

ABSTRACT

MCNEIL, CELETHIA KEITH. A Critical Examination of Diverse Students' Funds of Knowledge Inclusion in High School Mathematics: A Mixed Methods Study. (Under the direction of Dr. Karen Keene.)

This study characterizes teaching practices that involve students' funds of knowledge ([FoK], González, 1995; Moll, 1992; Moll, Amanti, Neff, & González, 1992). FoK may be defined as bodies of knowledge, skills, language, and experiences found in students' homes and communities for potential use in formal learning. I investigated how high school students' FoK are being incorporated into mathematics instruction. Instruction includes interactions and communication between teachers and students for students' understanding. Further, I determined if teachers' race and experience have any significance in FoK incorporation.

In this embedded mixed methods study, I identified teacher behaviors and classroom materials that focused instructional attention on language, culture, and social justice issues using a culturally responsive mathematics teaching (CRMT) framework and tool developed to evaluate mathematics instruction (Aguirre & Zavala, 2013). The study participants were four high school mathematics teachers and the students in one of their most diverse Common Core mathematics sections. There were two Black and two White teachers, one experience level per race: two novices (0-4 years), and two masters (20 or more). I categorized observed teacher behaviors from the video data (Powell, Francisco, & Maher, 2003) and artifacts from each observation day as they related to the following dimensions: (a) academic language support for English learners (ELs), (b) use of English as a second language (ESL) scaffolding strategies, (c) funds of knowledge/culture/community support, and (d) use of critical knowledge/social justice (Aguirre & Zavala, 2013).

Critical events found in the study were aggregated on attributes such as teacher participants' experience, race, and classroom demographics. Quantifiable items from various data sources were statistically analyzed. Responses from teacher interviews were compared to student survey responses and actual observations. I qualitatively described actions within the observed classrooms. Upon gathering all data, I merged findings from both qualitative and quantitative analysis to interpret results and draw conclusions.

Through observation and student data, I found that novice teachers in the study made more connections between the interests of their non-White students and their instruction than the master teachers. Teachers incorporated students' funds of knowledge in the following ways: (a) contextual problems, (b) dialogue, and (c) discovery. All teachers felt that their experience played a role in how they taught, however the master teachers discussed their teaching experience more than the novices. The themes that emerged concerning experience playing a role with incorporating students' funds of knowledge are: (a) non-teaching experience, (b) teaching experience, and (c) teacher education. Lastly, only the Black novice in the study felt that his race played a role in how he taught his class. The themes that arose from the study concerning race were: (a) Personal Experiences with Race and Racism, (b) the Role of Race in Teaching and Learning, and (c) Addressing Race in the Classroom.

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A Critical Examination of Diverse Students' Funds of Knowledge Inclusion in High School
Mathematics: A Mixed Methods Study

by
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DEDICATION

I dedicate this dissertation to my father Mr. Willie Jackson, a fallen soldier, who was and continues to be a constant source of strength in my life. I also dedicate the dissertation to my loving mother Ms. Thelma Keith, my earthly soldier, who never let me give up. I also dedicate this to my family, immediate and extended and to my best friend Lavon (deceased) who encouraged me to be a teacher. May this dissertation be a symbol of what can happen as others aspire toward their own goals.

BIOGRAPHY

Celethia Keith McNeil was born on February 12, 1982, in Fort Bragg, North Carolina. Since her parents were in the United States Army, Celethia lived in many places. In her early years prior to school age, Celethia lived in Trenton, New Jersey, and lived abroad in Heidelberg, Germany where she attended preschool. To keep her near family during her parents' temporary duty assignments, Celethia attended kindergarten in Currie, NC. Toward retirement, Celethia's parents settled back in Fort Bragg, NC, and Celethia moved to Fayetteville, NC in 1987. She attended Seventy-First High School in North Carolina where she was a member of several choirs all four years. After graduating from high school, Celethia attended and graduated cum laude from Fayetteville State University in May 2004 with a Bachelor of Science in Mathematics. Upon graduation, Celethia taught high school mathematics in public and alternative schools in Charlotte, NC and Lancaster, SC. During her four years as a high school teacher, she taught Algebra I and II, Geometry, Advanced Placement Statistics, and Advanced Functions and Modeling. After four years of teaching, she returned to her alma mater for a Master of Science in Mathematics and graduated in May 2010. Beginning in August 2010, Celethia attended the University of North Carolina at Greensboro; she then transferred to North Carolina State University in Raleigh, NC in July 2012 to continue working on her Ph.D. During her first year at NC State University, Celethia taught mathematics and statistics courses at Wake Technical Community College and ITT Technical College, and William Peace University. As a graduate assistant in the department of mathematics education at NC State, Celethia has taught undergraduate and graduate level courses, conducted research, and maintained pertinent responsibilities within the department.

She has attended research conferences and symposiums, and published findings in national conference proceedings.

Upon receiving her degree, Celethia will become part of the mathematics education faculty to teach methods courses on the undergraduate and graduate levels. She wants to pursue grant writing, and research concerning cultural pedagogy, funds of knowledge, and critical race theory in education.

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CHAPTER 1: INTRODUCTION

Although they want to make mathematics relevant to students' lives, teachers are typically not being empowered to develop culturally competent lessons or ways of thinking (e.g. frameworks and PD), which leads them to resort back to a more traditional perspective and ways of thinking that is mono-cultural and in many cases Eurocentric in nature (Swartz, 2003; Thomas et al., 1994). The continuous implementation of traditional Eurocentric ways of teaching may imply that teachers are not using students' authentic situations to help them learn, thus sustaining the inability to build bridges between what students know and the curriculum that is used to teach them. Consequently, students of color may have a decreased sense of belonging and self-worth, and do not see relevance of mathematics in their lives.

Schools in the US have been trying to make learning more equitable and responsive for students of color since the 1960s. Despite these efforts, underrepresented minorities continue to academically perform subpar to their white counterparts. Some factors are beyond teachers' control, like students' home lives and the chosen curriculum for the courses they teach. Most of the teaching force is white (Feistritzer, 2011) and many teachers of this demographic do not form constructive relationships with their students of color (Sleeter, 2008). Further, white teachers refer students of color to special education more than teachers of color while many white students from affluent backgrounds occupy the advanced classes (Harry & Klingner, 2006).

Literature suggests motives for the ongoing abysmal performance of students as they relate to beliefs and preparation of teachers, in-service and pre-service. As of 2011, the teaching force for the US is 84% white (Feistritzer, 2011), compared to over 40% of the K-12

student population who is not (National Center for Education Statistics [NCES], 2002). In particular, students of color make up over 60% in the nation's most populous states such as California and Texas (Boser, 2011). Researchers continue to find teachers who view white and Asian students as "more teachable" than students of color (Sleeter, 2008, p. 569), blaming their academic downfalls on their inability to learn. Such perception patterns are normally preexisting within white pre-service teachers prior to beginning their teacher education programs. Many of these teachers seek jobs away from low-income communities (Herbel-Eisenmann et al., 2013; Zozakiewicz, 2010) which negatively impacts teacher turnover for urban and rural schools.

Sleeter (2008) discussed why we need to counter three forms of "ongoing socialization" experienced by many white teachers. First, white individuals tend to associate primarily with other white individuals typically in homogeneous neighborhoods, which are those entirely or primarily occupied by white people. This context facilitates the minimal awareness of experiences unlike their own where they generally deny what people of color say about their own experiences, ambitions, and communities. Second, it is difficult for teachers to envision alternatives to how schooling should go or what teaching should look like when their experiences continue to be taken for granted and remain unchanged. And lastly, teaching and learning generally follows a transmission model, where content is prescribed and directly transmitted from the teacher to the student, opposed to student-centered experiences (Sleeter, 2008). These three constructs continue to characterize how teachers behave and may contribute to the disconnection between white teachers and many of their students of color.

Mathematics learning as a culture-free notion continues to be a commonly held belief in K-12 education, particularly for teachers. Additionally, the cultural mismatch between teachers and students persists due to the diversification of the student population and the whitening of the teaching force (NCES, 2002). For example, it has been documented that white teachers may have more difficulty developing constructive, meaningful relationships with students of color (Battey, 2013; Sleeter, 2008; Walker, 2007; Zozakiewicz, 2010). As a result, the incorporation of students' culture and interests continues to be far less than desired in mathematics instruction. According to Damerow and Westbury (1985):

It is easy to say that there exists a culture of mathematics and it is a common belief that mathematics is somehow 'culture-free,' in that it is somehow independent of external cultural influences. But what kind of mathematics are we teaching that lacks cultural context [?] Furthermore, should we enculturate students into a field that is essentially divorced from the everyday realities they face [?] (p. 177)

To increase the use of students' authentic situations to help them learn, teacher education programs for pre-service and in-service teachers need to model how to gather data from students and their knowledge bases. In turn, the data from students may be used for a bottom-up approach for more equitable learning situations for all students. Martin (2003) discussed the misalignment between top-down and bottom-up approaches in mathematics education. He mentioned how policy makers and mathematics educators decide what is important to learn and what constitutes equitable mathematics, a top-down approach. In contrast, marginalized students, parents, and community members define equity in mathematics differently: "it is more related to their day-to-day experiences in their out-of-

school contexts whose participations is mediated or dictated by knowledge of mathematics as it is to their school-based experiences...” (Martin, 2003, p. 12). Individuals in education who hold biases toward particular ways of teaching and learning may be reluctant to use bottom-up approaches because they are unfamiliar to them, regardless of empirical evidence presented in literature and research expressing its effectiveness (Leonard, 2008; Leonard, Napp, & Adeleke, 2009).

Through my research, I investigated high school classroom teachers’ beliefs and their behaviors as they use diverse students’ out-of-school knowledge to help students be successful academically. This study includes opportunities reserved for practicing teachers to watch themselves teaching on a video, and self-evaluate their behaviors while offering suggestions on how to improve targeted aspects of their practice.

Many teachers (not just mathematics teachers) are not adequately considering students’ culture and other intelligences in the classroom due to the lack of preparation to teach in ethnically, culturally, linguistically, and socio-economically diverse classrooms (Gay, 2000, 2002). Those who make attempts at cultural integration into the subject matter typically do so with name transplants in contextual problems (Aguirre et al., 2012b) to make problems include the student, regardless of how far removed the students may be from the context there within. Another common method for cultural integration is the “holidays and heroes” approach (Frankenstein, 2005; González, Moll, & Amanti, 2005), which isolates culture to a certain time of the school year rather than throughout the year. As a result, students of color are not included or engaged in the lessons, and the achievement gap continues to widen between them and more dominant groups. The teachers’ rationale for this

poor incorporation includes difficulty with implementation, curriculum, high stakes testing, and other authoritative obstacles, particularly in mathematics (Ukpokodu, 2011). In this study, I wanted to research whether cultural pedagogies are being implemented and whether diverse students are currently being given opportunities to achieve in mathematics classrooms through their authentic experiences.

Differences in academic ability among students are predominantly based on what is understood through prescribed teaching and supported by testing. Prior to entering the classroom, most teachers do not have meaningful interactions with individuals that live in communities outside of their own (Battey, 2013; Sleeter, 2008; Walker, 2007; Zozakiewicz, 2010). Teachers' understanding of students' communities, households, and the exchange of ideas and resources among them should be able to support those students' mathematics learning (Aguirre & Zavala, 2013).

There is a gap in the research related to practicing teachers' use of culture in teaching, as an abundance of current research focuses on pre-service and beginning teachers prior to them obtaining any teaching experience. No studies found mention any other training or experience that pre-service teachers have had outside of their teacher education programs or how experience impacts teachers' use of culture in mathematics teaching. As part of this study, I examined two levels of teaching experience while considering additional teacher training for the preparation of teaching diverse students (Ladson-Billings, 1999), and attempt to determine whether this experience and training together play a role in teachers' connection level of mathematics and students' lives. In the section that follows, I justify the purpose for the research questions to be answered through this investigation.

Rationale for Research Questions

The overall purpose of the study is to learn about the conscious or unconscious efforts teachers make in ethnically diverse high school mathematics classrooms that relate to students' FoK. Many teachers have difficulty with infusing culture and students' interests in mathematics instruction due to the top-down influences in the education system (Martin, 2003; Ukpokodu, 2011). In addition, there is a lack of teacher preparation to teach in diverse classrooms (Gay, 2000, 2002). Typically, teachers who make efforts to include culture into the subject matter tend to do so in isolated spurts with no true integration (Frankenstein, 2005; González et al., 2005). Therefore, teachers are not adequately using the knowledge that students bring into the classroom as assets for learning. In this study, I will examine how teachers incorporate their students' culture and community funds of knowledge (FoK) into mathematics instruction.

Teachers not understanding the students they teach as it relates to students' lives outside of the classroom or how they think may be due to the racial differences that exist among teachers and students, which in turn may influence the lack of meaningful interactions. Further, students of color are more likely to have teachers that question their academic ability (Sleeter, 2008). Ladson-Billings and Tate (1995) argue that race is significant in the US, and race in education is an under-examined conception. By investigating black and white teachers and their pedagogical practices, we may learn whether teacher race makes a difference. Teachers with similar backgrounds to their students may be able to make more meaningful interactions (Sleeter, 2008); those with different backgrounds

may have less than adequate outcomes. An investigation will reveal whether differences among teachers and students have any significance on teachers' instructional practices.

In addition to race, a teacher's experience level and training are promising qualities to consider for investigation. My rationale for this is because more experienced teachers may be more traditional in their methods, while less experienced teachers may be more willing to incorporate innovative teaching strategies, as these are becoming more prominent in teacher education programs. On the other hand, those with less experience may be more occupied with understanding and covering content for performance reasons, while the more experienced are more vetted and can use more effective strategies by learning who their students are as individuals and how they learn best. An investigation of teachers of different races and experience (both classroom and other) can shed some light on whether these teacher characteristics play a role in how and whether students' lives are adequately incorporated into high school mathematics instruction.

The following research questions were investigated during this study:

1. How are high school mathematics teachers in diverse classrooms connecting instruction to students' cultural/community funds of knowledge?
2. Does the experience of high school mathematics teachers play a role in incorporating students' cultural/community funds of knowledge? If so, in what ways?
3. Does the race of high school mathematics teachers play a role in incorporating students' cultural/community funds of knowledge? If so, in what ways?

Through this study, I hoped to achieve a better understanding of what is currently happening in the high school mathematics classroom. By examining teacher behaviors during

mathematics instruction, I anticipated finding a variety of pedagogical strategies and levels of authentic student experiences in the classroom across different teacher experience levels and races.

As will be discussed later, I used an already-developed framework as one of the primary means to answer the research questions. Aguirre and Zavala (2013) developed a framework that highlights under-examined dimensions of culturally responsive mathematics teaching (CRMT). By evaluating mathematics classroom instruction using this framework and its corresponding tool, I hoped to show the usefulness of this tool and report how teachers measure up in their cultural responsiveness. I also used other qualitative and quantitative techniques to pursue answers to these research questions.

Next, I provide definitions of terms that may be unfamiliar to readers or ambiguous in literature.

Definition of Terms

The section that follows highlights various terms and definitions that may need clarification for the study. The first set of definitions involves concepts that have been interpreted in many ways in the literature and I offer the definitions I used for this study. After that, I provide definitions for concepts related to race and ethnicities from various authors of literature (Davis, 1991) and US Census Bureau Briefs (Humes, Jones, & Ramirez, 2011; Rastogi, Johnson, Hoeffel, & Drewery, 2011) that potentially will be present in the classrooms under study.

Instruction. Any interaction and communication (i.e., written or oral) between teachers and students for the primary purpose of getting students to understand a mathematics

concept. Instruction may take different forms such as content development (whole-group instruction), grouped basic skill instruction, individual work, or feedback (Evertson, Emmer, & Worsham, 2006).

Funds of Knowledge. The term funds of knowledge (FoK) has been defined as the bodies of knowledge, skills, language, and experiences found in students' homes and communities for potential use for formal learning (Aguirre et al., 2012b; González et al., 2005; Moll & González, 2004). This may be extended to include one's community and serve as a research approach to understand students' culture that may have been historically considered academically or economically deficient as potential classroom resources (González et al., 2005; Moll et al., 1992).

Novice Teacher. A teacher who has taught at most five years; however, a teacher of any level may have life experiences that they draw on in order to integrate authentic situations and thus be a novice at teaching, but not at life.

Master Teacher. A teacher who has taught at least 20 years.

Critical behavior (for this study). Observed teacher behavior that makes a connection from students' community/cultural knowledge to formal mathematics. A behavior is deemed critical if it falls into one of the following categories (Aguirre & Zavala, 2013):

1. Uses L1 [home language] to support academic language development for ELLs [English Language Learners];
2. Utilizes scaffolding strategies to provide academic language development for ELLS;
3. Helps students connect mathematics with relevant/authentic situations in their lives; and/or

4. Supports students' use of mathematics to understand, critique, and change an important equity or social justice issue in their lives.

It is also noteworthy that I used critical behavior, incident, and instance interchangeably throughout this dissertation.

Scaffolding strategies. Strategies used by the teacher in a classroom that bridge known to unknown information of the student.

Authentic lesson. As it refers to mathematics learning situations and problem contexts for students, authentic is the conception that lessons are based on “known (not perceived, contrived, or assumed) student experiences as well as problems that stem from a local issue or situation that students find ‘genuinely problematic’” (Aguirre & Zavala, 2013, p. 166).

The following definitions cover the potential race categories that will be encountered in the classrooms in this study.

African American. Also referred to as Black Americans or Afro-Americans, African American is an ethnic group of citizens or US residents with some or all of their ancestry from any of the native populations of Sub-Saharan Africa (Rastogi et al., 2011). In addition, African American may be hyphenated or used to include only those individuals who are descended from African slaves. I use this term as an ethnic group within and not synonymous with Black as a race. Also, I will not hyphenate this term.

Black. The race Black refers to “a person having origins in any of the Black racial groups of Africa. It includes people who indicated their race(s) as ‘Black, African Am[erican], or Negro’ or reported entries such as African American, Kenyan, Nigerian, or Haitian” (Humes

et al., p. 3, 2011). I will use the term Black to describe participants in the study for categorical convenience, regardless of ethnicities within this race.

Hispanic. “Hispanic origin can be viewed as the heritage, nationality group, lineage, or country of birth of the person or the person’s parents or ancestors before their arrival in the United States. People who identify their origin as Hispanic, Latino, or Spanish may be any race... ‘Hispanic or Latino’ refers to a person of Cuban, Mexican, Puerto Rican, South or Central American, or other Spanish culture or origin regardless of race” (Humes et al., p. 2, 2011).

White. According to the US Census Bureau, one who identifies as White refers to “a person having origins in any of the original peoples of Europe, the Middle East, or North Africa. It includes people who indicated their race(s) as ‘White’ or reported entries such as Irish, German, Italian, Lebanese, Arab, Moroccan, or Caucasian” (Humes et al., 2011, p. 3). White Americans consider themselves White. We will not break down racial categories into Hispanic/Latino descent or otherwise (i.e., Hispanic White, non- Hispanic White, etc.). Similar to African American and Black, Caucasian is often used interchangeably although not synonymous with White; however, Caucasian is an ethnic group that is a subset of the White race.

American Indian. Also called Native American, this term refers to “a person having origins in any of the original peoples of North and South America (including Central America) and who maintains tribal affiliation or community attachment. This category includes people who indicated their race(s) as ‘American Indian or Alaska Native’ or reported their enrolled or principal tribe, such as Navajo, Blackfeet, Inupiat, Yup’ik, or

Central American Indian groups or South American Indian groups” (Humes et al, 2011., p. 3).

Asian. An Asian refers to “a person having origins in any of the original peoples of the Far East, Southeast Asia, or the Indian subcontinent, including, for example, Cambodia, China, India, Japan, Korea, Malaysia, Pakistan, the Philippine Islands, Thailand, and Vietnam. It includes people who indicated their race(s) as ‘Asian’ or reported entries such as ‘Asian Indian,’ ‘Chinese,’ ‘Filipino,’ ‘Korean,’ ‘Japanese,’ ‘Vietnamese,’ and ‘Other Asian’ or provided other detailed Asian responses” (Humes et al., 2011., p. 3). These entries are considered ethnicities. In addition, Asian Americans are Americans of Asian descent.

