science and math. Anna described their attitudes in the following example:

> A lot of them [the students] come in and say, "I don't like science." "Why don't you like science?" "I never do good in it." "That doesn't mean you don't like it. That just means you haven't done well in it. There's a difference." I just don't want them to be scared of science.

The negative student mindset expressed by Anna was echoed by the other teachers in the study. To protect the students' pride and not expose their learning

deficits, some students give little to no effort in the beginning of the school year. For example, Caleb said:

> I've learned that a student will gladly leave a question blank if they feel inferior, or don't know exactly which steps to take. . . as opposed to just writing something down that will be wrong. And they think in their mind, "I didn't write down anything, so I really didn't attempt that problem, so it doesn't make me look bad."

These statements show how the teachers recognized the students' inclinations not to engage if they felt they would fail.

As a result, the participants discussed their efforts to decrease the students' initial resistance to math and science and empower their learning. In Susan's math class, she used a sports illustration:

> I tell the kids, if you are on the basketball court and you missed a lay-up, does that mean you just go sit on the bench? No, you keep playing. This is math class, we do a guided practice problem, and [if] you don't get it, you mess up, you just put your marker down and you just stop? No, you can't do that.

Not only were the teachers encouraging their students to give their best efforts, they were urging them to see failure as an opportunity to learn, grow, and develop resilience. During an observation of Angela's class, a couple of students began asking for her assistance before even attempting to try on their own. She

quickly redirected them to their available resources that included the textbook and their notes and told them, “Sometimes, you gotta get it wrong to learn. Make an educated guess.” This approach helped to decrease the intimidation some students experienced by reassuring them that they can learn through their failures.

Cedrick, the Algebra II teacher, used himself as an example to decrease the negative attitudes his students felt towards the math curriculum when he shared:

> I always tell my kids “You don’t have to be a genius to learn math. Look at me. I was a dummy.” I considered myself a dummy back then, in the sense of I was unintelligent. It took a person like me who knew nothing at all [about math] and failed [it during high] school, and if a person like me can be successful [with math during college], then they can definitely do it through hard work and dedication.

In this example, Cedrick acknowledged the pressure many of his students experience because of their past failures in math. He recognized that his role was to encourage and support them to help them learn. This approach was something the other teachers also voiced as a key in their success with students.

One strategy teachers used to fill their students’ learning gaps was connecting to prior learning. Cedrick illustrated, “Today when I was explaining irrational functions, we went all the way back to fractions and I tied common factor in from the suspended fractions. That helped a lot. That helped me reach

those [struggling] kind of students." When preparing to introduce a new skill or concept, the teachers took time to explicitly attach the new content to something students had previously learned.

Additionally, the math and science teachers explicitly spoke about increasing their students' knowledge incrementally as a step-by-step process. Anna said:

> I try to let them see that they, "Okay, maybe you don't get all of it, but you got this part. So, all we have to do is start from here and work to here. It's only this much information you have to get."

This "small steps" approach to instruction was shared by many of the participants who worked to increase their students' learning. In particular, Keisha described, "Breaking it down and giving them small steps and practice, small steps and then practice. Just building them up in that way." By assessing their students' ability levels and shaping their learning based on that knowledge, these participants helped their students develop more positive attitudes toward math and science. Further, this method of identifying student strengths and building upon those to make STEM more understandable reflects the anti-deficit approach advocated by Harper (2010) and advanced by CRE (Aronson & Laughter, 2016).

These approaches require differentiating instruction based on the students' current level of knowledge. The term, *differentiating instruction*, refers to teachers addressing the different needs of individual students and maximizing

accessibility to the content by modifying three things: (a) content (what they learn), (b) process (how the student engages with the content, (c) product (how students demonstrate their knowledge) (Lynch et al., 2018). Keisha applied the concept in her classroom by classifying "three levels [of students]: majority average learners, advanced learners, slower learners." She designed her lessons with that in mind. Ethal also thought "about the education level of my students. I don't want to come in with an assignment, or some assignments that I feel like would be too difficult for them." In these examples, the participants explained that they worked to meet students on their level and did not expect all students to be ready for the same level of rigor in their classes. This approach served as a benefit to students who might otherwise have been left behind during instruction.