Native Hawaiian or Other Pacific Islander. These classifications refer to “a person having origins in any of the original peoples of Hawaii, Guam, Samoa, or other Pacific Islands. It includes people who indicated their race(s) as ‘Pacific Islander’ or reported entries such as ‘Native Hawaiian,’ ‘Guamanian or Chamorro,’ ‘Samoan,’ and ‘Other Pacific Islander’ or provided other detailed Pacific Islander responses” (Humes et al., 2011, p. 3).

Some Other Race. “Also known as ‘Other’ on many applications includes all other responses not included in the White, Black or African American, American Indian or Alaska Native, Asian, and Native Hawaiian or Other Pacific Islander race categories described above. Respondents reporting entries such as multiracial, mixed, interracial, or a Hispanic or Latino group (for example, Mexican, Puerto Rican, Cuban, or Spanish) in response to the race question are included in this category” (Humes et al., 2011, p. 3).

Diverse classroom. Generally, a classroom that consists of students with differences, e.g., ethnicity. For this study, I sought out classrooms that were not predominantly one race, but a fair mixture different races, dependent upon their representation in their schools.

People of color. A term referring to underrepresented minority groups such as African Americans, Latinos, and Native Americans (DeCuir-Gunby, Long-McMillian, & Grant, 2009).

Minority. Feagin (1984) characterized a minority group with five indicators: (1) suffering discrimination and subordination, (2) physical and/or cultural traits that set them apart, and which are disapproved by the dominant group, (3) a shared sense of collective identity and common burdens, (4) socially shared rules about who belongs and who does not determine minority status, and (5) tendency to marry within the group. (p. 10)
Specifically for this study, minority will refer to those racially classified other than White.

Whiteness. The concept of whiteness is an ideological social construction tied to social status. Whiteness studies focuses on cultural and historical proponents of people identified as White. In other words, one drop of White blood does not make one White, but one drop of Black blood eliminates one from possessing whiteness (Harris, 1993). Within one of the Critical Race Theory tenets, this is also conceptualized as a concept of racial superiority constructed socially that may justify discrimination against non-Whites (Lynn & Dixon, 2013).

Significance of the Study

This embedded mixed methods study stands to make a significant contribution to mathematics education research. Minimal research has been conducted using FoK as a

theoretical perspective at the high school level as earlier work using FoK tends to focus on elementary and middle school levels (Aguirre et al., 2012a, b; González, 1995; Moll et al., 1992). Additionally, since most FoK literature focuses on K-8 pre-service teachers, this study will add to the growing literature on secondary level mathematics teaching and learning. The classrooms studied on students' FoK have primarily been bilingual or having majority Latino/a students. This study broadens the race scope by seeking out diverse classrooms to include a range of different races to learn how teachers are incorporating the FoK from different race groups. This study also holds significance due to the topic of race and experience level being discussed and analyzed as potential contributing factors to how teachers incorporate students' FoK into mathematics instruction.

All of the findings in this study will inform teacher education and professional development for pre-service and in-service teachers by studying how practicing teachers of different races incorporate student experience into mathematics teaching. In addition, teachers with contrasting experiences may be able to teach each other; new teachers can teach veteran teachers about new innovative strategies recently learned and implemented in teacher education programs, and veteran teachers can help new teachers disseminate and support these innovative strategies since they have more seniority.

Chapter Summary

The chapter above introduces my study on how high school mathematics teachers (of different races, different experience levels, and in general) are incorporating their students' cultural and community funds of knowledge into mathematics instruction in mathematics classes. Chapter Two is the literature review that explores the overarching ideas

that surround the study. Chapter Three provides the research design and methods, in addition to validity and reliability measures. Chapters Four and Five will serve the purpose of reporting the analysis, findings, interpretations, and implications.

CHAPTER 2: LITERATURE REVIEW

The National Center for Education Information recently reported that 84% of the teaching force in the US is White, while the number of students of color increases to over 40% and almost 60% in the nation's most populous states, namely California and Texas (Boser, 2011; Feistritzer, 2011). As a result, teachers are extremely likely to encounter students culturally different than themselves in their classrooms (Swartz, 2003; Walker, 2007). Culture may be defined as having shared beliefs, experiences, and perceptions among a group; some embedded constructs include class, language, and race (Brown-Jeffy & Cooper, 2011). Similarly, some education researchers refer to class, language, and race collectively as "triple segregation" (Mackinney & Rios-Aguilar, 2012), specifically if these notions are used to marginalized particular groups when their culture does not assimilate with that of the dominant group. (Herbel-Eisenmann et al., 2013; Sleeter, 2008)

Several scholars in mathematics education have recently and consciously addressed the needs of marginalized groups especially drawing on concepts such as: funds of knowledge (Civil, 2002; Foote, 2009; González, Andrade, Civil, & Moll, 2001), culturally relevant/responsive theory and practice (Aguirre & Zavala, 2013; Gay, 2002; Ladson-Billings, 1995b; Rubel & Chu, 2012), and social justice (Gutstein, 2003; Leonard, Napp, & Adeleke, 2009). However, very few of these discuss mathematics teaching at the high school level.

Researchers desire to incorporate ongoing analysis and reflection into education as a means for keeping the achievement and persistence of disenfranchised groups a priority (Ladson-Billings & Tate, 1995; Martin, 2003). One way to do this is to examine strengths

and weaknesses of previous work. In this review of literature, there are four overarching themes that will be discussed to provide rationale and support for this dissertation study: (a) cultural pedagogy, (b) funds of knowledge, (c) the negotiation of language, and (d) critical race theory.

Cultural Pedagogy

Top-down approaches for mathematics learning focus on rote skills, mathematics out of context, and memorization (Martin, 2003). Equitable learning situations may be implemented in order to increase the achievement among students of color. Cultural pedagogy offers several different constructs that are used in schools to increase the success rate of a more diverse population of students: culturally relevant teaching (Ladson-Billings, 1994, 1995b), cultural brokering and border crossing (Aikenhead, 1997), culturally responsive teaching (Gay, 2000), culturally specific pedagogy (Irvine, 2002), and diversity pedagogy (Sheets, 2005). Although these domains have varying foci (e.g., sociopolitical ramifications or social justice), they all have the similar desired outcome toward academic achievement. The following subsections will describe the first three domains of cultural pedagogy with instances from research and practice. The focus here will be on the first three domains, as they align with this study.

Culturally Relevant Teaching

Ladson-Billings (1992) defined culturally relevant pedagogy as a “pedagogy of opposition that recognizes and celebrates African and African-American culture... contrasted with an assimilationist approach to teaching that sees fitting students into the existing social

and economic order as its primary responsibility” (p. 314). There are three pillars of culturally relevant teaching: (1) highlighting students’ academic achievement; (2) advancing students’ cultural competence; and (3) assisting the students’ development of critical consciousness (Ladson-Billings, 1992, 1994). For mathematics classrooms in particular, culturally relevant teaching also includes the acknowledgment that: (a) mathematics has been present in every culture since societies have recorded their histories; and (b) of the effect of mathematics on any culture and the people within it (Hatfield, Edwards, Bitter, & Morrow, 2000). Culturally relevant teaching has been viewed as a promising bottom-up approach that “empowers students intellectually, socially, emotionally, and politically by using cultural referents (objects, concepts, or events) to impart knowledge, skills, and attitudes” (Ladson-Billings, 1994, pp. 17-18). This pedagogy stands on the belief that poor and ethnically diverse students can learn, and it has been described as an effective way to meet the social and intellectual needs of students of color (Howard, 2003; Ladson-Billings, 1994).

Some teacher behaviors associated with culturally relevant teaching are as follows:

- Treating students as competent;
- Providing instructional “scaffolding” to help students transition from the known to the unknown;
- Exhibiting instruction as a high priority;
- Expanding on students’ thinking and abilities; and
- Having deep knowledge of students and content (Ladson-Billings, 1994).

Culturally relevant teachers recognize the interplay of learning and culture, view diverse students’ cultural capital as rich resources for the classroom, and use non-traditional means to

assess what students know using pedagogical strategies such as poetry, rap, role play, and group projects (Howard, 2003; Ladson-Billings, 1995b; Leonard, 2008). Although examples of culturally relevant teaching are clearly described in the literature, its implementation in the mathematics classroom is also minimal in high school, particularly in novice teachers (Albert, 2000; Ladson-Billings, 1994).

As an example, Albert (2000), a seventh grade mathematics teacher, described her difficulties with culturally relevant teaching. With the belief that her assignment was aligned with the *Principles and Standards for School Mathematics* (PSSM), she assigned her students an essay to write about a famous mathematician. The goal of the essay was to have students communicate their ideas, then clarify, refine, and solidify their thinking. As a Black teacher, Albert surprisingly learned that she failed to reach her Black students. Five Black males in her class asked her about an alternative to the assignment, to write a rap in lieu of the assigned essay. After critical reflection of her overall teaching practices, Albert came to the realization that her practices were Eurocentric and middle class in nature. Moreover, her practices did not capture the needs, interests, and cultural backgrounds of her students (Howard, 2003), and they marginalized the voices of her diverse students. Albert decided to modify the assignment for students to write about contributions from women and people of color in mathematics, and mediums of presentation were expanded to include poems, plays, creative stories, and rap.

By using students' suggestions and careful self-reflection for an alternative assignment, Albert (2000) was able to incorporate their interests and experiences into mathematics. This shift toward a culturally relevant pedagogy provided Albert with an

empowering way to teach mathematics (Howard, 2003). In my study, I note bottom-up teacher behaviors designed to reach a broader range of diverse students in the high school mathematics classroom.

To help incorporate more culturally relevant teaching in diverse environments like Albert (2000), Rubel and Chu (2012) conducted a research and professional development project at two urban high schools in low-income communities of color focused on seven teachers with experience ranging from first year to eight years. The project, Centering the Teaching of Mathematics on Urban Youth (CTMUY), served the purpose of developing instructional strategies while implementing CUlturally RElevant MATHematics Pedagogy, or CureMap, adapted from Ladson-Billings' (1994) culturally relevant pedagogy (see Figure 1). By modifying culturally relevant pedagogy to include mathematics, Rubel (2012), one of the developers of CureMap, argues that CureMap is a “promising approach to successful mathematics teaching” (p. 49), and deemed that teaching mathematics in a culturally relevant way “require[s]...teachers [to] have a deep and flexible knowledge of mathematics, of how to teach mathematics, and of their students and their students' communities” (p. 58).

As a professional development facilitator, Rubel (2012) collaborated with mathematics teachers to refine lessons prior to classroom observations via email and face-to-face mentoring, and then debriefed after lessons to reflect on methods of improvement. Similar to Ladson-Billings (1995, 2006), Rubel offers mathematics teachers suggestions rather than prescriptions to incorporate features from the CureMap framework that are applicable to their teaching style. To do mathematics as a community, teachers had opportunities to experience mathematical tasks firsthand by collaboratively working through

them during the professional development and those tasks, in turn, were adapted for their classrooms.

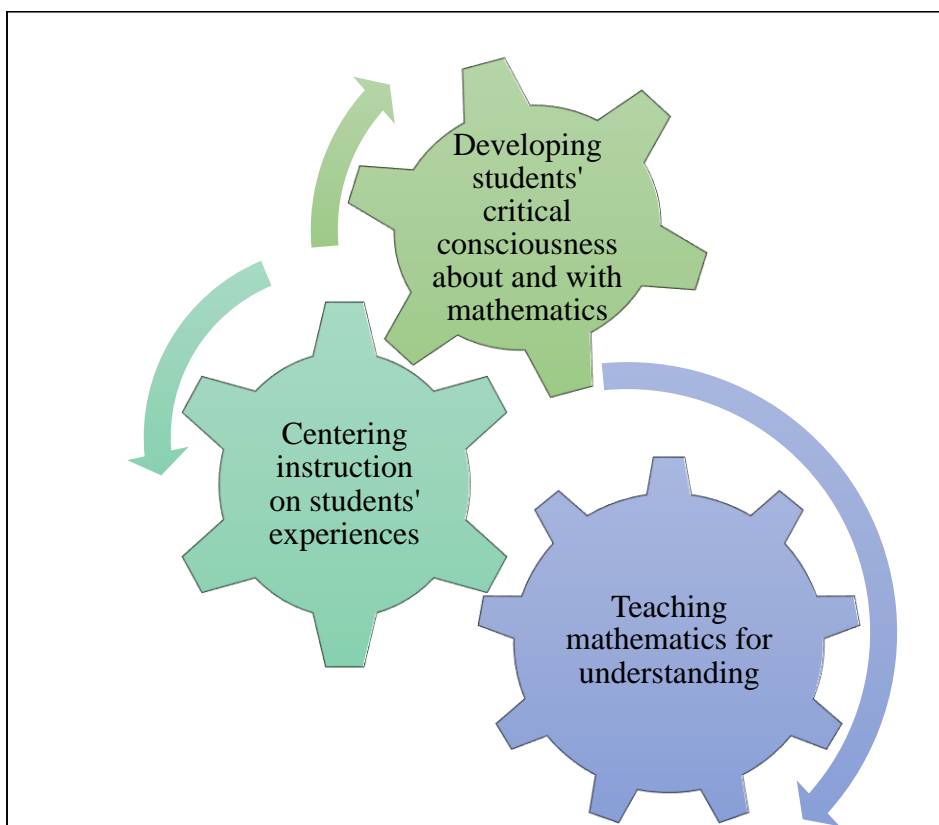


Figure 1: Dimensions of culturally relevant mathematics pedagogy (Rubel & Chu, 2012, p. 41)

Upon completion of one particular year's professional development, Rubel and Chu (2012) performed a mixed analysis on the CTMUY participants' perceptions and task implementation at the high schools under study. After the professional development, three themes emerged from their analysis that connected to Rubel and Chu's CureMap framework: (a) teaching for understanding by using tasks that enable connections between and among mathematical ideas and procedures, (b) centering mathematics instruction on students by offering to students multiple classroom modalities of participation in learning mathematics

and (c) centering mathematics instruction on students by mathematizing students' everyday experiences. (p. 46)

In Rubel and Chu's project, three teachers self-identified as White, and four Black. Similarly, my study will contain two White and two Black teachers; however as an extension, I studied two contrasting experience levels to include teachers who have been teaching less than five years and those who have been teaching more than 20 years. I note that part of the student survey for this study has items adapted from the CureMap framework (see Appendix I: Student Survey).

Cultural Brokering and Border Crossing

The term cultural brokering has been defined as "...bridging, linking, or mediating between groups or persons of different cultural backgrounds to effect change" (Jezewski, 1990, p. 497). One example of cultural brokering emerged out of Canada from Aikenhead's (1997) work with Native American high school science students. Aikenhead argued that science as a content area is foreign for many students because of the different cultures and views that exist between students and members of the science community (Aikenhead, 2001; Aikenhead & Jegede, 1999; Costa, 1995; Hennessy, 1993). Similar to Ladson-Billings (1994), Aikenhead identified some behaviors that science teachers should demonstrate to overcome this disconnection:

- Recognize science in Western culture as its own entity;
- Understand that most students experience a shift or cultural border crossing as they transition from their lives to the world of school science;

- Consider the multitude of cognitive conflicts with which students grapple due to cultural differences; and
- Help students negotiate their border crossings to minimize cultural conflicts.

Border crossing may be described as the movement between cultures and micro-cultures (Aikenhead, 1997). Specifically for students, this movement takes place between their culture and school culture in the classroom. To make this transition smooth, cultural brokering allows teachers to help students address conflicts that may occur during border crossing. Leonard (2008) provides an example of cultural brokering where a pre-service teacher helped her first grade students understand concepts in Earth science with the purpose of learning about how Earth's layers move to create folds and faults. The first grade teacher was able to use students' background knowledge by implementing a familiar context to vocabulary in Earth science (i.e., rocks, layers, stratigraphy, and scientists). Through the use of cultural brokering, the teacher helped her students understand the concept of layers, and border crossing was employed when the teacher asked her students about other things they knew that had layers. Expanded as *Know-Want-Learn*, the KWL process is a pedagogical strategy the teacher used to help her students organize what they *know*, what they *want* to learn, and what they *learned*. Moreover, this strategy helps teachers to gauge instruction on what or how they can teach to encompass students' interests.

Aikenhead (2001) built on the grounded theory of Costa (1995) to create hierarchical categories in which students cross borders into science at school while describing teacher behaviors as cultural brokers for each category. The six categories, their description, and metaphorical teacher behaviors can be found in Table 1 below.

Table 1
 Descriptions of Hierarchical Categories of Border Crossing and Teacher Roles (adapted from Aikenhead, 2001, p. 186)

Categories	Descriptions of Categories	Metaphorical Teacher Roles
Potential Scientists	Border crossing is smooth and leads to a deep understanding of science.	Coach
“I Want to Know”	Border crossing is adventurous and leads to a modest yet effective understanding of science.	Tour Guide
Other Smart Kids	Border crossing is easily managed but students have no personal interest in science related careers.	Travel Agent
“I Don’t Know”	Border crossing is hazardous with a shallow understanding of science. Students do not want to appear incompetent in front of peers or teacher.	Sherpa (guides students and helps them know challenges that lie ahead)
Outsiders	Border crossing is impossible and leads to physical or intellectual drop out of students.	Ambassador (risks are taken such as going to students’ environment)
Inside Outsider	Border crossing is impossible because of institutional discrimination in spite of students’ personal interest in understanding science.	Same as above

Note: The categories can also be applied to describe mathematics learners. The gradient arrow indicates degrees from a high level (top row) to a low level (bottom row).

Teachers have rarely been referenced in the literature as cultural brokers (Michie, 2003), but their opportunities to serve as such are significant. Cultural brokers can help elementary and middle school Latino/a students be successful in US schools without sacrificing their parents’ values (Cooper et al., 1999), and have also been used to help other groups become enculturated into different settings. Teachers as cultural brokers can check the placement of Spanish speaking students to make sure language is not the reason they are in special education classes, for instance. They can also encourage goals of children and what is

meaningful to them. By synthesizing the learning styles within these cultures, teachers can help their students succeed (Michie, 2003).

Before students reach school, they are in most cases influenced by their families and communities who may serve as cultural brokers. Parents as cultural brokers can provide their children with guidance and protection, which some may believe all that is needed to support achievement in school. They can teach their children to be respectful, honest, responsible, and model these behaviors (Cooper et al., 1999), but may lack formal knowledge to help their children academically. At this juncture, older siblings can help younger siblings adjust to school by modeling appropriate school behavior. Program staff in community centers can also serve as cultural brokers by helping children “feel confident and safe in their neighborhoods; learn alternatives to violence; gain educational experiences; and acquire the bicultural skills needed for success in school” (Cooper et al., 1999, p. 54). Further, they can encourage children to write down their goals for a career, education, families, and other areas of their lives. Similar to African Americans’ dilemma of “negotiating the academic demands of school while demonstrating cultural competence” (Ladson-Billings, 1995b, p. 476), children may be taught by program staff to become bicultural to successfully thrive in both school and home while maintaining community traditions (Cooper et al., 1999; Michie, 2003).

Culturally Responsive Teaching

Culturally responsive teaching is a concept that emerged from the multicultural education literature of the 1970s (Bowen & Salsman, 1979; Commission on Multicultural Education [CME], 1978; Comptroller General, 1971; Gay, 2000; Scott, 1978). Gay (2002)

defined cultural responsive teaching as “using the cultural characteristics, experiences, and perspectives of ethnically diverse students as conduits for teaching them more effectively” (p. 106). Culturally responsive teaching practices are based on the principle that academic knowledge positioned in students’ lived experiences and frames of reference can be more meaningful and interesting, and learned with more ease (Nunes, Schliemann, & Carraher, 1993). This may result in academic achievement of diverse students as learning takes place through cultural and experiential filters (Au & Kawakami, 1994; Foster, 1995; Gay, 2000; Hollins, 1996; Kleinfeld, 1975; Ladson-Billings, 1994, 1995a, b). The following is a compilation of characteristics of culturally responsive teaching (Frankenstein, 2005; Gay, 2000; Gutiérrez, 2000; Ladson-Billings, 1994; Leonard, 2008; Tate, 2005):

- Belief that students can learn and have the capacity to do high level mathematics;
- Provision of instructional scaffolding that support student success;
- Knowledge and caring about students;
- Positive interactions between teachers and students and positive relationships in the learning community;
- Promotion of cooperative, collaborative, and collective learning;
- Connection of formal teaching with students’ lives and communities;
- Practices with equitable and social justice approaches;
- Integration of students’ culture into the curriculum.

Although education researchers have provided evidence that many teachers often do not have meaningful interactions with diverse students until they are in their classrooms and may

carry uninformed and negative perceptions (Battey, 2013; Walker, 2007; Zozakiewicz, 2010), examples of how culturally responsive pedagogy has been used in mathematics education to promote the academic success of all students are also in the literature. Teachers could have meaningful interactions by not isolating themselves in groups that only include individuals with similar backgrounds (Sleeter, 2008) and have cultural immersion experiences (Ladson-Billings, 1999) where they are completely immersed in a culture unlike their own. In these experiences, teachers may become more culturally sensitive to what their students encounter, and relax preconceived notions about their students through understanding and appreciation.

Gay (2000, 2002), Wiest (2001), and Ukpokodu (2011) offered examples where teachers were successful in implementing culturally responsive pedagogy into mathematics instruction for students of color who primarily hold the belief that mathematics does not include them or value their knowledge. Further, other studies provide evidence of how implementing students' knowledge has positive effects on their learning (Ladson-Billings, 1994; Leonard, 2008; Villegas & Lucas, 2002).

As an example, after teaching a university course on urban classroom teaching and learning, Ukpokodu compiled her students' goals and expectations to find a common goal: they wanted to know how to teach culturally responsive mathematics and science. The author investigated this "researchable moment" to report why teachers are not teaching in a culturally responsive way and what these practices look like in a mathematics classroom. A diverse set of 45 pre-service and in-service elementary and high school teachers who participated in the study took a course under Ukpokodu with the aim of examining an

alternative theoretical framework in order to change urban teaching. Specifically, the course aimed to change the vision of the urban learner, the socio-cultural characteristics of urban students, and the sociopolitical contexts of urban schooling. The students in Ukpokodu's class examined research on culturally responsive and transformationist pedagogy. According to the Center for National Origin, Race and Sex Equity (1997), schools that apply a transformationist approach are equity focused and have the six following key components (Blackwell & Smiley, 2010):

- Equal access to courses, facilities, and activities, helping English learners (ELs) develop needed skills; encouraging students to enter all fields and developing a learning environment that supports all students;
- Attitudes that change from the inside out and are respectful and intolerant of bias or prejudice;
- Language that reduces or eliminates bias in vocabulary and usage or conveying ethnocentric attitudes, increasing sensitivity toward appropriate language use;
- Interactions in communication with students and their families or guardians and examining personal beliefs which might negatively influence how students are treated in class both academically and emotionally;
- Instruction that selects appropriate topics, assignments, and materials;
- Current and accurate materials with no bias in content, graphics, pictures and language.

Through the analysis of structured in-class activities, online discussions, and field notes, Ukpokodu (2011) found many themes. While trying to answer the question as to why teachers are not teaching in a culturally responsive way, the following four themes emerged:

- Views of many of the participants were that mathematics is culturally neutral.
- The textbook is used as an authoritative convenience in the mathematics classroom.
- Mathematics curriculum is standardized alongside high stakes testing.
- There are minimal models of culturally relevant teaching to follow.

In addition, four themes occurred when studying what culturally relevant teaching practices look like in a mathematics classroom:

- Teacher educators must move to deconstruct misguided beliefs about mathematics teaching and learning.
- Teachers should integrate content that is culturally relevant and highlight social and justice issues.
- By utilizing culturally responsive instructional strategies, teachers will be able to foster a community of learners.
- Appreciating students' thinking and problem solving should take place in the mathematics classroom as teachers detract traditional practices and become critically conscious to advocate for their students' mathematical success.

Ukpokodu (2011) used a diverse set of teachers with a variety of ethnicities, experience levels, and teaching contexts in an urban setting. Similarly, I intend to use two

experiences levels and ethnicities; however, I will remain exclusive to the high school context and I will not seek out only urban settings as I am as likely to encounter teachers in rural settings. In the next section, I address one of the common controversies around cultural pedagogy.

Cultural Pedagogy...or Just “Good Teaching”

Good teaching has not been well defined in the literature. In fact, Rahilly and Saroyan (1997), Ladson-Billings (1995), and Aguirre and Zavala (2013) have conflicting definitions of what constitutes good teaching. Below are different perspectives as they pertain to the arguments of good teaching versus cultural pedagogy.

After six years of examining teachers of academically successful African Americans (Ladson-Billings, 1992, 1994, 1995a), teachers and administrators wanted to know how to replicate this success. Ladson-Billings (1995a, 2006) has been asked to share how teachers could incorporate culturally relevant teaching practices into the classroom. Instead of offering some rigid prescription for how to teach in a culturally relevant way, the author’s usual response to this inquiry is “But, that’s just good teaching!” (Ladson-Billings, 1995a, p. 159). Like Rahilly and Saroyan (1997) discussed later in this section, Ladson-Billings noted that good teaching is more than just routine practices or well-written tasks; as an extension, Ladson-Billings illustrated particular exemplars of culturally relevant pedagogy and questioned its absence in classrooms (Ukpokodu, 2011).

By making links between school and culture and discussing the theoretical underpinning of culturally relevant teaching in an ethnographical context, Ladson-Billings offered some examples of the implementation of culturally relevant pedagogy. For instance,

considering how students can choose academic success, Ladson-Billings described one White female teacher who focused positive attention on African American males in her class. Being the majority of her class, the teacher recognized the social power possessed by the males. By addressing issues and ideas that were meaningful to the dominant population in her class, the teacher transformed this power oftentimes viewed as negative into academic power by allowing the males to take on leadership opportunities. As a result, other students in the class perceived the new roles of the African American males as positive and began to follow suit. By finding ways to value the skills and abilities of the males and channeling them for academic success, the teacher diffused a potentially negative relationship.

Looking across the teachers she studied, Ladson-Billings found no common threads pulling all teachers together as it related to their practices; the researcher dug deeper to find similarities in their teaching philosophies, how they thought about themselves as teachers and members of the community, and how they thought about others. Ladson-Billings advocates for the replication of this study to look for good teaching beyond practices.

To extend the examination of “good teaching” in a postsecondary context, Rahilly and Saroyan (1997) conducted research analyzing the differences in how university professors perceive critical events in classroom teaching. Through analysis of questionnaires of three levels of instructors (i.e., inexperienced, experienced, and award-winning), the authors wanted to investigate how instructors having expertise in their subject matter rather than formal teacher training exhibit good teaching. Instructors were asked to recall memorable teaching episodes, one exemplary and one poor, with a Critical Incident Questionnaire (CIQ) adapted from Flanagan’s (1954) Critical Incident Technique. The CIQ

responses were coded using the following four categories: knowledge, processes, goals, and actions. The results suggested that these categories are overemphasized in education; these categories and those related to mathematical thinking are focused on more than culturally responsive teaching (Aguirre & Zavala, 2013; Battey, 2013). The authors found the categories difficult to separate as many of them overlapped in practice. Additionally, it was highly contingent on the instructors' experience level of where this overlap occurs. The award-winning instructors did not mention pedagogy on their CIQ and Rahilly and Saroyan believed this knowledge may be taken for granted in their described exemplary events. Rahilly and Saroyan have found implications that would help each level of instructor in the study. They found that through interventions, the inexperienced instructors may learn to take cues from students to learn how to plan and be more flexible, while award-winning instructors may learn to get information from their students and to better deal with their emotions during instruction. It is noteworthy that even the most experienced instructors struggle with content, according to the study.

Good teaching strategies in Rahilly and Saroyan (1997) were viewed by the professors as the best recommended way for planning instruction, preparing handouts, capturing the interest of students, and evaluating learning. In contrast with Ladson-Billings (1995a), these routine practices are the only main sources of good teaching, and there is no explicit mention of culture or students' lives as a means to ensure that what the teachers are doing relates to the students. There are implications to get information from the student, but Rahilly and Saroyan do not reveal what information would be useful to instructors or how it

is to be applied to instruction, supporting Ladson-Billings (1995a) and Ukpokodu's (2011) argument of few models for teachers to follow.

Like Rahilly and Saroyan, I used two different level of experience of high school mathematics teachers to learn whether these differences play a significant role in the way teachers incorporate students' cultural and community funds of knowledge. Rather than using a questionnaire format like Rahilly and Saroyan, I interviewed each teacher in the study individually after five teaching episodes and allowed them time to watch two chosen video segments to accurately recall, reflect, and self-evaluate particular aspects of teaching.

There continues to be a call to understand teaching practices that impact the mathematics learning of students of color. Battey (2013) answered this call by examining urban classroom practices that do not succumb to those traditionally found in environments where students of color and the poor are educated. The purpose of this study was to analyze teacher knowledge in the classroom and its practical use when teaching mathematics. The author reported engaging reform-oriented pedagogical strategies and how interactions can mediate access to mathematics. Relational interactions between teachers and students can take place in four ways in the classroom to mediate access: addressing behavior, framing students' ability, recognizing students' contributions, and attending to language and culture. This last strategy is one that Aguirre and Zavala (2013) found to be the least developed for teachers, particularly students who do not speak the language of the dominant group. Battey noticed different emphasis during interactions which may be internalized positively or negatively: tone, repetition, multiple verbal and nonverbal cues, in contrast to the teacher's treatment of his or her students. Overall, interactions with students of color were more

confrontational in nature, while other interactions were pleasant and praising. In my study, I also examine how culture and language are implemented into mathematics instruction.

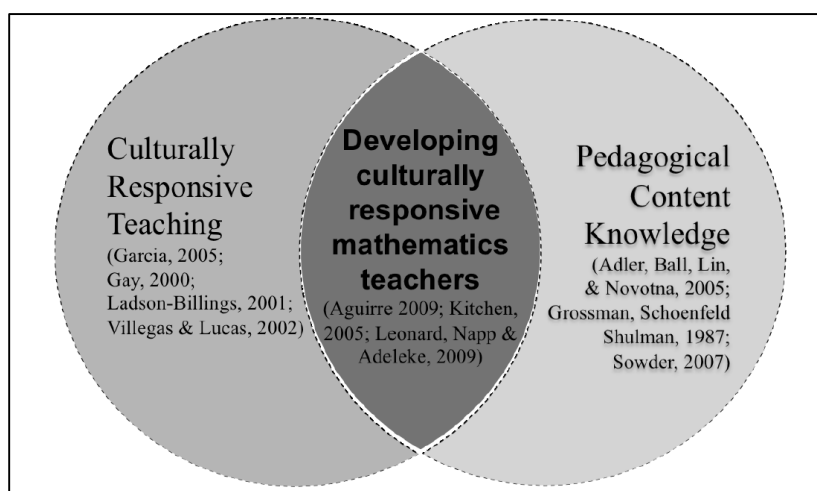


Figure 2: A framework for culturally responsive mathematics teaching (Aguirre et al., 2012a, p. 116)

Teachers can be evaluated on dimensions related to pedagogical content knowledge and cultural responsive teaching. Aguirre and Zavala (2013) developed a mathematics lesson analysis instrument called the culturally responsive mathematics teaching (CRMT) tool that examines teachers' use of culturally responsive mathematics teaching and offers a framework for analyzing this teaching. The overlap in Figure 2 indicates the emergence of the two literature bases that inform the elements that build Aguirre and Zavala's definition of good teaching and that informed the development of the CRMT tool (see Appendix L: Dimensions 6 through 8 of the CRMT tool). Like Battey (2013), Ladson-Billings (1995a), and Rahilly and Saroyan (1997), the first author (Aguirre, 2009) argues that the focus on one of these bases without the combination of the two does not provide equitable and accessible

mathematics for students. However, the authors Aguirre and Zavala contended that the pedagogical content knowledge in teacher evaluations has been overdone, while the culturally responsive teaching aspect has been minimal in teacher education and evaluation (Kitchen, DePree, Celedón-Pattichis, & Brinkerhoff, 2007). I plan to investigate some of the dimensions from the framework in the CRMT tool that highlight prominent characteristics of culturally responsive teaching. The dimension of the CRMT framework and its corresponding rubric will be presented in more detail in the following section on FoK.

Funds of Knowledge

Coined by Greenberg (1989) and Vélez-Ibáñez (1988, 1996), the term *funds of knowledge* (FoK) may be generally defined as “the knowledge base that underlies the productive and exchange activities of households” (Moll & González, 2004, p. 700).

Although FoK is considered a collective and may be viewed as plural, I will refer to it as a single entity unless talking about two or more individuals’ FoK. It is noteworthy that the term FoK has three meanings in literature as: (a) the aforementioned bodies of knowledge from students (which I will be using as I analyze student surveys in the study), (b) a curriculum development methodology for teachers described in the next section, and (c) a dimension in the CRMT tool described in the conceptual framework below. I will be using the FoK dimension within the CRMT tool (part c) to understand how students’ FoK (part a) is incorporated into mathematics instruction for the study.

The FoK theory (specifically the one mentioned in part b in the preceding paragraph) originated through collaborative research on the Funds of Knowledge for Teaching (FKT) project (Civil & Andrade, 2003). The main purpose of the FoK concept was to provide

teachers theoretical and methodological tools to address diversity through a development of engagement with the everyday conditions of life (González, 1995; Moll, 1992; Moll et al., 1992). FoK uses life experiences from students that can be valued and incorporated into the classroom. By discussing some studies that apply the theoretical underpinnings or methodology of FoK, we will better understand its appropriateness for mathematics teaching and learning and how it can be a form of teacher self-evaluation, teacher education, and pedagogical implications.

FoK demonstrates the reflexive relationship between research and practice by capitalizing on the infusion of resources from students' homes and communities into classroom instruction. FoK was established as an approach to developing curriculum by trying to understand students' communities and households that may be considered academically or economically deficient as potential resources (González, Moll, & Amanti, 2005; Moll, Amanti, Neff, & González, 1992, 2001; Moschkovich, 2013). Many studies using FoK are in the K-8 context when it comes to connecting students' mathematics with their community as a means to create authentic experiences (Aguirre et al., 2012b; Civil, 2007; Foote, 2009; González et al., 2005).

As an example, Moll et al. (2005) used a qualitative inquiry approach to linking students' classrooms and communities. Their aim was to capitalize on and develop innovative teaching strategies incorporating community and cultural resources (e.g., language, interests, experiences, etc.). When Moll et al. (1992, 2001) combined ethnographic observations, case studies, open-ended interviews, and life histories, they portrayed households in sociohistorical contexts to develop a research approach.

Although FoK is becoming more recognized as a respectable methodology, it tends to focus primarily on K-8 Latino/a students and communities. In my study, I will purposefully select diverse high school mathematics classrooms and analyze what is happening with the FoK incorporation of all present ethnic groups. Below I will give a brief description of the FoK methodology, the CRMT tool used to assess the FoK incorporation into mathematics lessons, and how these constructs and tools will apply to my study.

Three Interrelated Constructs of FoK

Ethnographic home visits. In an effort to teach the whole student (Brown-Jeffy & Cooper, 2011), teachers may learn about students' multiple roles outside of the classroom through home visits (González et al., 2005). Ethnographic researchers may accompany and support teachers during visits into students' households to ensure proper data collection. It is noteworthy that most of the targeted households in which FoK research takes place are situated in less affluent neighborhoods considered by many to be economically and experientially deprived. Upon teachers' arrivals into their students' households, teachers tend to establish rapport with parents due to the familiar nature of the relationship, resulting in a more fluid exchange of information among the family, teacher, and researcher (González et al., 2005; Moll et al., 1992). Interactions with students' families inform teachers on how to design a lesson or unit in a familiar context to the student. Teachers must exhibit a trustworthy demeanor for students and their families to feel safe with sharing their ideas and contributions. Extending Ladson-Billings' (1994) conception of culturally relevant pedagogy to draw knowledge out of students, FoK goes a step further and focuses on home visits for teachers to learn from students' homes (González et al., 2005). Students' homes should not

be visited in isolation from their communities; teachers and ethnographic researchers following the FoK methodology must be cognizant of the immediate environment that students encounter on a daily basis. Data collection should begin in the students' community as part of this construct.

In a similar manner, Moll et al. (1992, 2001) used ethnographic visits to collect data on how families develop networks that link them with their environments, and the relationships that allow the exchange and development of knowledge, skills, and labor that make households thrive. After studying Mexican immigrant homes in Arizona, Moll et al. compiled general themes that would afford teachers opportunities to reciprocate the role with students by getting parents involved as teachers in an effort to establishing mutual trust among teachers, students, and parents to close the divide between school and home culture. Table 2 below represents a sample FoK that Moll et al. compiled from students' homes and communities for study groups (described next) to collaborate and create authentic lessons for students.

After school study groups. The study groups consisted of teachers collaborating with ethnographic researchers to reflect on and make sense of findings from household visits (González et al., 2005; Moll et al., 1992). Once the data has been deposited from researchers and teachers after home visits to teachers in the study group, the teachers then brainstorm and create project-based lessons.

Table 2
A Sample of Household Funds of Knowledge (Moll et al., 1992, p.133)

Broad Themes	Concepts within Broad Themes
Agriculture	Ranching and farming Horse riding skills Crop planting Soil Irrigation management Animal management Hunting, tracking, dressing
Mining	Timbering Minerals Blasting Equipment operation Maintenance
Economics	Business Market values Appraising Labor Laws Loans Accounting Consumer knowledge Accounting Sales
Medicine	First aid procedures Midwifery Herbal knowledge Folk cures
Material & Scientific Knowledge	Carpentry Design and architecture
Repair	Airplane Tractor House Maintenance
Religion	Bible studies Moral knowledge Ethics

While implementing authentic experiences for students, FoK could be used to assess a lesson's fidelity to the research findings discussed in the study group, incorporate parents in classroom instruction, and provide teachers with research-based knowledge to inform their classroom practices (Fennema et al., 1993). Similar to González et al. (2005) and Moll et al. (1992), Aguirre et al. (2012a) found similar ideas that support the three categories along a learning trajectory continuum discussed in a later section: (a) initial practices, (b) making connections, and (c) incorporating. As teachers have more experience with creating lessons to implement authentic experiences for students, they will be able to foster a richer environment that acknowledges what students bring into the classroom during instruction.

Examining classroom practices. Study groups and home visits were used to inform the curriculum and instruction through the FoK framework. Teachers and researchers collaborated to conduct household research for “ethnographically informed classroom practices” (Moll et al., 1992, p 132). Classroom practices may use FoK to be more inclusive of students' knowledge bases and experiences. Teachers must understand students' community/cultural FoK in order to not revert back to a traditional teacher-centered pedagogy, ineffective for many (Aguirre et al., 2012b; González et al., 2005; Tate, 1995). Interactions in classrooms with practices that use students' FoK are meant to build a sense of community among students where they have to be accountable for each other (Ladson-Billings, 1995b); teachers should allow community building to occur in a way that builds off of the experiences and knowledge of the students. Next I will discuss how FoK has been used in education research as a conceptual framework.

Studying Teachers' FoK Implementation Using as a New Framework

Using FoK as a conceptual framework, Aguirre et al. (2012a, b) studied 70 pre-service teachers in elementary mathematics methods courses across three universities where the participants were asked to visit communities in the area and develop mathematics lessons that reflect these settings. There are three inductive areas in the learning trajectory for the practices the participants learned to incorporate students' knowledge into mathematics (see Figure 3 below): (a) initial practices, (b) making connections, and (c) incorporating.