While the teachers made it clear that they were working to fill students' learning gaps, they placed an equal amount of emphasis on having high expectations for their students' achievement. Milner (2012) identified the most dangerous viewpoints teachers can hold are low expectations and deficit mindsets concerning students of color. Although many of their students might have been behind grade level or felt threatened by the subject matter initially, the NWA teachers who participated in the study made it clear that they maintained high academic expectations, which was critical in the process of empowering their students to success. Cedrick explained:

> I do believe that all students can learn, that's for sure. Some students need to be pushed and pushed beyond their measures [the students' expectations of themselves]. It's our job as educators to find out their measures as soon as possible and to push them beyond their measures.

When it came to high expectations and moving their students toward them, the consensus of the teachers could be summed up in the words of Angela, "We just got to keep pushing [the students]." This sentiment was echoed by other participants who also expressed their commitment to motivate their students to reach their highest potential.

The final stage in the process of empowerment student learning involved the teachers encouraging their students to function as independent thinkers. Although they wanted to be great resources for their students, the teachers aspired to help students gain independence and think critically. Jasmine explained the process based on her experience:

> In the beginning there was a lot of, "Oh my God, she gives a lot of work." It's really not the work, it is the fact that you're causing them to think, and they are not used to thinking deeply; they are not used to drawing conclusions on their own. [I tell them] "I'll guide you where to look for the answer, but [I am] not necessarily providing the answers." Once they get used to the process then they are like, "This is easy."

In classrooms, I observed teachers' efforts to foster the students' independence by encouraging them to look back at their notes, to a peer, or to the Internet to find the answers. For example, Tony had a student request to use a calculator to work the assigned math problem. He declined the student's request and encouraged him to try working the problem on his own before depending on the calculator. Tony shared his thoughts on critical thinking as follows:

> Critical thinking, which is the hardest thing to get them to do, think. The kids will look at it and go, "Oh it's a word problem, I'm not going to read it."
>
> "Why not?"
>
> "It's hard."
>
> "Did you even read it?"
>
> "Well no."
>
> "All you have to do is read and think about it." They have to learn those critical thinking skills because it's not always going to be in simplified form like solve the equation.

Likewise, Caleb was very clear about what role he played in his classroom with his students as he shared:

> In my class, I really try to give them the independence of learning, and what I mean by that is I don't want them to view me as an answer key. I don't want you to view me as: "When I struggle, you're the one I raise my

> hand and get the attention of." "I want you to realize you're an independent learner in my room." And that's what I really try to produce out of all of my students.

The participating math and science teachers made it clear that they promoted students' independence by requiring them to think critically and not be dependent on the teachers.

This effort to build learning autonomy also extended beyond the classroom. For instance, Anna explained her desire to arm her students with the knowledge of her subject area and empower them to challenge others in positions of power in the real world. She explained:

> My goal is that when the kids walk away from my classroom, with biology, that they're better prepared to go out in the real world. They're going to encounter biology. Especially if they have kids [laughs], they're going to encounter biology, and have some knowledge of what's going on. Where they're not those people who [when] they take their kid to the doctor, the doctor could say they have the blue tongue disease, and they're like, "Oh no," and they freak out. It doesn't even exist.

These examples reflect the NWA's math and science teachers' desire to empower their students think critically, ask questions, and stretch themselves to learn more. Esposito and Swain (2009) said building these skills is the first stage for students to become change agents in their own lives and communities. The

teachers encouraged students to think deeply and even more importantly to gain confidence in their own abilities to solve problems and complete academic tasks on their own.

## Departmental Collaboration

One unique dynamic of this study was examining the success of the science and math teachers from a departmental perspective. While interviewing teachers individually, it became evident in the first few interviews that the teachers' perceived the accomplishments of their departments to be closely tied to collaboration. This notion supports previous research, which focused on two types of teacher collaboration associated with increased student achievement: (1) analyzing student data and planning responses and (2) curriculum and instruction decision making (Ronfeldt et al., 2015). In line with those findings, the teachers from both departments referred to their weekly departmental and team meetings as opportunities to reflect, plan, and prepare for instruction together as a team.

During one of the week's conference periods, teachers spent time in a departmental professional learning community (PLC) meeting learning instructional strategies from their master teacher in another conference period, based on subject team area, teachers met to collaborate on lesson and instructional planning for the upcoming week. In these meetings, teachers pooled resources for upcoming lessons, shared what worked and did not work in their classrooms the week before, designed tests and quizzes, and reviewed student work among other

collaborative tasks. Jasmine explained why the faculty viewed these meetings positively:

> I think it's [the reason for the science department's success] because we plan together. We really just grind together and get our plans together. We discuss what activities worked in one, what worked in the other. I think because we have that planning process that allows us to be successful.

Planning together seemed to be a major contributing factor for the math department's accomplishments as well. Tony stated, "We work in teams a lot. It's a lot of teamwork, so that helps make our department strong." Tony added that these meetings helped "make sure we're on the same page as far as lesson pacing." Being able to ensure appropriate pacing with the lessons was important to both departments' teachers. Similarly, Lindsey et al.'s (2009) findings concluded that collaboration allows teachers to support each other and maintain peer accountability while planning with student interests in mind. These practices have been shown to be key contributors in increasing teacher effectiveness, and thus student achievement (Banerjee et al., 2017; Goddard et al., 2007; Reeves et al., 2017, Ronfeldt et al., 2015).

Another important aspect of the collaboration at NWA had to do with the relationships the teachers built with each other. In addition to planning lessons and supporting each other with classroom objectives, the teachers spoke frankly about the closeness of their relationships with one another as teammates. Cedrick,

a math teacher, said that because they have strong relationships with each other, "We don't mind sharing our strengths and weaknesses with each other, and we are open to ideas." Keisha described the science department relationships as "very, very close knit. We're family." In sum, the interactions between the math and science teachers within their departments contributed to their departments' effectiveness. Taking time to meet formally multiple times a week, and informally daily, gave the participants an opportunity to engage in both forms of collaboration that have been proven by research to increase their instructional effectiveness. This approach helped teachers to work together towards shared goals and left none of the participants to work in isolation.

## Summary

In this chapter, I have presented my findings and analysis from the interviews, observations, and artifacts collected from North Woods Academy. The participants' perceptions of their successes with students of color in science and math were explained in relation to building meaningful relationships with students, bridging culture and standards, seeing learning as a process, and collaborating with their departmental colleagues. These findings help to fill gaps in research related to the implementation of CRE in science and math as well as the focus on departmental approaches to teaching in schools. In the next chapter, I address my research questions and explain implications for research, theory, and practice.

# Chapter 5

## Conclusions and Implications

Using an anti-deficit perspective, this study explored the mathematics and science departments' teachers' perceptions about culturally relevant education (CRE) practices as facilitating or hindering STEM interest and science achievement among students of color at a single high school. The following were the four behaviors of culturally relevant educators that framed the study: (a) using culture as a bridge to connect to academic skills and concepts, (b) facilitating students' critical reflection of their lives and society, (c) building students cultural competence to take pride in their culture, and (d) critiquing discourses of power to challenge the status quo (Aronson & Laughter, 2016). These elements of CRE may explain the science and math teachers' successes with students of color in this specific high school that has met and/or exceeded state expectations for standardized testing pass rates for the last five years. Therefore, the research questions in this study focused on teachers' perceptions and demonstration of the use of Culturally Relevant Education (CRE) in their science and math classes. This chapter summarizes the findings, discusses CRE at North Woods Academy, and provides implications for future research, practice, and policy.

### Summary of Findings

Each of the research questions' main findings is presented in the following three subsections. The questions were aligned with the following teacher

behaviors as characterizing CRE classrooms that were identified by Aronson and Laughter (2016): (a) using culture as a bridge to connect to academic skills and concepts, (b) facilitating students' critical reflection of their lives and society, (c) building students' cultural competence to take pride in their culture, and (d) critiquing discourses of power to challenge the status quo (Aronson & Laughter, 2016). It is important to note that while the teachers at NWA did not explicitly say "culturally relevant education" or "CRE" when describing their pedagogical approaches, most of their descriptions and actions were aligned to CRE practices. The first subsection addresses the teachers' use of the four CRE behaviors.