Figure 3: Pre-service teacher learning trajectory of key practices for engaging with students' multiple mathematical knowledge bases (Aguirre et al., 2012b, p.181)

From left to right in Figure 3, the three major areas in the learning trajectory are considered inductive because the major categories increase in the degree of connection to students' mathematical knowledge bases; the farther right a teacher's lesson is rated on the trajectory, the more meaningful the connection between the lesson and his or her students. The authors found very few of the pre-service teachers were able to make and maintain meaningful

connections between FoK and lesson plan or project components (in the second level of the trajectory). Some pre-service teachers made transitional connections beyond superficial that moved toward meaningful connections. For the majority of the tasks discussed in the article, the authors noticed that the teachers in the study made emergent connections with little to no recognition of student strategies, where many of the tasks had a low cognitive demand, and a resemblance of traditional tasks not connecting to students' communities. In the middle level of the learning trajectory approaching meaningful, emergent connections indicate the minimal level of connections that teachers make to students' knowledge bases (see Figure 3).

Most of the pre-service teachers in Aguirre et al.'s (2012b) study were White females in their 20s. Also the study focused only on the second section of the trajectory with minimal mention of the first and third sections of the trajectory, initial practices and incorporating, respectively. In this study, I intended on having a more diverse sample as it relates to experience and race.

Many roles are switched during the use of the FoK framework: teachers become researchers and learners, while students and parents become teachers. FoK as a methodological tool can ensure adequate implementation of students' culture as a basis for learning and that lessons are infused with experiences from the students' homes where learning may be more intuitive and in a familiar setting. FoK and other conceptions have since been considered within the culturally responsive mathematics teaching (CRMT) tool (Aguirre & Zavala, 2013) described below.

Culturally Responsive Mathematics Teaching Tool

As an expansion of culturally responsive pedagogy (Gay, 2000), the concept of culturally responsive mathematics teaching (CRMT) integrates the knowledge necessary for teachers to teach mathematics to linguistically, culturally, and socio-economically diverse students (Aguirre et al., 2012a). Many researchers have studied CRMT in terms of teacher development (Aguirre, 2009; Gay, 2000, 2002; Kitchen, 2005; Leonard, Napp, & Adeleke, 2009; Sleeter, 2001; Ukpokodu, 2011; Walker, 2007; Wiest, 2001; Zozakiewicz, 2010). However, there is minimal research on how teachers can analyze their own mathematics lessons. Extending from Aguirre et al. (2012b), the first author and others developed a framework to analyze mathematical lessons with respect to CRMT, who define it as “a set of specific pedagogical knowledge, dispositions, and practices that privilege mathematical thinking, cultural and linguistic funds of knowledge” (Aguirre et al., 2012a p. 114). The CRMT framework combines the traditional elements of pedagogical content knowledge (PCK) with key components of culturally responsive mathematics teaching (Aguirre & Zavala, 2013). The overlap of the Venn diagram in Figure 2 in the above section illustrates this combination.

Arising from the framework, Aguirre and colleagues created a specific “tool” for teachers to evaluate themselves in categories about children’s mathematical thinking, academic language supports, cultural/community funds of knowledge, and critical math/social justice (Aguirre et al., 2012a, b; Aguirre & Zavala, 2013). The authors’ intended purposes of the CRMT tool are teacher evaluation and self-analysis, professional support and development, and a productive discussion instrument.

Using the CRMT tool, Aguirre et al. (2012a) conducted a mixed methods study describing efforts to improve K-8 pre-service teachers' pedagogical content knowledge by means of culturally responsive mathematics teaching. Pre-service teachers created mathematics lessons and rated themselves according to the categories or dimensions of the tool (Aguirre & Zavala, 2013). The authors found most teachers gave high self-ratings for categories related to children's mathematical thinking and high variance in the categories on language, culture, and social justice. According to Aguirre and Zavala, the dimensions corresponding with those that received the high ratings have been historically overemphasized on traditional classroom observation tools (Kitchen et al., 2007). On the other hand, the categories with high variance concerning academic language for second language learners, cultural/community funds of knowledge, and social justice are less implemented and less developed. Similar to Ukpokodu's (2011) research, Aguirre and Zavala qualitatively analyzed written reflections from the teachers and found that they were highly receptive to developing their ability to integrate FoK into their mathematics lessons and less receptive to integrating social justice. The researchers also found that there are four pillars of teaching mathematics on which PSTs focus: mathematical thinking, language, culture, and social justice (see Appendix L).

For the purpose of this study, I used the CRMT tool as the conceptual framework and its particular rubric to inform my data collection and analysis. As the vehicle for the CRMT framework, the CRMT rubric provided the criteria applied to classroom observations and reflective interviews for the study. There are a total of eight dimensions in the CRMT framework. The first five dimensions focus on *students' mathematical thinking* and

pedagogical content knowledge which have been historically used in classroom observations and teacher evaluations (Kitchen et al., 2007); the last three dimensions are *academic language for second language learners*, *cultural/community FoK*, and *social justice*. As the latter three dimensions are best suited for this study and less explored in general (Aguirre & Zavala, 2013), I used these dimensions during the investigation. The dimension *academic language for second language learners* was defined with two interrelated parts (i.e., 6A and 6B). If considering 6A and 6B as two separate entities, there are four dimensions that I am considering in this study:

1. (Dimension 6A) Uses L1 [home language] to support academic language development for ELLs [English Language Learners];
2. (Dimension 6B) Utilizes scaffolding strategies to provide academic language development for ELLS;
3. (Dimension 7) Helps students connect mathematics with relevant/authentic situations in their live (Funds of Knowledge)s; and
4. (Dimension 8) Supports students' use of mathematics to understand, critique, and change an important equity or social justice issue in their lives.

A detailed rubric for the scores one through five that correspond with each dimension may be found in Appendix L.

A major strength of Aguirre and Zavala's (2013) study is the utilization of a mixed methods approach which allows further justification of the qualitative descriptions of findings (Creswell & Plano Clark, 2011). For my study, I used a similar mixed methods approach in my research design, while focusing on the latter four dimensions of the CRMT

tool. However, I am using the tool and its corresponding guiding questions beyond the authors' application here for teachers' self-evaluation through the means of observations and interviews. It is important to note that the seventh dimension of the CRMT tool that tends to FoK should not be confused with FoK defined earlier. Dimension 7 of the CRMT tool, *funds of knowledge/culture/community support*, focuses on how teachers' lessons help students connect mathematics with relevant situations in their students' lives; FoK are the knowledge bases that students bring into the classroom. Further, Dimension 7 (number 3 in the list above) measures and describes how well some data source in the study connects mathematics to students' community and cultural knowledge and experiences. In Chapter 3, I will briefly review the framework and explain how I used the CRMT framework and tool in the data collection and analysis for the study.

The Negotiation of Language

Language plays an important role in thinking and learning. However, most schools in the US are unable to meet the academic needs of linguistically diverse students, affecting the education of over five million English learners (ELs; Mackinney & Rios-Aguilar, 2012). The problem is further aggravated with restrictive language policies in education, and difficult teaching conditions help shape teachers' perceptions on the actions that take place to support or hinder the academic and linguistic needs of ELs (Gillborn, 2005; Mackinney & Rios-Aguilar, 2012). There are negative effects on the overall education experiences of students who are treated as deficient, where culturally- or ethnically-based language is one type of deficiency (Moschkovich, 2013; Pollack, 2013). Black and Latino/a communities have been ridiculed, demoted, and shunned for not speaking English efficiently as the dominant group,

while having their culture, home language, and pronunciations treated as inadequate (Bose & Choudhury, 2010; Glick, 1999; Mackinney & Rios-Aguilar, 2012; Musanti, Celedón-Pattichis, & Marshall, 2009; Smitherman, 1998).

Language is an important factor to consider in education as it is a barrier for ELs for social relations, inclusion, and academic survival (Lanehart, 1998; Mackinney & Rios-Aguilar, 2012). Some researchers view education policies more conducive to the dominant group. Below I will review literature surrounding ELs, code-switching and code-mixing, and stigmatized dialects of English as it relates to education. This section will primarily discuss Black and Latino/a experiences due to these two ethnic groups being the largest and most researched minority groups in the US. Moreover, these groups are also the primary ethnicities over all other minority groups in this study. Next I will discuss the policy on bilingual education for ELs and the negotiation of language.

English Learners

English learners (ELs) are students who do not fluently speak or effectively learn in English. These students typically come from homes and backgrounds that speak a different language other than English and do not have the ability to adequately participate in American society. Many terms that also refer to ELs are English language learners (ELLs), limited English proficient (LEP) students, non-native English speakers, language-minority students, and (emerging) bilingual students (*Hidden curriculum*, 2014). Some of these terms are viewed as carrying a deficit connotation (e.g., LEP). To avoid this thinking and for the sake of clarity, I will use the term English learner (EL), as many of them have overlap and similar bodies of literature.

There has been much political debate surrounding language policies in states with a high concentration of ELs such as Arizona, New Mexico, Texas, and California (Mackinney & Rios-Aguilar, 2012; Palmer, 2010). Despite empirical evidence from the National Assessment of Educational Progress (NAEP) illustrating the substantial achievement gap between ELs and their native English speaking counterparts, Arizona and California remain English-only states with corresponding instructional policies (Gándara & Orfield, 2010).

One government mandated policy included Arizona's recently implemented four-hour English language development (ELD) block. The ELD block has been designed for students who score on the low end of an English proficiency assessment, consisting of students with different first languages and grade levels. Each instructional day, two hours in the morning and two hours in the afternoon were spent on learning the English language (i.e., speaking, reading, vocabulary, writing, and listening). The students had mainstream mathematics and science, missed social studies daily, had fewer electives than their peers, and were excluded from the annual state testing. Mackinney and Rios-Aguilar (2012) examined how urban middle school teachers of ELs made sense of the ELD block in relation to their teaching conditions. The authors discovered five emergent themes through observations of and interactions with teachers: (a) teachers' beliefs regarding students' use of L1 in the classroom, (b) teachers' beliefs about the use of students' first language (L1) as a pedagogical tool, (c) use of content area instruction, (d) negotiation of Arizona standardized testing and EL instruction, and (e) teaching practices before and after English-only policies. Teachers felt pressured to implement language policies mandated by the state including objectives, standards, curriculum materials, and professional development. Students' L1, or

students' home language, was portrayed in the ELD blocks in different ways (i.e., in small groups to facilitate their learning, allowed only if they can repeat what was said in English, not used to exclude others, and reading comprehension).

Only one of the four teachers in Mackinney and Rios-Aguilar's case study used students' L1 as a teaching tool; this teacher found that doing so motivated ELs to learn English while using prior knowledge. The four-hour ELD blocks only left two hours in the school day to work on content in other subjects, which did not align with the beliefs of the teachers who desire to teach English through content. Education researchers argue that beliefs affect practice and how teachers implement curriculum (Aguirre & Speer, 2000; Mackinney & Rios-Aguilar, 2012; Musanti et al., 2009; Stein, Remillard, & Smith, 2007). Mackinney and Rios-Aguilar's (2012) case study has its limitations. First, the authors used a biased selection approach as they were chosen conveniently through previously established relationships. Second, they mentioned the use of qualitative and quantitative data for their study, but they only provided descriptive survey results with percentages. As a result, no statistical inferences may be drawn from their analysis. Lastly, the study was not generalizable due to the sample being one site with four teachers. In my study, I will avoid these limitations as much as possible by purposely choosing my sample and sites, and conducting adequate statistical analysis.

While Mackinney and Rios-Aguilar's (2012) study discusses the negotiation of policy and teaching conditions with ELD in an English-only school, other studies explore language identities and process of negotiation from a bilingual education perspective (Bose & Choudhury, 2010; Palmer, 2010; Planas, 2011). The language used during group work and

the reasoning behind bilingual education contradicts the monolingual ideologies in research, particularly in mathematics classrooms (Mackinney & Rios-Aguilar, 2012; Planas, 2011). Their arguments collectively dispel the notion of culture-free mathematics (Shulman, 1987), and justify the teachers' actions in Mackinney and Rios-Aguilar (2012) to teach ELD within content. My study will allow teachers to have time to reflect on their actions in order to potentially improve their practices and examine strategies used to support ELs in high school mathematics classrooms (Aguirre & Zavala, 2013; Moschkovich, 2013; Musanti et al., 2009).

Code-Switching and Code-Mixing

As some states have English-only policies in the classroom, individuals that acquire more than one language other than their native or primary language (L1) may typically switch from L1 to a secondary language (L2), a phenomenon known as code-switching (Aguirre & Zavala, 2013; Bose & Choudhury, 2010; Smitherman, 1998). In the process of code-switching, sentences may be altered in structure. A similar but different concept not to be confused with code-switching is code-mixing, where each sentence is spoken in L1 with words (i.e., subject, predicate, adjectives, objects, etc.) exchanged with those in L2. In code-mixing, the sentence structure is uninterrupted. Essentially, code-switching occurs during a conversation, whereas code-mixing occurs only when one or a few words are interchanged for the other language. It is worth mentioning that code-switching and mixing does not only pertain to well-defined languages; these phenomena also refer to the transition from formal to informal language, and vice versa. Commonly, informal language refers to everyday speech, while formal language, sometimes called academic language, refers to the language used

during instruction, oftentimes far removed from everyday language. Below I discuss work that contributes to the ideas of language negotiation in multilingual mathematics education.

Bose and Choudhury (2010) wanted to understand how students in a mathematics classroom negotiate the use of two languages through code-switching and code-mixing. In addition, they aimed to learn how the language integration results in a new set of knowledge, similar to Mackinney and Rios-Aguilar (2012). Like in Musanti et al. (2009), analyzing multilingual mathematics classroom discourse helped the researchers characterize the different ways that language helps students' mathematical understanding. The researchers found that in the analysis of code-mixing and code-switching, the instances of one pure language (i.e., completely English or Hindi) versus some form of language swapping were approximately half and half for both code-mixing and switching. However, there were about five times more instances of code-mixing evidence, and Bose and Choudhury inferred that code-mixing allows for more fluid conversation when an individual cannot think of the appropriate word for an object. Therefore, they concluded that lacking language proficiency does not sidetrack students from the task at hand (Mackinney & Rios-Aguilar, 2012). The researchers also noticed sentences that they considered hybrid sentences. These are cases where L1 is indistinguishable from L2, and the entire sentence is code mixed and structured in a complicated way. In summary, Bose and Choudhury found code-mixing to enhance students' vocabulary knowledge.

Code-mixing and code-switching has been modeled and encouraged in the literature on FoK, education policy, and social justice (González et al., 2005; Gutiérrez, 2013b; Moll et al., 2005). For instance, code-mixing in FoK literature was modeled by González et al.

(2005) and Moll et al. (2001) with the use of the term *confianza* which translates to mutual trust, particularly between teachers and parents of students in their classroom to allow entrance into their households. Similarly, Gutiérrez (2013b) addressed political *conocimiento* which translates into knowledge or knowing, as she discussed why urban mathematics teachers need political knowledge. As expressed in Bose and Choudhury (2010), certain words in one's L1 can be switched or mixed for the enhancement of L2. Dimension 6 of the CRMT tool mentions code-switching and code-mixing as a part of academic language development and scaffolding strategies for ELs (Aguirre & Zavala, 2013). I intended to analyze classroom observations using this tool to see whether there is any evidence of L1 acceptance and implementation during student and teacher interactions. Next I will discuss other forms of code-switching and code-mixing as they relate to African American Vernacular English (AAVE).

African American Vernacular English. Many education researchers have examined language negotiation through code-switching and code-mixing to benefit classroom learning (Aguirre & Zavala, 2013; Bose & Choudhury, 2010; Mackinney & Rios-Aguilar, 2012; Smitherman, 1998). However, most literature in this genre does not appeal to dialects of a language. African American Vernacular English, formerly known among linguists as Black Vernacular English (BVE) or Vernacular Black English (VBE), can be viewed as a minority dialect spoken in African American communities (Nero, 2006; Sidnell, n.d.; Smitherman, 1998). Although AAVE has a debatable origin and research that dates back to 1884, I have narrowed the scope down to focus on work that dates back to the 1990s and that which concerns education in the US (Lanehart, 1998; Smitherman, 1998). Despite the perspective

of mainstream society, linguists recognize AAVE as a language and it has been accepted as the primary language in the Oakland Unified School District since 1996 (Lanehart, 1998; Pullum, 1999; Smitherman, 1998; Tamura, 2002). Also termed as Ebonics, AAVE and its acceptance were central to debates around the use in the school districts teaching literacy skills toward learning Standard American English (SAE; Smitherman, 1998), as AAVE is not highly esteemed or respected in Corporate America.

African American Vernacular English has been considered a “mockery of the English language” (Biale, 1987), “garbage” (Kaufmann, 1994), “gibberish” (McGrory, 1996), slang, and as having bad grammar and a lazy pronunciation (Baugh, 2000; Hoover, 1998; Wolfram, 1998). Tamura (2002) has provided a historical comparison and implications for education policymakers concerning both dialects centered on academic achievement and language politics. I will focus on academic achievement here, because my study is more about what happens in the classroom, and less so about educational policy. Ironically, the author found that the strongest critics of AAVE grew up speaking the very dialects they are against. At the same token, many minorities have rejected a part of themselves and their history viewing their own dialect as substandard, and embrace SAE as the superior dialect of those of an elite status.

The pedagogical literature on non-standard forms of English is saturated with many perspectives and implications for teachers and students (Harper, Braithwaite, & LaGrange, 1998; Hoover, 1998; Perry & Dalit, 1998; Taylor, 1998; University of Hawaii, 2000), some overlapping while others are mutually exclusive. Tamura (2002) highlighted some major points from educators and sociolinguists. First, teachers should value non-standard dialects

and understand the resistance against SAE. Second, teachers should start with the known and move to the unknown. Specifically, they should learn the structure, pronunciation, and rhetorical style of different dialects that students bring to school in order to bring them to SAE. Third, students should acquire the tools to be “bidialectal” (Tamura, 2002, p. 25) by understanding the structures of both SAE and their non-standard dialect. Lastly, teachers must understand the societal causes of low student achievement. These aforementioned notions concerning language negotiation in the classroom will be investigated in the study. Next I discuss implications of applying language in mathematics learning and how language will apply to this study.

Applying Language in Mathematics Learning

Students who are English learners (ELs) bring resources that are an essential part of their FoK that teachers can readily use in their classrooms (Mackinney & Rios-Aguilar, 2012). The triple segregation that teachers in bilingual communities face is the result of the teaching conditions in places where government mandates English-only school districts (Gadara & Orefield, 2010). Some may believe that to deny a group’s use of their native or home language is to deny their culture and identity. Languages and English dialects are considered substandard to Standard American English (SAE), but should be considered part of education to show that teachers appreciate students’ knowledge to bridge their known world toward an unknown one. Code-switching and code-mixing may be used to help build this bridge without discounting students’ language. In my study, I used the CRMT tool developed by Aguirre and Zavala (2013) to analyze the data sources for how teachers’

lessons support academic language and provide scaffolding strategies, particularly how language is negotiated in the classroom for mathematics learning.

Critical Race Theory—Theoretical Lens for Study

Critical race theory (CRT) has been noted in the literature as a viable framework to examine underlying social inequities in education (e.g., DeCuir-Gunby & Walker-Devose, 2013; Ladson-Billings, 1995b; Martin, 2006). For the last two decades, education researchers have expressed a desire to incorporate CRT for ongoing critical analysis and reflection as a means for keeping the achievement and persistence of disenfranchised groups a priority (Brown-Jeffy & Cooper, 2011; Tate, 1995; Ladson-Billings & Tate, 1995; Lynn & Dixson, 2013; Martin, 2003). Critical theories give marginalized populations a voice (Creswell 2013), and there is great potential for critical race mixed methods studies in education (e.g., DeCuir-Gunby & Walker-Devose, 2013). In an effort to strengthen the oftentimes unheard voices of diverse teachers and students, I used CRT as the theoretical lens for the study. In the following section, I will describe: (a) the emergence of CRT, (b) its tenets, (c) the “Spin-off” movement, and (d) critiques and misuses of CRT. Where appropriate, I mention how CRT will be pragmatic to the study.