**Research Question 1: How do science and math teachers at a successful high school with students of color describe and demonstrate the use of culturally relevant education in their classrooms?**

**Culture as a bridge**. One of the first CRE behaviors exhibited by this study's teachers was using culture as a bridge to connect the student's interests to academic skills and concepts. Although bridge building is essential in CRE classrooms, the critical distinction between Aronson and Laughter's (2016) described behaviors and its application by the case study teachers involved the teachers' emphasis on the importance of forging strong relationships with the students they served. The teachers in this study were able to connect culture to skills and concepts only after they first gained an in-depth understanding of their students' culture through relationship building. Further, the teachers explained

using their relationships with their students as the driving force for their pedagogical decisions. At NWA, I listened as teachers described the value of the deep, rich relationships they developed with their students. Moreover, I observed the teachers as they connected with their students during their interactions in the classroom.

As part of bridge building, the NWA teachers connected academic skills and concepts with any content-relatable item from pop culture, video games, music, dance, sports, television series, and much more. While most teachers admitted in their interviews that they could not fill every lesson from beginning to end with cultural connections, they reported their commitment to making those associations often, because they helped link student interests with academic content. This connection to culture may also be a result of the instructional rubric employed on the campus that included indicators for cultural responsiveness.

**Facilitation of critical reflection**. For the second descriptor of CRE, facilitation of students' critical reflection of their lives and society, many of the teachers described using their instructional decision-making processes to design lessons and projects that caused students to think deeply about their choices during their daily lives. For instance, in the science classes, teachers emphasized the importance of students reflecting on their own health and wellness and understanding how the content they were learning could enable them and their family members to have longer lives and healthier bodies. Meanwhile many of the

math teachers highlighted the everyday use of math for solving problems that students will encounter that require critical thinking skills that are taught in their classes. Thus, the NWA science and math teachers believed their students ability to think critically about the information they were exposed to in and out of school was important to their departments' success.

**Building students' cultural competence**. Some of the teachers also applied the third CRE indicator, building students' cultural competence to take pride in their culture. Teachers discussed the importance of exposing the students to scientists and mathematicians of color even though most of the prominent images in the district-assigned resources were people who historically did not look like NWA's high school students, who were mostly students of color. In addition, the NWA's mathematics and science teachers used themselves to illustrate available career and college major choices from which the students could choose. Essentially, the NWA teachers built cultural pride in the students they served both in the interviews and in their instructional delivery.

**Critiquing discourses of power**. The final indicator of CRE is related to the NWA teachers' efforts to engage their students in critiquing discourses of power to challenge the status quo. While I did not find ample overt evidence of this point in the study, the teachers described behaviors akin to planting seeds in their students' minds to empower them to challenge the status quo as a byproduct of developing critical thinking skills. For example, the NWA mathematics and

science teachers spoke with clarity about wanting their students to become independent thinkers and to learn not to depend on teachers or other authorities as sole sources of knowledge. One teacher, Anna, explained wanting her NWA students to have enough confidence in their own ability to use research to find answers that they would not, for example, blindly accept the view of anyone, even a medical doctor, if that information was suspect. Anna challenged students to understand that knowing about biology mattered when going to the doctor and obtaining good healthcare. She encouraged them to ask critical questions of doctors based on their own understanding of science. While this approach is not explicitly challenging the status quo, Anna is helping her students build a foundation so they can become smart consumers.

**Research Question 2: Do high school science and math teachers at a successful high school perceive CRE practices as *promoting* or *hindering* the *achievement* of their students of color and in what ways?**

Even without explicitly stating any exact CRE-oriented term, the findings showed that the teachers worked together to create rich, relatable experiences in which students could gain in-depth understanding of mathematics and science content. Further, the participants explained how working with their department colleagues helped them generate effective instructional experiences that connected science and math curriculum to students' interests, making content relatable to their students' lives.

The NWA teachers expressed clarity about their classroom practices making a difference in student achievement. The participants credited their scaffolded approach to filling in students' learning gaps as important to their students' academic success. Instead of forging ahead and admonishing students to keep up with teacher-based instructional pacing, these teachers spoke, at length, about assessing the students' needs and working towards incremental growth through practice.

The teachers also seemed to understand that they did not create the culturally relevant lessons in isolation. They recognized the value of collaboration within their departments as an essential element in the achievement of their students. In fact, they credited the interactions with their colleagues as being a primary factor in their instructional success.