The Emergence of CRT

As an application of critical theory, critical race theory (CRT) generally focuses on how race and racism are grounded in the pillars of American civilization (Brown-Jeffy & Cooper, 2011; Creswell, 2013; Delgado & Stefancic, 2012; Lynn & Dixson, 2013). This theory began as an intellectual movement derived from a collection of and actions taken on

historical events of the time; many scholars offer their perspectives on CRT's genealogy (Brown & Jackson, 2013; Delgado & Stefancic, 2012; Ladson-Billings, 2013; Lynn & Parker, 2006). The genealogy of race theories traces back to the 17th century when the English first encountered American Indians and Blacks in the New World (Outlaw, 2012), but the scope of this section will be school-based events leading up to the first CRT meeting in 1989 (Brown & Jackson, 2013; Delgado & Stefancic, 2013) after the Civil Rights Movement.

A string of Supreme Court decisions concerning school segregation and unconstitutional race discrimination in the 1960s and 1970s followed the 1954 *Brown v. Board of Education* decision to integrate public schools (Brown & Jackson, 2013). In the late 1970s, Critical Legal Studies (CLS) scholars, activists, and lawyers sought to challenge the views of intellectuals within the predominately White legal academy since there was conflict between what the laws claim, how laws were enforced, and scholars' findings (Delgado & Stefancic, 2012). Critical Legal Studies may be defined as a theoretical movement that contests norms and standards in legal practices that are outgrowths of power relations in society. The work of the Civil Rights Movement had become stalled and oftentimes rejected and the CLS scholars presented evidence of legal decisions being "indeterminate, incoherent, and deeply embedded in both politics and the personal biases of the deciding judges" (Brown & Jackson, 2013, p. 13). It is important to note that critics of CLS believed that this movement did not tolerably address micro-aggressions and other struggles of people of color, particularly for Blacks. Further, many critics believed that legal rights were dismissed and no

longer properly enforced. Such critiques alongside discourses in ethnic studies and additional legal and political events motivated the first meeting about CRT.

Derrick Bell, Alan Freeman, and Richard Delgado put forth literature highlighting injustices of the current and previous times. Soon enough, they were joined by other like-minded individuals, and a total of 24 legal scholars of color held a weeklong conference at a convent outside of Madison, Wisconsin in the summer of 1989. Many of these legal scholars were initially involved in CLS. This initial meeting marks the dawn of CRT as a movement (Brown & Jackson, 2013; Delgado & Stefancic, 2012). In light of this meeting, more conferences and meetings took place, some being open and closed to the public. The closed sessions worked on internal affairs, and the open sessions were more consistent with modern day conferences to include keynote speakers, plenary sessions, and panels, with interdisciplinary representation among participants (Delgado & Stefancic, 2012).

In addition to being a theory that acknowledges and challenges social injustice and oppressive practices, CRT helps illustrate the relationship of power and culture (Crenshaw, 1995). In the tenets sections to follow, I will interpret selected tenets through definitions and applications, and discuss critical perspectives in the literature. These tenets have been chosen to specifically relate to and support the study.

CRT Tenets

Within CRT, there are many interrelated tenets and CRT analysts normally choose up five to six tenets as a baseline. Education researchers typically ground their work on one CRT scholars' set of essential CRT tenets (e.g., Denson, Avery, & Schell, 2010; Ladson-Billings, 2013), or a collection from different sources (e.g., DeCuir-Gunby et al., 2009;

Palmer, 2010). Ladson-Billings and Tate (1995) are credited for introducing this critical perspective into education, opening the door for more education researchers (e.g. Dixson & Rousseau, 2005; Lynn, 2004; Lynn & Parker, 2006; Martin, 2003; Stovall, 2006). Here, I will discuss the five fundamental tenets put forth by Ladson-Billings (2013) and Delgado and Stefancic (2012): (a) racism as normal, (b) interest convergence, (c) race as a social construction, (d) intersectionality and anti-essentialism, and (e) voice or counter-narrative. I find these five tenets to be the most appropriate as I want my study to expand on previous work in education.

Racism as normal. The *racism as normal* tenet has also been referred to as racial realism (Lynn & Dixson, 2013), racialized power, and the permanence or centrality of race (Brown-Jeffy & Cooper, 2011). CRT emphasizes racism as an eternal pandemic in American culture, a “normal science,” and the common everyday experience for most people of color (Delgado & Stefancic, 2012). Ladson-Billings (2013) has affirmed that the first CRT tenet does not simply highlight random, isolated acts of poor behavior, but it should be recognized as the normal order of things in American society. Many critical race theorists argue that those trying to improve conditions of the oppressed must accept their permanence (Delgado & Stefancic, 2012; Lynn, 2004). However, there are others (Bell, 1992; Matsuda, Lawrence, Delgado, & Crenshaw, 1993) who feel that fighting against racism and oppressive behaviors is well worth the battle. Bell (1992) addressed the permanence of racism:

Black people will never gain full equality in this country. Even those herculean efforts we hail as successful will produce no more than temporary ‘peaks of progress,’ short-lived victories that slide into irrelevance as racial patterns adapt in

ways that maintain white dominance. This is a hard-to-accept fact that all history verifies. (p. 12)

Although the struggle against racial oppression is believed to be ultimately fruitless by many critical race theorists, Bell suggests that Blacks should not accept oppression but fight to be empowered through the struggle. At the same token, Matsuda et al. (1993) had as their sixth unifying theme of CRT that “CRT works toward the end of eliminating racial oppression as part of the broader goal of ending all forms of oppression” (p. 6).

Using CRT as a theoretical framework, Denson et al. (2010) conducted a qualitative study to examine African American high school students’ perceptions of engineering and the associated cornerstone courses by identifying influential self-reported factors. The researchers found emergent themes of racism as it affords opportunities for group advantage with suspicion of colorblindness. As an extension, the authors concluded that the field of engineering has succumbed to stereotyping, being predominated by White middle-aged males.

Throughout Denson et al.’s (2010) work, the authors tended to use “Caucasian” synonymously with White (Americans). According to the 2010 US Census Bureau, Caucasian is a subgroup within the White race (Humes et al., 2011). It is suggested that the authors not use these terms interchangeably and remain consistent with White or White Americans when referring to this race. Also there is the lack of previous work that has considered CRT as a framework to emphasize or justify their contribution to education research. Denson et al. discovered that the students never were afforded opportunities to have fair exposure to engineering or learn about contributions from Black engineers. Thus, a

perpetuation of stereotyping for the engineering field continues since the field is dominated by White, middle-aged males. In my study, I will clearly define ethnic subgroups, avoid interchanging Caucasian for White, and provide supportive work that implements CRT in education

Interest convergence. Most CRT scholars support the interest convergence tenet, which states that there exists a racial hierarchy of White over color serving its purpose for the dominant group (Delgado & Stefancic, 2012). Further, Bell (1980) argued that racial justice is only sought by White people when there is something in it for them. Bell also provided a retrospective critique of the *Brown* decision using the interest convergence tenet, stating that it is justified by the advancement of elite Whites, contrasting with the belief that it was meant to defend the constitutional rights of Black children. Bell affirmed that the credibility of the US as it fights against communism was rapidly improved upon the *Brown* decision. Matsuda et al.'s (1993) second unifying theme in their work, "expressions of skepticism toward legal claims of neutrality, objectivity, colorblindness, and meritocracy" (p. 64), and is essentially the interest convergence tenet. An instance of interest convergence in more recent literature is when Denson et al. (2010) discussed students' exposure to engineering being positively correlated with teachers' interest.

Similar to Denson et al., Palmer (2010) used interest convergence and the right to exclude in order to frame her analysis while ethnographically investigating parents of diverse second grade students in a school with a dual-language program. The author provides additional clarity with the construct of colorblind racism (Bonilla-Silva, 2006) and normative whiteness (Hurd, 2008); the former is the unwillingness to openly acknowledge racial issues,

and the latter is the expectation of assimilative integration. Palmer argues that even in schools that make great efforts to include diverse communities, marginalized students of color still fall victim to these constructs.

Race as a social construction. According to Delgado and Stefancic (2012), the *social construction* thesis notes races as products of social thought and relations with no biological or genetic reality. Instead, races are categories that society invents and manipulates; people of common origin share traits that have no bearing on intellectual or high order traits. On the other hand, there are theorists who believe that race has some biological connection. One particular instance of this debatable notion is when Outlaw (2012) takes a scientific perspective discussing race as a concept within traditions of critical theory, characterizing race as a “biological or metaphysically given, thereby self-evident reality” (p. 141). Race theories were not developed in the seventeenth century, but are retrospectively justified as a fundamental component of a way of organizing and conceptualizing society. Different members of society may be classified differently for different advantages (Delgado & Stefancic, 2012). Andreasen (2012) offered arguments for both sides: race as a biological reality and as a social construct. I will focus on the latter.

In contrast to the culture-free perspectives of mathematics teaching and learning (Shulman, 1987), Martin (2006) conducted three ethnographic and participant observation studies on African American parents in an attempt to characterize mathematics learning as racialized experience. The parents in Martin’s ethnographic study were able to formulate personal theories about what it means for race to be socially constructed. Through in-depth case studies illustrating parental beliefs and perspectives on mathematics learning, Martin

revealed two themes that encompass race as a social construction. First, African American parents consider race as a factor in their struggles with mathematics which extends to shaping their identities and their children in their community as African Americans and mathematics learners. Second, the parents in his study have experienced racial discrimination in many different mathematics contexts where they had to prove themselves competent. It is noteworthy that Martin acknowledged that the narratives and perspectives presented in his work should not be definitive of all African Americans, but just some experiences. However, I argue that he became subjective in the study by stating how the experiences revealed in the study are reflective of his own. In my study, I will make clear my personal biases to avoid contaminating the study findings.

Voice. Critical race theorists who hold the *voice* (or counter-narrative) tenet believe that minorities have different histories and experiences with oppression that they may be able to relay to their White counterparts (Delgado & Stefancic, 2012; Lynn & Dixon, 2013). Also known as counter-stories, these histories and experiences are not well defined and have been subjected to multiple interpretations. Due to moral realities typically being interpreted and communicated by the dominant group, CRT scholars use chronicles, storytelling, and counter-narratives to reveal everyday existences of racism and racial discrimination through people of color. Stories from classrooms can reveal how teachers' expectations can affect the academic performance of diverse students (Warren, 2007). Coexisting in tension with anti-essentialism, the voice of color thesis is the notion that allows Black, Asian, Native American, and Latino/a individuals to communicate unlikely known racial biases to their White counterparts that are deeply embedded in the unstated norms of American law and

culture (Brown & Jackson, 2013; Delgado & Stefancic, 2012). In opposition to CRT, many dominant group members presume that racial inequality stems from the lack of adequate enforcement of discrimination laws or cultural problems within minority groups (Brown & Jackson, 2013).

Using counter-stories in education research has emerged not just as a tenet, but as a qualitative inquiry approach, allowing people of color to have a voice amidst dominant perspectives. For example, Harris (1993) has conceptualized whiteness as property and voices how the legal system affords privilege and power to Whites, or those who appear to be White. She tells a story about her light-skinned grandmother that passed for white in the 1930s, which helped her get a job catering to middle class Whites. According to Delgado and Stefancic (2012), *passing for White* or *passing* is a phenomenon of how certain groups move in and out of the White race. This story was meant to deliver the message that being White helped Harris' grandmother gain access to privileges she would not have otherwise had, thus drawing the conclusion of the security of whiteness.

Storytelling and counter-narrative are the most reliant to bring forth issues in education as they relate to race and injustices (Solórzano & Yosso, 2002). Similar to Martin (2006), DeCuir-Gunby (2007) used interviews to expose the counter-stories of the ways in which six African American high school students negotiate class and race identity at a predominately White school. Like Delgado and Stefancic (2001) and Solórzano and Yosso (2001), DeCuir-Gunby noted that counter-storytelling has two purposes: as methods of (a) telling unheard stories of marginalized groups, and (b) analyzing the dominant discourse and reality. After analyzing the counter-stories of the high school students, the author discovered

emergent themes within the counter-stories: difficulty to negotiate race identity in a “bubble,” and problems with the elite context.

Vaught and Hernandez (2013) piloted a graduate seminar named Pedagogies, and were vested in learning about public modalities where racialized identity are enacted and how these modalities shape education. While addressing institutional privilege and oppression in education, the authors had their students to practice a critical pedagogical exercise grounded in counter-storytelling (Ladson-Billings, 1999; Solórzano & Yosso, 2001), where the authors developed theories around the collaboratively constructed and sometimes contradicting narratives from students’ experiences. The students in the seminar studied the principle of specificity, which may be viewed as a verb or descriptors of identity. These two ideas of specificity might shift between what is learned in the classroom and respective praxis sites through discourse, reflection, and action (Vaught & Hernandez, 2013). Different students in this class used what they learn in this seminar to apply to their unique experiences, institutional and otherwise. As a class, they concluded that the act of incorporating specificity around race, power, and White privilege were essential to effectively implement CRT into practice. In essence, the students in the seminar were sharing their counter-narratives expressing how they put what they learned into action and reflected on the outcomes. A noted weakness in Vaught and Hernandez is not clearly defining specificity, a major topic in their chapter. However, their use of counter-stories provides a contextual idea of the meaning behind specificity as a principle.

Intersectionality. The *intersectionality* (or anti-essentialism) principle is the belief that no individual can possess a single identity, loyalty, or allegiance, but rather overlapping

ones (Delgado & Stefancic, 2012). In contrast to intersectionality is essentialism, a perspective that individuals in the group have everything in common in the exact same way (Ladson-Billings, 2013). Believing in essentialism may lead to stereotyping and misunderstanding. Grillo (1995) has argued, “An essentialist outlook assumes that the experience of being a member of the group under discussion is a stable one, one with a clear meaning, a meaning constant through time, space, and different historical, social, political, and personal contexts” (p. 19). Unlike the Marxian beliefs of Hill (2009), Darder and Torres (2004) and Cole (2009), Grillo proceeded by stating that race and class can never be separated since they are intertwined with gender. For the purpose of this review, I will only discuss intersectionality and its application in education research.

For example, DeCuir-Gunby and colleagues (2009) used critical race feminism (CRF) to explore the emotions and identities of minority female professors in engineering while challenging the dominant discourse there within. CRF is an outgrowth of critical legal studies (CLS) which amalgamates CRT and feminist theory (Wing, 2003), exhibiting a theoretical example of intersectionality of race and gender. As a result of the study, DeCuir-Gunby et al. found major themes similar to those in Denson et al. (2010). First, minority female professors in engineering had difficulty interacting with their male counterparts, which negatively impacted their academic experiences and career development. Similar to what was revealed in Martin (2006) when the Black parents felt they had to prove themselves as mathematically competent, DeCuir-Gunby et al. found the female professors’ ability was devalued and resources were unfairly distributed. Second, the interactions between the professors and their students were oftentimes less than pleasant. The students challenged the women’s authority

and knowledge, eliciting hostile emotions from the professors. Third, the women professors in the study had to simultaneously cope with racism and sexism. Although the DeCuir-Gunby et al.'s work was previously mentioned under the voice tenet, the intersectionality tenet is also prominent here, as majority of engineering students are White men (Denson et al, 2010), whereas the professors under study were minority and female. In the section that follows, I will address critiques and misuses of CRT in education.

Critiques and Misuses of CRT

As CRT scholarship increases in education, there tends to be more critique from Marxian scholars, according to Dumas (2013). Marxian scholars hold the belief that social inequities are grounded in capitalism, class exploitation, and the political economy (Dumas, 2013). Further, these scholars argue that CRT incorrectly assumes race to be the reason for social inequities as it replaces class. While Cole (2009) and Hill (2009) critiqued CRT in education with a Marxian perspective in the UK, Darder and Torres (2004) have done so in the US. For Darder and Torres, a theory must be transcending instead of revolving around social construction to help us understand systems of power. On the other hand, Cole and Hill do not feel that CRT can adequately provide comprehensive analysis or political action necessary to contest capital, as he feels CRT is not situated in class analysis.

One way that people have misused CRT is to apply it to their research simply because their study includes people of color (Lynn & Dixson, 2013). Another misuse is of CRT is to go on a purposeless tirade or blame others for misfortunes. For the voice tenet of CRT in particular, Ladson-Billings (2013) noted that the purpose of storytelling is not to rant or vent without making a principled argument, and many aspiring CRT analysts use this tenet

inappropriately in this way. In the next section, I mention some spin-offs of CRT that address racial injustices of different subgroups. In so doing, I acknowledge the diversity within the classrooms under study and teacher behaviors that may or may not lend themselves to the CRT tenets. The section that follows discuss some ramifications of CRT as it expands into different ethnic groups.

The “Spin-Off” Movement

Analogous to how CRT became an outgrowth of Critical Theory, other specialized critical theories have recently fragmented into new subgroups. These subgroups not only include the issues of people of color, but other races and cultures that have suffered societal injustices: Latino/as (LatCrit), Asian Americans (AsianCrit), American Indians (TribalCrit), women (FemCrit) and Gays and Lesbians (QueerCrit; Creswell, 2013; Delgado & Stefancic, 2012; Lynn & Dixson, 2013). These “spin-offs” (Delgado & Stefancic, 2012) are sustained through periodic conferences and gatherings, and each critical theory has its own body of literature and set of priorities. Although the focus here is on racial issues in education and they are important, I will not describe LatCrit, AsianCrit, and TribalCrit due to lack of space. Therefore, I will still use CRT in a general sense, whether or not students of color are present while considering the previously listed ramifications.

Chapter Summary

The overarching topics in the literature review above are those that will be expressed throughout my study. The ideas within are from respected sources in different literature bases including cultural pedagogy, language, funds of knowledge, and critical race theory. The traditional way of teaching and learning mathematics has been a top-down approach, which

assumes a mindset of assimilation. Research suggests the need to break the silence about oppressive practices in classrooms. Students must be given a voice and their language and dialects should be appreciated. Teachers should assume the responsibility of affording students the opportunity of code-mixing and code-switching while also being culture brokers as students cross borders from previous to new knowledge. Ideologies of what is accepted as the standard need to be dismissed as teachers and teacher educators broaden their methods of making education more accessible. Cultural appreciation beyond the acknowledgement of isolated holidays and heroes can move to challenge interlocking systems of privilege and oppression that plague the education system in the US (Herbel-Eisenmann et al., 2013), and meaningfully integrate students' cultural and community funds of knowledge into their learning (Aguirre et al., 2012b). Culture, knowledge, and power have a dialogical relationship where culture is the basis for knowledge which leads to power. Through the examination of education with critical theory, teacher and teacher educators can identify and confront systems of power to advocate for their diverse students' educational opportunities.

My aim in this study is to make a contribution in mathematics education by examining mathematics classrooms and teacher behaviors that contribute to funds of knowledge, language supports, culture, and social justice. As most research in these areas has taken place within the elementary grade band, I focused on secondary level mathematics. In so doing, I revealed degrees of observable culturally responsive mathematics teaching practices, which may potentially serve as a basis for more self-evaluation of teachers and mathematics teacher development to improve education for all students.

CHAPTER 3: METHODS

The purpose of this study is to explore how high school mathematics teachers integrate the cultural and community knowledge from their diverse student population into classroom practices. As previously stated, the first research question governing this study is “How are high school mathematics teachers in diverse classrooms connecting instruction to students’ cultural/community funds of knowledge?” Two other research questions for this study are “Does the *experience* of high school mathematics teachers play a role in incorporating students’ cultural/community funds of knowledge? If so, in what ways?” and “Does the *race* of high school mathematics teachers play a role in incorporating students’ cultural/community funds of knowledge? If so, in what ways?”

In order to examine teachers’ behaviors that integrate students’ FoK in mathematics instruction, I employed a primarily qualitative embedded mixed methods research (MMR) study design (Creswell & Plano Clark, 2011). In this chapter I will discuss the rationale for using qualitative and quantitative approaches for each research question. Further, this chapter will give a description of the study, and address participant selection, the conceptual framework, data collection and analysis, research validity and reliability, and ethical considerations.