**Research Question 3: Do high school science and math teachers at a successful majority minority high school perceive CRE practices as *promoting* or *hindering* the *interest* of their students of color and in what ways?**

The teachers perceived their CRE practices as promoting students' interest in mathematics and science because of their efforts to make relatable connections between the interests and backgrounds of their students of color and the content. It was common for the teachers to talk about infusing their lessons with games, music, dances, etc. as a way to guide the students through the science and math

curriculum. The consensus among the mathematics and science teachers was that appealing to students' interests was one of their main instructional goals. They admitted that using that information helped them connect with the students throughout the year.

Moreover, this practice extended beyond the classroom to their students' lives outside of school. The teachers were committed to showing students they cared about them and the issues they confronted in their daily lives. The participants believed that knowing their teachers cared about them contributed to the students' willingness and excitement for participating in projects and class activities.

## Recommendations

Each of the three research questions produced recommendations that are presented in the following three subsections. First the implications for future research are discussed. Then, the practice and policy implications follow.

### Implications for Future Research

This research was focused on exploring the perceptions of science and math teachers who were successful with students of color at the high school level. This study was qualitative, and the findings cannot be generalized to other schools or departments. Therefore, future researchers may consider extending this study design to other schools (i.e., elementary, middle, and high schools) in which the

math and science teachers successfully serve students of color to validate the findings of the use of CRE practices presented in this study.

This study was unique in its focus on the departmental aspect of the high school's success. Future researchers may choose to look at the role teacher collaboration plays in the successful implementation of CRE practices both in schools predominantly serving students of color and in schools in which students of color are not representative of the school's majority student population, as all students may demonstrate increased achievement and interest when CRE strategies are implemented by teachers. In addition, this study did not isolate individual practices to see which may contribute more to student success, so future quantitative research may explore specific efforts (e.g., teacher collaboration, incorporation of cultural references, external motivators) to determine which may prove more effective in supporting student achievement.

Further, the number of racially diverse teachers at NWA are an anomaly when compared to the number of diverse teachers in the state of Texas. Since the majority of teachers in the state of Texas are White and overwhelmingly female, further research examining the perceptions of White teachers' experiences implementing CRE in schools populated primarily by students of color may yield unique insights about the successful implementation of CRE across races, ethnicities, and cultures. Such research could inform practitioners of best practices for successful implementation of CRE in schools serving students of color.

Additionally, future researchers may choose to focus on students' perceptions of the impact of CRE practices on their achievement and interest in mathematics and science. High school students are educated and experienced enough to understand and articulate their thoughts and experiences about effective instructional approaches in mathematics and science classrooms. Such research could be useful for better understanding students' perceptions of their own successes and interests in science and math, thereby informing the pedagogical approach of practitioners.

Finally, because instructional effectiveness has strong associations with standardized test scores, more empirical quantitative research examining if CRE impacts students' academic achievement on state and national standardized examinations is needed. If additional research findings indicated CRE to be a contributing factor to students' academic successes, these practices could be moved to the forefront of relevant educational policy and practice agendas. Standardized tests could gain revisions based on additional research findings.

**Implications for Practice**

While the NWA teachers who participated in this study showed evidence of using CRE practices in their classrooms, they did not use any CRE practices in isolation. The mathematics and science teachers employed CRE practices as a team. For this reason, high schools' instructional leaders may regard the findings as beneficial for designing and facilitating professional development to promote

the effective implementation of culturally proficient collaborative teams in schools.

Additionally, through campus and district-wide trainings, instructional leaders would have an opportunity to set high expectations for teachers and provide continuous support as teachers work to implement CRE practices in their classroom. This approach would ensure school leaders are aware of the importance of CRE strategies and also give them an opportunity to model using such strategies when they deliver professional development sessions to the teachers.

Similarly, teachers currently teaching math and science may find the examples given by these participants useful for instruction in their classrooms. Such pedagogical examples include: the P90X exercise lesson in Jasmine's class, the implementation of T.V. commercials in Ethal's math class, the adoption of anime-illustrated science books in Anna's class, or even the "Minecraft" activity in Caleb's math class. These explicit examples of connecting content to student interest could serve as inspiration for educators that need these practical examples to springboard their own connections to the students they serve.

Lastly, colleges and universities may view the findings as informative for their teacher preparation programs. Before preservice teachers are hired to work on campuses with students of color, they could gain necessary exposure in their preparation programs to the importance of developing relationships with students

and using the knowledge of those relationships to inform their pedagogical decisions in all content areas. Additionally, preservice programs may offer in-depth opportunities for students to plan and practice utilizing CRE methods and gain experience with connecting the content of lessons and students' interests over the course of the program with intention.