Mixed Methods Research Methodology

Why MMR? Many researchers tend to use a descriptive methodology for studying minority students in elementary, middle, and occasionally high school classrooms (Fulmore, 2005). The affordance of “methodological eclecticism” (Teddlie & Tashakkori, 2011, p. 286) in a mixed methods research (MMR) design allows me to draw from qualitative and

quantitative methods to select the best techniques to thoroughly investigate the phenomenon of interest without being restricted to one inquiry approach. I found it most appropriate to use an embedded MMR study design for three main reasons. First, I concurrently collected and analyzed both quantitative and qualitative data within a traditional qualitative design while adding a quantitative strand (Aguirre & Zavala, 2012a). Second, I gathered supporting data before and after the main data collection period through interviews and follow-ups with participants. Third, there was a need for a deeper understanding of teacher behaviors and how instruction occurs while teachers incorporate students' FoK which called for qualitative methods.

Description of this MMR study. The first research question, both quantitative and qualitative in nature, aims to describe how teachers integrate students' FoK into instruction. A mixed method suited this question as I explored a phenomenon that is not easily explained by mere measurements (Creswell, 2013). I wanted to understand the participants' contexts and settings, and a natural setting is most suitable and potentially comfortable to discuss sensitive topics. Emotions and interactions among teachers and students are difficult to capture with a purely quantitative design, making qualitative research appropriate here.

Data sources intended to capture the setting are teacher biographical surveys, preliminary teacher interviews, classroom observations (i.e., field notes and video data), reflective teacher interviews, and student surveys.

To support the qualitative findings of a study, I used a quantitative component within this MMR design (Creswell & Plano Clark, 2011; Patton, 2002; Teddlie & Tashakkori, 2011). Quantitative components of data collection and analysis were employed for all

questions, but particularly the second and third research questions to determine whether each teacher's experience and race were significant characteristics in the integration of students' FoK. Generally, the quantitative approach offers the ability to measure people's reactions in order to facilitate comparison and statistical data aggregation (Patton, 2002). For this study, I quantified data from various sources in order to find any existing statistical differences in how teachers of varying study criteria incorporate diverse students' FoK into their mathematics instruction. The quantitative data was mined from all of the data sources that were mentioned previously.

Finally, each research question was answered using qualitative and quantitative components as appropriate. The qualitative descriptions for each research question were accompanied with descriptive statistics or more complex statistical methods, and vice versa. Next I will describe the conceptual framework used to analyze the classroom observations for the study.

Conceptual Framework

The conceptual framework that informed my data collection and analysis is Aguirre and Zavala's (2013) Culturally Responsive Mathematics Teaching (CRMT) framework and the corresponding evaluation tool (see Appendix L). I used the tool to analyze classroom observations and reflective interviews. As mentioned earlier in the literature review, there are a total of eight dimensions. The first five dimensions focus on students' mathematical thinking and pedagogical content knowledge which have been historically used in classroom observations and teacher evaluations (Kitchen et al., 2007); the last three dimensions focus on academic language for second language learners, cultural/community FoK, and social

justice. I chose to use the latter three dimensions (with one dimension having two interrelated parts) because they are best suited for this study and less explored in general (Aguirre & Zavala, 2013). These dimensions from the CRMT tool evaluates how a mathematics lesson:

1. (Dimension 6a) Uses L1 [home language] to support academic language development for ELLs [English Language Learners];
2. (Dimension 6b) Utilizes scaffolding strategies to provide academic language development for ELLS;
3. (Dimension 7) Helps students connect mathematics with relevant/authentic situations in their lives (FoK); and
4. (Dimension 8) Supports students' use of mathematics to understand, critique, and change an important equity or social justice issue in their lives.

Originally I had planned to use all of the aforementioned dimensions; unfortunately, I found minimal data related to language and social justice, so I narrowed the scope of the study to only include Dimension 7. I coded for all dimensions during video analysis, but only reported findings on Dimension 7. Details are provided for further rationale for only reporting Dimension 7 findings in Chapter 4.

Participant Selection

My specific criteria allowed me to perform a purposeful selection of sites and participants for this study (Creswell, 2013; Patton, 2002). I selected four high school mathematics teachers with different experience levels to expand those commonly used in FoK research (i.e., pre-service), where two of the four teachers are White and the other two are Black, all teaching Common Core Mathematics courses (see Table 3). One teacher of

each race was considered one of the following experience levels: novice (at most five years) and master (at least 20 years). The differences in experience levels can also tell us more about what is happening in classrooms after teachers get into their profession after their education program or training. The rationale for choosing different races and experience levels of teachers stems from previous studies that helped develop the CRMT framework and tool having participants that were majority White and pre-service (Aguirre & Zavala, 2013; Aguirre et al., 2012a).

Superintendents of school districts within the southeastern region of the US were contacted via written letter (see Appendix B: Letter to Superintendent) adapted from Fournier (2009) informing him or her about the study. Along with the permission letter, I included the consent form for the study participants (Appendix E: Teacher Informed Consent Form). If an email is located on the district website to the superintendent's office, I emailed the letter and consent form. After I received written permission from the superintendents to conduct my study in their school district, I emailed the principals at the respective high schools to request access to their schools (see Appendix C: Initial Contact Email to Principals). In addition, the email to the principals explained the purpose of the study, included teacher letter and consent forms for their viewing, and asked for recruits and volunteers who they considered successful teachers with diverse students. Upon approval and by principals' recommendations, I emailed a letter to all mathematics department chairs and teachers, particularly those recommended by principals explaining the purpose of and their potential involvement in the study (see Appendix D: Letter to Department Chairs and Teachers). In some cases, principals

emailed the teacher letter to their mathematics teachers, and I received correspondence from the teacher individually if they were interested in participating.

Agreeing participants completed an informed consent form (see Appendix E: Teacher Informed Consent Form) and a biographical information survey (see Appendix F: Teacher Biographical Information Survey). Electronic copies of each document were emailed to each teacher for them to complete, scan, and return via email. A hard copy was also available if he or she preferred to fill out the form manually, but the survey had to be sent via email since this was a vital data source for the selection process. From the volunteers, I selected teachers based on their responses of their survey on the following areas: teacher experience level, teacher ethnicity, currently taught classes, and classroom demographics. Four teachers were selected based on the alignment of responses to the necessary criteria and proximity: Mr. Pryor, Ms. Monroe, Mr. McMillian, and Mr. Ferguson (pseudonyms). Table 3 shows how each selected participant fits the study criteria and their respective schools.

Table 3
Study Participants' Race, Experience Level, and Course Observed

	School A	School B	School C	
Teachers	Mr. Pryor	Ms. Monroe	Mr. McMillian	Mr. Ferguson
Race	White		Black	
Experience Levels (years)	Master (25)	Novice (4)	Master (23)	Novice (3)
Observed Course (one section per teacher)	Math 3 Honors	Math 2	Math 3 Honors	Math 3
Student Diversity (White: Non-White Students)	8:9	4:16	4:11	4:13

The selected participants were asked to choose their most ethnically diverse mathematics classrooms at their respective high schools. The volunteers were located at three different rural school districts in the southeastern region of the US, where two were at the same school (see Table 3). The free and reduced lunch rates at these schools ranged from 34% to 62%, and teacher turnover rates ranged from 15% to 33% in 2012. The schools' minority enrollment ranged from 36% to 73% at the time of the study. All study participants teach three classes per day within a four-by-four block structure. The block structure of classes refers to the four 90-minute class schedule taught per semester, with the exception of School B which has 75-minute blocks.

Similar to the teacher participants, the students in the classrooms under study had consent forms (see Appendix G: Student Informed Consent Form for Research) and letters to their parents/guardians (see Appendix H: Letter to Parents/Guardians) requesting permission for the students to participate in the study. In the letter, I assured that no psychological harm would come to the students. I gave out hard copies to the students for both them and their parents/guardians to sign. I gave each class of students one week to turn their forms in to their teacher who kept them until I arrived to begin the study. Some students who did not turn in their surveys after the allotted time requested to have the form sent to them electronically. In order to retrieve as many surveys as possible, I created an electronic form of the same survey that they received in class, and the teachers placed the link on their class webpage for students' convenience. For the number distributed and received surveys, see Table 6.

Once the survey was submitted, I received the data electronically. There was no identifying information attached to the data. If consent and survey were not achieved, I excluded the students from data collection, video recording, and any other study involvement. The teacher sat these students where they would not show in the classroom recordings. Below I describe each participant and school data relevant at the time of the study.

Mr. Pryor at School A. Holding a B.S. in Mathematics Education, Mr. Pryor has been teaching high school mathematics for 25 years, in his current district for 22 years, and at School A for 14 years. He met the study criteria for the White master level teacher. As one of seven high schools in the school district, School A is a comprehensive four year public high school with a wide range of course offerings available to all students. It offers Advanced

Placement (AP) courses, extracurricular clubs, athletic activities academic competition, cultural arts programs, technology offerings, exceptional children's programs, and service projects provide additional learning experiences for their students. Out of 1,194 students, 28% of the students at School A participate in AP courses. Thirty-four percent of them were economically disadvantaged and the school did not receive Title I funding. At the time of the study, there were a total of 66 teachers and the student-teacher ratio was 19:1. Ninety-five percent of the teachers at School A were fully licensed and 22% had advanced degrees. With a teacher turnover rate of 15%, School A was a school that brought the community together in support of education, athletics, and every student enrolled. Over half of the teacher population at School A has over 10 years of teaching experience. Out of the three schools in the study, School A was the largest.

Ms. Monroe at School B. Ms. Monroe holds a B.S. in Psychology, and obtained her teaching licensure in grades 6-12 Mathematics and Psychology while in the Teach for America (TFA) program. In her fourth year of teaching at the same school, Ms. Monroe met the study criteria for the White novice level teacher. School B is one of three high schools in the school district, and has an emphasis on project-based learning (PBL), while also enforcing a uniform policy for its students. Unlike School A, School B was a recipient of Title I funding with 61% of the 194 students being considered economically disadvantaged, receiving free or reduced lunch. The participation rate for AP courses was 38% at the time of the study. The school consistently offered community service opportunities for its students. There were 13 full time teachers and 37% of them were fully licensed. Some of its students were dual enrolled at different schools or go to the main high school in the county for other

ambassador type responsibilities. The student-teacher ratio for School B is 15:1. Eight percent of the teachers at School B hold advanced degrees, and there was a 24% teacher turnover rate. Over half of the teachers have been teaching at School B for at most three years. School B is the smallest school in the study.

Mr. McMillian and Mr. Ferguson at School C. Mr. McMillian holds a B.S. in Computer Science and a M.S. in Mathematics. He obtained his certification to teach high school after receiving his master's degree, and has been teaching high school mathematics for 23 years. Mr. McMillian has been teaching in his current district for seven years and at School C for four months. Mr. Ferguson has a B.A. in Fine Arts and a M.A.T. in Mathematics, and has been teaching in his current district for four years, where three of those four years were at School C. Mr. McMillian and Mr. Ferguson met the study criteria for my Black master and Black novice level teachers, respectively. Both of them were substitute teachers before deciding to pursue their high school mathematics teaching careers.

As one of three high schools in the district, School C is an early college high school housed on a community college campus, where students were allowed to take college courses as early as their sophomore year. Mr. McMillian and Mr. Ferguson were experimenting with flipped classrooms, an instructional strategy that reverses traditional learning environments by presenting instruction in online videos created by teachers for students, and activities for homework are moved into the classroom. Similar to School B, School C gravitates toward a project-based learning philosophy where students are tasked with interdisciplinary projects for their courses as well as projects outside of class with other students on the same grade level. Unlike the other schools in this study, School C does not participate in AP courses. Out

of 204 students, 53% are considered economically disadvantaged, and the school received Title I funding. Like School A, the student-teacher ratio is 19:1 with 11 full time teachers. In the 2014-15 school year, the teacher turnover rate at School C was 33%, at which time 91% of the teachers were fully licensed, and nine percent had advanced degrees. Over two-thirds of the teachers at School C have taught less than 10 years at the time of the study. Although School B is the smallest school overall, School C only outnumbered School B by 10 students during this study.

Before I conducted the preliminary interviews and classroom observations with each teacher, diversity was determined by asking teachers to provide the racial distribution of their potentially observed, most diverse class on the teacher biographical information survey. The purpose for having the teachers select their most diverse class was to remain faithful in answering the proposed research questions about diverse students. Table 4 below exhibits the racial distributions for all observed classes. Note that the numbers in the table only reflect the students who turned in their consent form and surveys.

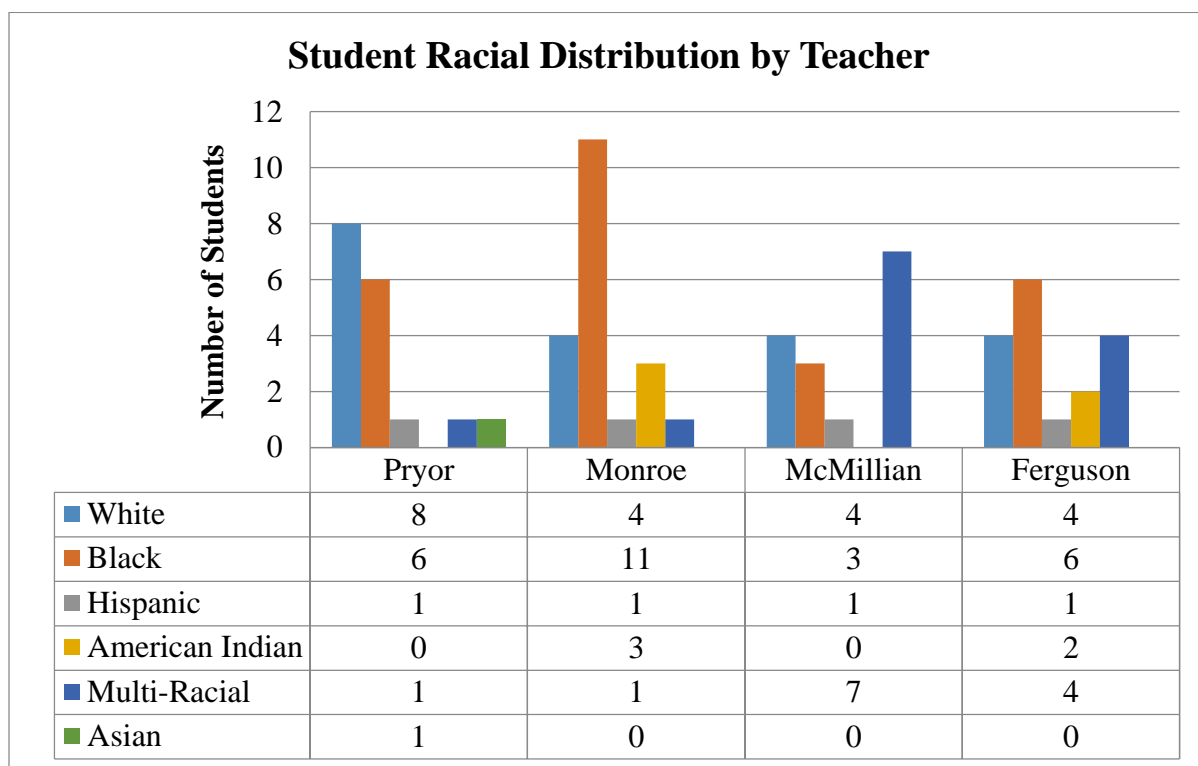


Figure 4: Student Racial Distribution by Teacher

Data Collection

I collected data between February 2015 and May 2015. Different data sources were implemented in order to triangulate the study findings and ensure their trustworthiness (Creswell, 2013). Data sources for this study included: teacher biographical information survey, two individual teacher interviews (one preliminary before and one reflective after classroom observations), video recorded classroom observations, and student surveys.

Table 4 below shows the location and duration of data collection for each data source. Note that the teacher biographical survey and student survey did not have a duration period like the interviews. The biographical surveys were sent and submitted via email so no

specific time allotment would be feasible. The student surveys were distributed on the same day as the preliminary interview but before the first observation. Students were instructed to complete the survey outside of class and return within a week to the teacher, who then returned them to me. Similar to the teacher biographical surveys, the student surveys did not have a duration time to display in the table. Specifically for location, all interviews and observations took place in the teachers' classrooms at their respective schools. Below I describe each data source, their origin, and intended purpose in the study.

Table 4
Location and Duration of Data Collection for each Source

Teachers	Location	Duration		
		Preliminary Interview (hh:mm:ss)	Observations (all 5 days; hh:mm)	Reflective Interview (mm:ss)
Pryor	School A	00:41:35	7:55	44:28
Monroe	School B	00:43:39	6:15	40:22
McMillian	School C	00:29:02	7:30	47:55
Ferguson		1:13:38	7:30	56:34

Teacher Biographical Information Survey. Teachers in the study were given a biographical information survey (see Appendix F: Teacher Biographical Information Survey) to complete before the preliminary interview. Adapted from Fulmore (2005), this form captured data such as the teachers' race, years of experience teaching high school mathematics, currently taught classes, and the number of students of each represented race in their most diverse Common Core mathematics class. The form was modified to capture all races in each teacher's observed class, unlike Fulmore's version which only accounts for

percentages of African American students. The biographical information helped me purposefully select my participants and construct a background profile for the study.

Preliminary Teacher Interview. I adapted Creswell's (2013) interviewing approach which focuses on the data collection process. The preliminary teacher interviews were individually conducted and semi-structured (see Appendix J: Preliminary Teacher Interview Protocol). The questions from the preliminary teacher interview protocol may also be found below in Table 5. The purpose of the preliminary interview was to understand each teacher's philosophy on helping diverse students, and whether they felt their race and experience played roles in their teaching. Note that experience level (i.e., novice or master) is included within teacher experience (e.g., years of teaching, training, workshops, and teacher education). Therefore, I also inquired about their teacher education, professional development, and other experiences that may or may not have helped them teach diverse students. As I audio recorded the interviews, I captured responses from teachers to enable understanding of the ways their experience and race played parts in how their students' FoK was incorporated into mathematics instruction. The teachers' descriptions of their effective teaching strategies provided a baseline for classroom observations since interviews were administered beforehand. Interviews took place face to face which allowed me to observe gestures and other body language from the respondent. An audio recorder was used to capture the dialogue between the interviewees and myself to later be transcribed verbatim. Table 6 below provides references and rationale for each preliminary research question.

Table 5
Preliminary Interview Question Rationale

Interview Questions	References	Rationale
<p>Imagine school just started and you have students that you do not know. What methods do you use to learn about your students' lives outside of the classroom? How do you use this knowledge in mathematics instruction?</p>	<p>RQ 1; Aguirre & Zavala, 2013</p>	<p>Want to learn whether teachers are taking time to learn about and use their students' cultures, communities, and interests in mathematics instruction.</p>
<p>How does your race play a part in incorporating students' knowledge, skills, and experiences from their homes and communities into mathematics?</p>	<p>RQ 3</p>	<p>Directly informs the third research question.</p>
<p>How do you address race in the classroom? If you were to include race into mathematics, how would you go about it? Give me a scenario.</p>	<p>Gutstein, 2003; Leonard, Napp, & Adeleke, 2009</p>	<p>Help with the understanding of how and whether teachers are actively addressing and appreciating different ethnicities in the classroom.</p>
<p>How does your experience play a part in incorporating students' knowledge, skills, and experiences from their homes and communities into mathematics?</p>	<p>RQ 2</p>	<p>Directly informs the second research question.</p>
<p>Recall a specific time when you were successful helping your students understand a mathematics concept. When did this happen (e.g., during class, before/after school, etc.)? Specifically what tools, techniques or routines did you use? Why do you think this particular practice helped this student? What teaching strategies do you use to teach diverse students?</p>	<p>Flanagan, 1954; Fulmore, 2005</p>	<p>For teachers to recall a significant moment during the observation. Teachers will have a chance to reflect on positive teaching experiences which may be observed in the study.</p>
<p>Recall any specific academic training, personal experiences, or programs that you have had that helps with effective teaching in a diverse environment.</p>	<p>Fulmore, 2005</p>	<p>To learn whether teachers are receiving or seeking out opportunities to effectively teach unfamiliar ethnic groups.</p>

Table 5 continued

What role do you think language (home and math), culture, family, and community play in learning and teaching mathematics?

Aguirre &
Zavala, 2013

To learn whether teachers are valuing students' out of school knowledge and whether they feel it plays a role in mathematics learning.

Note: If no reference is provided, the interview question is directly based on research questions.