### Implications for Policy

Since the effects of CRE and its success with students of color has been shown in research for many years, policy makers may use these findings and similar ones to provide funding for required training programs that equip teachers to better understand and implement CRE practices in classrooms. Even though encouraging practitioners to consider best practices is a noble idea, there is no way to ensure that states, universities, alternative certification programs, and school districts will have the funding and personnel to implement CRE in classrooms without passing legislation or creating funded policy in which funds are earmarked for supporting these efforts explicitly.

## Conclusion

Many researchers have studied culturally relevant education and the role it has on the educational experiences of students of color and their individual teachers. The current study filled a gap in the research by focusing on teachers' perceptions of the use of CRE in successful math and science classes from a departmental perspective. The qualitative research methods applied to this study

allowed for a nuanced examination of the teachers' descriptions and demonstrations of their practices.

This study highlighted high school mathematics and science teachers who generated academic success among students of color. Oftentimes, these classrooms are places where authentic relationship building between teacher and student take priority. The teachers' commitment to getting to know their students and integrating that knowledge into their science and math lessons was essential for academic success among the students. While the inclusion of students' interest in lessons varied from classroom to classroom, the case study teachers were clear about their intentions to connect to students' interests as often as they could find ways to do so in their curriculum.

Further, the teachers maintained high expectations and consistently assisted their students whom they pushed toward academic achievement. No matter the academic ability of their students, the teachers believed they could help students grow. By focusing on what interests, understanding, and abilities the students brought into their classrooms, these teachers focused on strengths, fostered their students' learning, and generated conditions for academic success.

Finally, this study also examined the success of a school from the view point of departmental teams instead of individual teachers. In states, like Texas, accountability and student success is measured from a departmental perspective. Because the teachers' efforts at NWA were supported by the department, they

weren't operating in isolation. They had somewhere to go and someone to ask if they sought answers. The result was that the school is successful, which means that the students are.

Appendix A

Invitation Email

Greetings Teachers,

My name is Stephanie Boyce and I am a Ph.D. candidate at the University of Texas at Arlington. I am conducting a study to better understand the practices of successful high school science and math teachers of students of color. Participants will participate in one face-to-face interview and allow me to observe one classroom lesson. Participation in this study is totally voluntary and you will remain anonymous in the reporting of the findings. All participants will receive a $10 Starbucks gift card as a thank you for your participation.

If you are interested in participating in the study, please respond to this email indicating which day of the week and time period you prefer to have your interview and observation.

Thanks so much for your attention!

Sincerely,

Stephanie Boyce, M.Ed.

Appendix B

Teacher Interview Protocol

I am conducting research on the practices of science and math teachers of students of color at a successful school. We'll start by talking about the department and then about your specific classroom.

1. To what do you attribute the success of your department? (e.g., support, leadership, approach to teaching, teachers, students)
2. Tell me a little about what led you to become a science or math teacher.
    a. Background/experiences
    b. Why did you decide to teach your specific subject (i.e. biology, geometry, chemistry, algebra, physics, etc.)?
3. Do you have a philosophy of teaching? Please describe. How do you connect that philosophy with what you do in the classroom? Please describe what this looks like in your classroom.
4. What do you consider when planning your lessons?
5. What are the main goals for your students in your X class?
    a. Is there anything beyond subject content that you hope all students leave your class understanding? (e.g., critical thinking) Please describe.
    b. Why those goals? What does this look like in your classroom?
6. Do the students in your class affect your approach to planning? If yes, in what ways? What does this look like in your classroom? If no, why?

7. Have your approaches to teaching changed since you began? In what ways (if they say yes) Why did you make these changes?
8. How do you include the interests and/or backgrounds of your students in class? Please describe. Do you include lessons or activities that require students to think deeply about their own lives and society? How do students respond to these efforts? Do any of your lessons cause students to think critically about the world around them?
9. Is there anything else about your approach to teaching that you think helps your students of color, in particular succeed, which we haven't discussed.

Appendix C

Classroom Observation Protocol

Date:

Lesson Title:

Learning Objective:

| Time Stamp | Teacher (Words) | Teacher Actions) |
|---|---|---|
| | | |

**Descriptions:**

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## Biographical Information

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