By doing the interviews before classroom observations, I learned each teacher's objectives and what he or she considered effective teaching strategies for their students. I scheduled interviews to last between an hour and an hour and fifteen minutes; see Table 5 for actual duration of each teacher's interviews. During the interviews, I facilitated the responses to make sure the interviewees and I were staying true to the questions and the specified time. I was consistently objective, respectful, and courteous while allowing the respondents to do most of the talking.

Mr. McMillian appeared to have given the shortest preliminary interview; however he spoke rather rapidly. When compared with the duration and length of the other teacher's interviews and transcriptions, Mr. McMillian only differed 18 lines from the next shortest interview which lasted 12 minutes and 33 seconds longer than his (i.e., Mr. Pryor's interview).

Student Surveys. Before classroom observations, I surveyed a total of 80 students from all teachers' classes (see Appendix I: Student Survey) to elicit their knowledge acquired outside of school (i.e., students' FoK), languages spoken, whether and how often their math teachers used their life experiences when teaching, and helpful and unhelpful teaching strategies. I explained the purpose of what information was needed for the survey for

students to complete outside of class. The student survey was completed on a form by hand and all responses remained confidential. In order to keep track of survey data and the respondents, all teachers and students were assigned identification numbers where the students' numbers corresponded with their teacher. The survey was attached to a letter addressed to the students' parents/guardians, along with an informed consent form. I only used data from surveys where parents granted me permission for the student to participate in the study. Out of 80 surveys, I retrieved 69 completed surveys to analyze in the study. Table 6 below displays the number of student surveys distributed and retrieved from each class.

Table 6

Number of Distributed and Retrieved Surveys by Teacher

Teachers	Number of Surveys Distributed	Number of Surveys Retrieved (%)
Pryor	18	17 (94%)
Monroe	20	20 (100%)
McMillian	21	15 (71%)
Ferguson	21	17 (81%)
Total Students	80	69 (94%)

When I arrived on the first day of observation, I retrieved and reviewed the surveys. All teachers had some students who did not complete the survey, or misinterpreted questions. After I highlighted the mistakes and informed the teacher of these errors, he or she re-distributed the surveys for students to correct and return before the end of the class the same day. I did not get all student surveys within the week allotted prior to observations; for student convenience, I created an electronic version of the survey in order to retrieve as many

additional surveys as possible. Teachers who had missing surveys from their classes were given a link to the survey that they put on their class webpage for students to access. Students who had missing paper surveys were then instructed to go online to complete the form. Three of Mr. Ferguson's and nine of Mr. McMillian's students completed their surveys in this manner. I provided a few extra hard copies to all teachers as well. An electronic version of the original survey was sent to Ms. Monroe who made additional copies for students who misplaced theirs. These surveys were retrieved in person on either a scheduled observation day or the day of the reflective interview.

Data from the student surveys were used to answer all research questions in some capacity. The following quantitative analysis methods which will be discussed later were used on the student surveys:

- descriptive statistics,
- chi-square test or non-parametric Fisher's exact test, and
- two-sample independent *t*-test or non-parametric Wilcoxon test.

Class Observations. One of the key tools for collecting qualitative data is field observation (Creswell, 2013; Patton, 2002). Each teacher was observed and video recorded for five instructional days so that we could later accurately recall teacher behaviors that were critical to use the CRMT framework for analysis during the reflective interview. For each classroom observation, I watched the participants, activities, interactions, physical setting, and behaviors, considering how these classroom components lend themselves to the research questions, primarily the first one. I selected two video segments from classroom observation data for teachers to watch later during the reflective interview. These segments were selected

based on whether the teacher was solving a contextual problem with the class or had a high level of interaction with his or her students. LiveScribe technology (i.e., pen, notebook, and headphones) was used to document observable actions and settings in real time. I chose this to be the criteria for video selection because I wanted similar videos for all teachers and felt that more student interactions may yield an abundance of various teacher behaviors. Also, using videos that highlight contextual problems will help teachers realize whether contexts used in class are relevant to their students' lives. Throughout the dissertation, I will use smartpen interchangeably with LiveScribe technology when talking about how I collected data during observations, as the smartpen is used to write field notes.

Video data is considered “a valuable methodological instrument for gathering data” (Powell et al., 2003, p. 408). Simultaneous details of complex interactions in the classroom became accessible in real time, which may not be completely observable at the time of observations. By reviewing video data, I was able to account for any data missed while physically being in the observed setting. As observations are grounded in the purpose of the study, I assumed the role of a direct observer since I only spoke directly to students to administer the survey prior to observations (Trochim, 2006). I observed and took notes with minimal to no involvement during instruction. Outside of introducing myself and explaining the purpose of the study, I had a detached role during observation. Rationale for direct observation during the study was to not bias the observations and maintain focus. According to Trochim (2006), technology such as recording devices are highly useful during direct observation, and such observation techniques are more focused than, say, participant observation, where one becomes immersed in the observed environment.

Each teacher was observed for five days based on availability of the teacher. After the preliminary interview, we (each teacher and I) worked out a tentative schedule together to ensure I was only observing instruction. Due to tests, Spring break, conferences, and other scheduling conflicts, all days were not consecutive as anticipated. For all observations, the video cameras were either in a corner, on the teacher's desk, or near the wall, all the while focused on the teachers to capture interactions with their students. Teacher wore a lapel mic during each observation, and all teachers granted me permission through their consent form to video record their classes. For each observation, I collected all teaching artifacts used (e.g., mathematical tasks, handouts, and assessments). My intention was not to collect student work, just blank documents. However, Ms. Monroe had her students to create contextual problems. I collected their contextual problems as part of the teaching artifacts and covered up the students' names to maintain confidentiality. Collectively, these artifacts were used to support or initiate interactions in the classroom and were used to identify and rank classroom observations according to the CRMT tool.

My intention was to record using two video cameras each day. On Mr. Pryor's first observation day, the video camera with the lapel mic feature was not working properly. There were a few times where the smartpen used to take field notes during observations was low on battery. As a result, I hand wrote or typed some notes for all teachers at least once with the exception of Mr. Pryor. Also the batteries in the lapel mic depleted rather quickly and had to be changed during one of Ms. Monroe's observations. I also noticed that the sound did not record on the lapel mic video camera for one of Mr. Ferguson's video recordings.

Reflective Teacher Interview. Teachers in the study were individually interviewed after his or her five-day observation period (see Appendix K: Reflective Teacher Interview Protocol). The reflective and preliminary interviews had similar structures, but the teachers were asked different types of questions and watched two video segments of their teaching during the reflective interview. Prior to the reflective interview, I selected two video segments of their teaching. The selection criteria were based on whether the teacher was solving a contextual problem in class, or if the segment included student interactions. The rationale for the criteria was explained earlier in the section on classroom observations. The interview afforded teachers time to explain their actions while they watch themselves on the video segments. In addition, I asked teachers the guiding questions that go along with the CRMT tool for how their lessons address each dimension. Finally, I asked whether they felt their experience and race played roles in how they taught mathematics. I asked them a similar question during the preliminary interview to see whether they were consistent.

During the reflective interview, I asked the following questions:

- How did you feel the observations went?
- Is there any particular event or student stood out to you? If so, what or who?
- Can you think of any connections that you may have made that I may not have noticed?
- Tell me about what you were thinking as you watch yourself teaching on the video.
- How does your lesson:
 - use L1 [home language] to support academic language development for ELLs [English Language Learners]?

- utilize scaffolding strategies to provide academic language development for ELLS?
- help students connect mathematics with relevant/authentic situations in their lives?
- support students' use of mathematics to understand, critique, and change an important equity or social justice issue in their lives?
- Do feel your race and/or experience play a role in your ability to incorporate students' informal knowledge bases? Why or why not?

I used an audio recorder for the reflective interview to capture the responses of the teachers and transcribed later for analysis; in addition, I used a smartpen to audio record and jotted down notes about teacher observable reactions while they watched themselves on the selected video segments from the observations. The second half of Mr. McMillian's reflective interview did not audio record. This was not realized until the transcription period approximately two weeks after I originally conducted the interview. I contacted Mr. McMillian over the phone to set up a time to conduct the missing portion. I began the second reflective interview after we watched the second video segment again. While writing with the smartpen in the smart notebook, I audio recorded using the audio feature on the smartpen and a computer software called Express Dictate.

Data Analysis

To analyze the video footage from each day for each teacher, I time stamped and noted critical teacher behaviors that occurred during the lesson in a spreadsheet as they related to the four dimensions from the CRMT tool for this study: (a) academic language

support for ELLs, (b) use of ESL scaffolding strategy, (c) FoK/culture/community support, (d) and use of critical knowledge/social justice. The critical behaviors were used as evidence to justify dimension rankings. An excerpt of recorded evidence from Ms. Monroe's class for the FoK dimension (Dimension 7) coding can be found in Table 7 below for the first two observation days. After reviewing the critical evidence and their respective artifacts collectively for each of the five days, I provided daily scores for each dimension for each teacher.

Table 7
An Excerpt of Critical Evidence from Ms. Monroe for the FoK Dimension

Day	Time stamp (00:00)	Critical Evidence (How lesson helps students connect math with relevant/authentic situations in their lives?)	Artifacts
1	0:00	Students log into computers to do the Do Now. There are word problem with contexts such as how many buses are needed for a bus trip, difference between scores, total of needed paint tins, and weights in kg.	Day 1 Do Now on PC: For starters
1	46:39	Word problem with burger king context for how many whopper and chicken sandwiches were sold.	1.4 Polynomial notes
2	0:00	Day 2 Do Now's context is about standing in line at a bus stop. Students are asked to click and drag people to rearrange them in line to find the different ways they can be ordered. Teacher has 4 Students to act it out.	Day 2 Do Now on PC: Standing in Line
2	18:45	Asks if they need a moment before beginning the lesson. There was a death of a student over the weekend that was affecting the students.	
2	19:00	Reads word problem to class Asks questions on what to do. Context is painting a wall. Tells students to draw a picture.	3.2 homework worksheet
2	21:29	T: If door won't be painted, what will get painted? S: All around it. Teacher shades her drawing to indicate painted wall. Other context on work sheet is finding the area of the hedge with sculpture in the middle.	3.2 homework worksheet
2	24:00	Hypothetical situation about their wall is given by teacher to relate to their problem.	3.2 homework worksheet
2	42:46	Teacher asks about what cylinders they knew of in real life.	3.2 homework worksheet
2	52:41	Students in partners create their own word problems. Teacher assigned partners.	Students' word problems

As stated earlier in the conceptual framework section of this chapter, I decided to narrow the scope to the FoK dimension due to the minimal level of foreign language and modified English usage during observation. Further, the FoK dimension is the most relevant

dimension out of the proposed four as it relates the closest to incorporating students' FoK into math instruction. Particularly, the FoK dimension deals with authentic situations in students' lives and how the teacher uses this knowledge in his or her mathematics lessons. Student surveys and classroom observations facilitated the development of the major themes for answering the first research question.

I did all of my coding for the interviews in NVivo software. In order to find categories for emergent themes for the first research question, my intention was to use references from the coded preliminary interview responses coming from codes concerning teaching strategies and student knowledge implementation for diverse students. However these references over the five day period did not align well enough to pull directly from the strategies used by teachers. In addition, most of the teachers stated that they did not do anything different for diverse students. As a result, I revisited the critical evidence for each teacher, and extend the table to include two more columns after the artifacts. Within the FoK dimension, I identified the teacher contexts for each episode of critical evidence and its respective implementation method.

Next, I compiled all of the student survey and observation data in spreadsheets. By finding the overlapping topics from teacher contexts and students' self-reported FoK, I narrowed down the implementation methods to themes for the first research question. The implementation methods that had matches among teachers' contexts and students' FoK are essentially the teaching strategies that teacher participants used to incorporate their students' FoK, the first research question. These implementation methods that emerged from matches between observations and surveys were: (a) contextual problems (i.e., warmup, homework,

projects, and classwork), (b) instructional and non-instructional dialogue (i.e., storytelling, analogy, and general inquiry), and (c) discovery. The classroom observations and surveys were the data sources used to help me answer the first research question; the interviews were the primary source to help answer the second and third research questions. The analytical means used on data from observations were descriptive statistics, Fisher's test, and chi-square test.

I used NVivo qualitative software to code each of the interviews (preliminary and reflective) in the order I interviewed the teachers. For preliminary interviews, I read through their responses to each question from the protocol, categorizing them by the noticeable topics using a line by line approach (Bernard & Ryan, 2010). I inductively added codes when something different emerged from an interview response that was not previously coded. As coding progressed, there was a hierarchy that formed within codes. For instance, when asked about the tools and techniques used to help students learn during the preliminary interview, some teachers gave benefits and constraints while offering their responses. These types of responses were coded in a hierarchy underneath teaching strategies.

For reflective interviews, the questions were aimed to help teachers reflect on two video segments from two different observations. I added two codes for the video reflections used strictly for the reflective interviews. There was an identical hierarchy for each of these, because each teacher was asked the same questions for each video segment. I coded on the questions for the reflective interviews in order to compile all responses from the teachers. Unlike the line by line approach used to code the preliminary interviews, I coded the reflective interviews in larger chunks by teachers' responses to each interview question

(Bernard & Ryan, 2010). In addition to the video reflection codes, I coded on the roles of race and experience using codes that were already established from the preliminary interviews. Open coding both types of interviews collectively yielded 138 codes.

After open coding, I eliminated the codes that were superfluous to the study in order to analyze data specific to each research question. For instance, when teachers reported the tools and techniques they used to help students learn, I did not report on the benefits and constraints codes reported during the preliminary interview. However, I did include the observed teaching strategies while developing themes for the first research question, keeping in mind the conversations during the preliminary interview about tools and techniques. I was able to use 12 codes out of the original 138 codes from the interviews to develop themes for each research question. Codes around the second and third research question came directly from the interview codes, but the first research question needed more development beyond what was found in the interviews. Tables 10 through 12 below give the codes and themes for each research question to be discussed in more detail in Chapter 4.

For the first research question, the most relevant codes from the interviews that helped determine the major themes were the role of language, culture, family, and community, student knowledge implementation, teaching strategies, and reflection on how each mathematics lesson captured in the video segments used relevant and authentic situations in their students' lives. However, classroom observations (i.e., video data and artifacts) and student surveys were the data sources most helpful when answering the first research question. I aligned the contexts teachers used in class and out-of-school activities reported by students, and recorded the teaching strategies used during this time to develop the following

themes: Contextual Problems, Dialogue, and Discovery. In Table 8, there are the themes for the first research question and components from each teacher that lend themselves to each theme. I define each theme below.

Table 8
Origin of Themes for Research Question One

Teacher	Contextual Problems	Dialogue	Discovery
Pryor	Homework, warmup, notes	Storytelling, questioning, direct instruction, reference to own FoK, conversations with students (individual and whole group), Tell Me Something Good	Number e in nature, extra credit
Monroe	Classwork, instruction, Do Now (i.e., warmup), create word problem, homework	Enactment of Do Now, questioning, group work	Real life cylinder brainstorm, word association for prefixes (i.e., tri-, bi-, mono-)
McMillian	Homework, guided practice, warmup	Storytelling, direct instruction, helping each other in group	n/a
Ferguson	guided practice, review, warmup	Discussion, food for thought, analogy, project recall	Analyzing the Relationship between Log Functions and its Inverse, Circle Theorems

The first theme, Contextual Problems, describes word problems that teachers use to teach mathematics concepts that have various contexts. The four main activities where contextual problems were implemented during math lessons in the study were warm up,

homework, classwork, and projects (see Table 9). I collected and analyzed artifacts used during class as part of each classroom observation. I did not observe projects in action; however two out of four teachers mentioned them during their interviews as their means of incorporating real life or relevant situations for students. Further, past projects were connected to present concepts.

The second theme to answer the first research question, Dialogue, may be instructional or non-instructional in nature. Dialogue may include storytelling, the use of analogies, and general inquiry were observed from teachers in the study. Some teachers had conversations during class related to real life scenarios or student interests. Lastly, Discovery, the third theme to help me answer the first research question, was an observed method used by most teachers to incorporate their students' FoK. This theme refers to moments during class where teachers allowed students to think aloud on an idea, brainstorm, or do some out-of-class research on a mathematical concept. As teachers ask questions about a problem while teaching, he or she may ask how something relates to something they know already in an effort to make a connection to their lives with the mathematics. Details for the developments of the themes may be found in the qualitative section of Chapter 4.

For the second research question on experience, I coded for teaching and non-teaching experience, teacher education, and learning situations that the teachers in the study have had to help them teach diverse students. I transcribed each teacher's self-reported confirmation or disconfirmation of how their experience plays a role in their incorporation of diverse students' FoK and support their reports with teachers' responses on each major theme concerning experience.

Some of the codes and sub-codes can be found below in Table 10. The NVivo Codes in Table 10 became the major themes to help answer the second research question. From these codes, three primary themes emerged which will be discussed further in Chapter 4: Non-teaching Experience, Teaching Experience, and Teacher Education. Table 9 includes examples from the preliminary interview on teachers' views about experience. I will describe each theme below.

Table 9
Origin of Themes for Research Question Two

NVivo Codes	NVivo Sub-codes	Examples
Role of Experience	Low	Pryor: <i>"I've gotten into archery in the last five years and one of my students several years ago found out about it and that was a conversation we could have on a daily basis."</i>
	High	Pryor: <i>"Experience can always help because the more you experience the more you're able to apply it..."</i>
Teacher Experiences	Teaching Experience	Monroe: <i>"I was taught very traditional. Sit down; we're going to take notes. We're going to do problems. You're going to go home and do some more problems, and that's how it's gonna be. And I thought that was how I was supposed to teach. I tried that my first year; nobody was learning anything because the kids that want to come to [school name] want to do hands-on."</i>
	Non-Teaching Experiences and Beliefs	Ferguson: <i>"I have all these experiences that I didn't understand why I was doing them at the time but now I can share those with these kids, and if I didn't share them it would be a waste of experience."</i>
	No excuses	McMillian: <i>"The African American kids can't use the excuse that 'I can't do this because...' And I tell the kids upfront 'I used to stink at math. Math was my worst subject ever of all time. Hated it with a passion, but it was because I didn't apply myself. Once I started applying myself, everything changed.'"</i>
Teacher Education	Discovering Weaknesses	McMillian: <i>"Because when I first started teaching, there was so much. I was like I knew it all. Then I went to grad school, I realized I didn't know anything."</i>
	Grade level disconnect	McMillian: <i>"Most of what they taught was the elementary level but for us, the individual teacher has to find a way to bring it into your class."</i>

Experience addressed in the third research question includes teaching and non-teaching experience, and teacher education. Non-teaching experience as a theme may be described as teachers' hobbies, interests, or previous jobs that have in turn helped them in the classroom.

These experiences may also include events in teachers' lives that may have impacted their teaching behavior in a diverse setting. The Teaching Experience theme addresses experiences the teachers in the study have had or learned from within the classroom and how these experiences have impacted their teaching over the years. Beyond teachers' experience inside and outside of the classroom that shape their teaching philosophies, the Teacher Education theme describes education opportunities that teachers revealed that have helped them teach diverse students to include but not be limited to college courses, professional development, conferences, and workshops.

Similar to the second research question discussed above, I included an excerpt of codes and sub-codes from the NVivo coding as they related to race for the third research question (see Table 10). I coded teacher responses to the preliminary interviews with the following categories: personal experiences with race and racism, the role of race, addressing race, and empathetic storytelling. Although I coded the reflective interviews with a separate set of codes, I did code for the role of race similar to the preliminary interview responses. I categorized the individual teacher responses and used the major codes directly on race. The third theme, Personal Experiences with Race and Racism, came from the role of experience code since some of them involved episodes on race and racism. Similar to the research question about experience, I stated whether each teacher confirmed or disconfirmed his or her race playing a role based on implications from their interview responses. The emergent themes for answering the third research question discussed in more detail in Chapter 4 are as follows: Personal Experiences with Race and Racism, The Role of Race in Teaching and Learning, and Addressing Race in the Classroom.

Table 40
Origin of Themes for Research Question Three

NVivo Codes	NVivo Sub-codes	Examples
Role of Race	None to minimal	<p>McMillian: <i>“To be honest, I don’t think my race plays a part at all. A lot of people say ‘You’re a Black role model so the kids will look up to you.’ I have just as many White kids looking up to me as I do any other race, Black, Indian race or any other race.”</i></p>
	Role models	<p>Ferguson: <i>“I’ll have to say race and sex, just because a Black male really has two images. Well two popular images amongst the Black community, but they have several. And I’m not one of the two popular ones. So when they see it, it’s something different and if you can catch their attention....you can just unload so much on them. And, believe it or not, they hold on to that stuff.”</i></p>
	Difficulty in relating	<p>Monroe: <i>“I think race probably hindered me maybe my first year but now I don't think it has an impact at all. It hindered me because I was unfamiliar with other cultures especially in this community and being a minority.”</i></p>
	Offending others	<p>Pryor: <i>“Yes, there’s been learning experiences for me through the years where I’ve stepped on somebody’s toes culturally or racially and it causes me to learn what I can say what I can’t say. If I see another student maybe can help me prevent them, help them understand what this other cultures about and maybe not offend.”</i></p>
Addressing Race	Offensive Behavior	<p>Pryor: <i>“My personal experience, learning, having made mistakes in both race and culture has helped me learn what I need to, how I need to behave, how I need my students to behave, and if I see incorrect behavior, I can address it. Hopefully, before it becomes an issue.”</i></p>
	Math Instruction	<p>Ferguson: <i>“I want to hit every little piece of racism that I can touch.”</i></p>
	Never thought about it	<p>McMillian: <i>“I never thought about saying this to the kids... I never looked at it as telling the kids about the race aspect.”</i></p>

The first theme I highlight to help me answer the third research questions on race is Personal Experiences with Race and Racism, which I describe as background information, upbringing, or philosophies that help teachers in the study understand or learn about race and racism. The second theme is the Role of Race in Teaching and Learning, described as teachers' perspectives on how their race contributes to, hinders, or does not influence their ability to teach diverse students. Lastly, the third theme for the third research question is Addressing Race in the Classroom, which includes how teachers diffuse offensive behavior among students and as part of instruction or projects. When a teacher did not have any instruction or projects to discuss that addressed race, I asked for a hypothetical scenario for a way that he or she may address race in the classroom. Next, I will describe the quantitative analysis of this study.

Description of Quantitative Analysis

For the quantitative analysis, because of the sparseness of the frequency of certain FoKs, I combined student race categories when appropriate and analyzed them as White and non-White. Non-White is a compilation of all represented races from each observed class that did not identify as White: Black, Hispanic, American Indian, Multi-Racial, and/or Asian. My rationale for combining all non-White races is to provide enough non-zero values to be able to run statistical tests. I used Statistical Analysis Software (SAS) to conduct analysis by reporting important characteristics of each data set with frequency distributions, means, standard deviation, percentiles, and various graphical displays on student and teacher data. Then I ran statistical tests such as chi-square and Fisher's exact test on the categorical variables pertinent to each research question.

A univariate test was conducted on continuous variables to learn whether the data was normal to run a *t*-test. If the test for normality showed a *p*-value that is not significant ($p \geq 0.05$), then ANOVA or *t*-test was an appropriate statistical test. Otherwise, a significant *p*-value of less than 0.05 resulted in the use of non-parametric tests, particularly the Wilcoxon test, to conduct statistical analysis. All calculations for *p*-values were found using SAS software. In Chapter 4, I will present results from categorical data analysis, followed by the continuous data analysis. Next I will discuss the validity and reliability of the study.

Validity

Confirming and triangulating data from several sources take place during data collection and study validation (Creswell, 2013). Creswell uses the term validation (external and internal) explaining that it allows a researcher to ensure credibility of a study and its findings. Below I define each type of validity and explain how each type will be addressed in the study.

Internal validity occurs *within* the study, and answers the question “*Was the study done correctly?*” It denotes how well an experiment is done and whether it avoids confounding variables. Validation strategies to be used for this study are (a) prolonged engagement and persistent observation, (b) triangulation, (c) peer review or debriefing, (d) clarifying researcher bias, (e) member checking, and (f) giving a rich, thick description (Creswell, 2013). For this study I observed and video recorded each classroom for five days excluding non-instructional days. Different data sources were used to compare quantitative and qualitative findings and make interpretations. The notion of validity of measures tests the degree to which any measurement technique and instrument is successful in describing or

quantifying what it is designed to measure (Weiner, 2007). Moreover, validity of measures reflects errors in measurement that are constant or systematic. To address this aspect, I had an appointed colleague to review the CRMT tool and rubric descriptions to analyze two video segments from two different teachers that I felt represented most of the dimensions fairly well. The purpose was to find out if we would come to a similar conclusion to rate each observation day. The table that displays this information is found in the next section under reliability. I have made my biases explicit and understood through my biography. Data and interpretations were shared with participants so they can review and approve the analysis process. Lastly, to address internal validity, I described the settings where the study takes place, the participants, and their behaviors in adequate detail.

On the other hand, external validity takes place *outside* of a study and answers the question “*does the same thing happen in other settings?*” It refers to how well the data and theories used apply to other situations. For this study, CRT is the theoretical lens used and I addressed external validity by examining different races of teachers with different experiences and their incorporation of all students’ FoK into instruction. I collected data in the context of diverse high school mathematics classrooms, unlike previous research around FoK (Aguirre et al., 2012b; González et al., 2005).

Reliability

According to Creswell (2013), “reliability often refers to the stability of responses to multiple coders of data sets” (p. 253). Key issues for reliability may be discussed in terms of code agreement and having an audit trail (Creswell, 2013; Merriam, 1998). I had a variety of data sources alongside other researchers and colleagues to review the process. In particular, I

trained a colleague on my methods and how to code the data from the various sources to check for reliability of my analysis. I evaluated observer measurement reliability through inter-rater agreement by comparing my results with those of an external rater or observer with a data sample (see Table 11). In so doing, I was able to strengthen internal validity (Aguirre et al., 2012a; Hagborg, 1994; Merriam, 1998).

To assess reliability, I had a colleague to code two samples of video using the CRMT tool after my analysis. Before analyzing video, I provided my colleague with the CRMT tool and rubric with my modifications. The modifications were made based on the context of the study and adjustments that needed to be made due to the contents of the study sample. In five-minute intervals for approximately 15 minutes each, we watched two video segments: one from Mr. Pryor and one from Mr. Ferguson. We watched and discussed what we saw before categorizing each video segment into their respective dimensions. Once we established which behaviors we would consider to rate each segment, we individually rated each segment on each dimension from one to five according to the CRMT tool's rubric. We justified our ratings as we reported on each dimension. We used 17 incidences to rate Mr. Pryor's video segment, and 15 incidences to rate Mr. Ferguson's. I considered ratings with a difference of one as an agreement. For instance, I rated Mr. Pryor's video segment on dimension 6A as a three, while my colleague rated it a four. Since we are only one point away, I considered this is an agreement; otherwise, it was a disagreement. With this interpretation, we agreed on all dimensions. In particular, we scored three out of four dimensions exactly the same for each segment, and were one away on one dimension: 6A for Pryor and 7 for Ferguson.

Table 51
Inter-rater Reliability Chart

Dimensions	Mr. Pryor		Mr. Ferguson	
	17 incidences		15 incidences	
	Researcher	Colleague	Researcher	Colleague
6A	3	4	3	3
6B	4	4	3	3
7	1	1	3	2
8	1	1	3	3

After discussion with my colleague, I found it necessary to add some clarifying statements for two of the dimensions. For instance, distinguishing between a 3 and 4 was difficult. To clarify, I included quantities that correspond with the phrases “at least one” and “many”; one through three correspond with at least one, and four or more for many. Another addition for clarification was a list of scaffolding strategies, which may include repeating or restating a question or instruction, writing something on the board during instruction or after a statement, providing hints or clues on an approach, reading aloud, visual aids, asking questions or reviewing, pre-teaching vocabulary, tapping into prior knowledge, using mnemonics. The section that follows discusses the ethical considerations for the study.

Ethical Considerations

Ethical issues may occur during any phase of a research study (Creswell, 2013). Upon approval to conduct research from IRB and gatekeepers but prior to data collection, I obtained signed informed consent forms from parents and teachers informing them of the use of all collected data (Powell et al., 2003). Participants were notified when the video camera is recording, and given the option of interrupting and member checking any recording session

(Bernard & Ryan, 2010; Creswell, 2013; Patton, 2012). Full disclosure of the study's purpose was addressed during the initial phase of the study to inform participants of what was to be expected. Some of the participants were concerned with the preservation of their privacy; I masked their names with pseudonyms and safely stored their data to address this issue (Creswell, 2013; Powell et al., 2003).

To prevent any psychological harm, I approached the topic of race with caution and remained objective. By reporting contrary findings, I avoided siding with any participants and gave multiple perspectives. Asking teachers to recall events concerning race may stir emotions, and I was sensitive to their needs and built rapport to gain access to delicate matters. Participants had access to transcripts of video segments and the videos were stored in a safe place to preserve confidentiality. Creating a safe environment was a priority I withheld throughout my study.

Chapter Summary

Mixed methods research (MMR) offers more evidence that quantitative and qualitative research cannot capture alone (Creswell & Plano Clark, 2011; Teddlie & Tashakkori, 2010). The practicality of MMR gave me the freedom to use all possible methods to address my research questions, inductive and deductive reasoning, and skills of observing and recording teacher behaviors (Creswell & Plano Clark, 2011). The quantitative strand nested within a qualitative experiment in this embedded MMR design implicates analysis of at least one type of data within a design and associates it with another type of data. Moreover, MMR afford me the opportunity to implement descriptions and inferential statistical tests to answer my research questions.

In this chapter, I addressed how I selected my participants, and obtained consent from teachers, students, and parents of students in the study. I also discussed how I collected data with each data source with corresponding methods of quantitative and qualitative analysis, as well as reliability, validity, and ethical considerations. The study schema provided below in Figure 4 exhibits the organization of activities to take place for the duration of the study. The next chapter will illustrate the findings after all of the data has been analyzed.

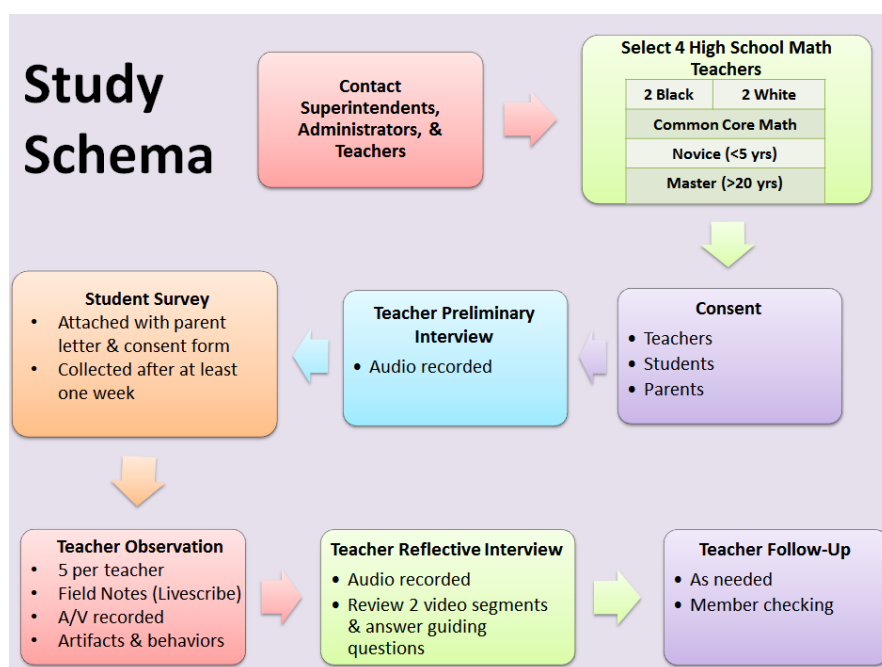


Figure 4: Study Schema

CHAPTER 4: FINDINGS

The overall purpose of the study was to investigate whether teachers in an ethnically diverse high school mathematics classroom meaningfully incorporate their students' (FoK). Moreover, I report whether characteristics such as teacher race and experience level play roles in the incorporation taking place. Chapter 4 begins with individual teacher profiles including each teacher's education history, classes taught, and student information for the class. In addition, the profile sets the stage for the rest of the findings with a description of each teacher's school setting and a typical day observed over the five-day period. Once setting and descriptive statistics have been given for each teacher and their observed class, I report the qualitative and quantitative findings. The chapter concludes with a summarization of the answers found for each research question.

Setting the Stage

Mr. Pryor

Mr. Pryor has a B.S. in Mathematics Education and has been teaching high school mathematics for 25 years. As a White male with over two decades of teaching experience, Mr. Pryor was suited for a position in the study as the White master teacher. Mr. Pryor taught Math 3 (Honors), Pre-Calculus, and Calculus at the time of the study. I observed his 3rd block Math 3, which has a total of 18 students: 9 White, 6 Black, 1 Hispanic, 1 Asian, and 1 Multi-Racial. Mr. Pryor had good rapport with his students, as there was periodic laughter and students appeared to be having fun during class. Mr. Pryor's way to elicit knowledge from his students was sporadic in nature, as he would randomly ask individual students, 'Tell me something good.' In addition, Mr. Pryor also eavesdropped on student conversations to learn

about their lives and activities outside of school. As far as workshops on cultural differences, Mr. Pryor recalled at most four workshops held in the 20 years since he has been in his current school system, none of which were linked to mathematics.

As I entered Mr. Pryor's classroom, I heard music playing from an online radio station from his computer at the back of the room that played a variety of genres to include old soul, reggae, doo-wop, and rhythm and blues. Mr. Pryor's class was set up in rows, split down the middle facing each other. There were math posters on the walls, current students' work, and drawn pictures of mathematicians and math related designs from previous students. Mr. Pryor's main teacher desk was in the back of the classroom; but in the front of the classroom near the white board, he had a desk at which he sat to sometimes work problems under a document camera. The observed class was a lunch block and lunch was about 30 minutes into the class.

On a typical day in Mr. Pryor's class, there would be a warm up projected onto the SmartBoard for students with review problems from previous teachings. Mr. Pryor made announcements of upcoming quizzes and assessments, and then checked students' homework for completion. Students would complete their warm up and volunteered to put one up on the white board. After Mr. Pryor went over the warmup, he projected homework solutions from their online Algebra 2 textbook onto the SmartBoard. After time has been given to check their homework answers for correctness, Mr. Pryor would sit at the front desk and take requests to go over certain problems in detail. The homework review was normally followed by instruction of the next section on the class syllabus.

Mr. Pryor's teaching style was very traditional in nature. He used direct instruction daily with textbook problems for homework. His instructional notes were pre-written and were accessible online for students' convenience. Students were expected to read through notes prior class, but most of them did not. Mr. Pryor characteristically used catch phrases and inventive words to help students learn and remember mathematical concepts. For instance, the word 'commonator' referred to the need to create a common denominator for rational expressions and equations. At the time of the study, Mr. Pryor's class learned about logarithmic functions and their inverses. In order to bring variable exponents down as coefficients, Mr. Pryor taught his students to apply the logarithmic operation to both sides of an equation with the catch phrase 'hit it with a log.' Students visited the white board to work problems daily for participation points, and Mr. Pryor had a notification capability where he would send texts to his students from his computer to give students more chances to receive extra points periodically by coming during lunch to solve bonus problems.

According to Mr. Pryor, his experience influenced his teaching more than his race. Although he would address race if a student was being offended, Mr. Pryor avoided talking about race in the classroom. When asked about the roles of family, culture, and community on learning mathematics, Mr. Pryor discussed how these external factors have positive influences on students from different countries, but are typically more negative for Black and White students. In particular, he stated that different cultures value education more than Americans, and that families from different cultures breed the importance within their children. Through teaching and sharing the importance of education, Mr. Pryor wants to counteract such external factors that may have negative influences on students.

Ms. Monroe

Ms. Monroe has a B.S. in Psychology, and obtained her teaching licensure in grades 6-12 Mathematics and Psychology while in the Teach for America (TFA) program. She was recruited for TFA during her undergraduate studies and taught elementary mathematics in Mississippi as part of their intensive summer program. In her fourth year of teaching at the time of the study, Ms. Monroe met the study criteria for the White novice level teacher. She taught Pre-Calculus, Integrated Math 4, Math 3, and Math 2 at the time of the study. I observed her 2nd block Math 2, which has a total of 20 students: 4 White, 11 Black, 1 Hispanic, 3 American Indian, and 1 Multi-Racial.

Ms. Monroe stated that she did not listen to teacher talk; her colleagues would offer negative and oftentimes stereotypical comments about her students. An instance of teacher talk she would hear from her colleagues was that her White students will do better than her Black and Hispanic students, and her Black students will make trouble. Upon meeting her students, Ms. Monroe told them that she wiped the slate clean for them to create their own identity, regardless of what other teachers told her about them. In addition, she surveys her students and plays games to get to know them. Ms. Monroe is known at her school for having the strongest connection to her students, as she goes to her students' ball games and other events to support them. Ms. Monroe is the first TFA teacher who has stayed passed her two-year obligation at School B and plans to continue teaching at School B. She believes in creating a safe place in the classroom for students to feel comfortable enough to say whatever they want while in class in order to express themselves with no holds barred.

The students at Ms. Monroe's school are required to wear a color-based uniform: gray or white polo and khaki or navy slacks. Ms. Monroe had tables and chairs where her students sat in groups of four. Her classroom was lined with a class set of desktop computers separate from where the students sat for instruction and class work. Ms. Monroe's desk was catty-corner in the front of the class where there were bulletin boards decorated with freelance student pictures, thank-you cards, and copies of college acceptance letters from students. The other walls in Ms. Monroe's classroom were cascaded with motivational and math-related posters. At the front of the room is a white board with an attached projector which she used for instruction, similar to Mr. Pryor but without the SmartBoard.

The typical class I observed for Ms. Monroe began with students going to their individual computers to view the daily agenda and begin their warm up that was uploaded on a link on their class website. After giving students a few minutes to complete their warm up, students were directed back to their tables and Ms. Monroe went over the warm up. The warm up normally consisted of some form of mathematically related puzzle. Instruction began with notes Ms. Monroe would write underneath the document camera on white paper with colorful markers to later post online for students to review. Throughout the lesson, Ms. Monroe gave examples for students to apply newly taught concepts. She would sometimes let students come up to the document camera, work out a problem, and explain their reasoning at which time Ms. Monroe would ask questions that she anticipated from her students. After the instruction of the day, students were given a task to complete during class and Ms. Monroe circulated through the class and helped them as needed. To conclude the class, Ms. Monroe gave the students an exit ticket to complete before class was over. It is noteworthy that Ms.

Monroe's school provides a project-based learning (PBL) environment, and the classes I observed were not the norm. They normally spend a lot of time working on projects and hands-on activities with little direct instruction. Ms. Monroe thought it would be more helpful to me for her to do less projects and more direct instruction during the course of the observations.

Ms. Monroe appeared to be a strict time manager. After instruction, she gave her students frequent time checks when they started a new task. In addition, Ms. Monroe called on many students by name and asked them a lot of questions. To reduce distraction and for a daily bonus point, Ms. Monroe collected students' mobile phones at the beginning of class and re-distributed toward the end of class. Ms. Monroe had her students to do a progress chart as a means of self-assessment after every unit test. In so doing, students were tasked to reflect on their test performance, compare themselves to their classmates, provide rationale for their score, and give a plan for how they will prepare for the next unit test.

According to Ms. Monroe, her race was an issue at first due to the way she was raised. But as she gained more experience, Ms. Monroe became more comfortable at being around students of color and now has a special bond with her students. She is very active in her community, visits homes, and focuses on learning who her students are outside of the classroom. One instance when Ms. Monroe visited a student's home was to get materials before a community service event in which she had her students involved. Through sporadic home visits, Ms. Monroe has gotten to know parents really well. Another situation of home visits was for homebound instruction, where she would go to the students' home and bring them their assignments if they were on maternity leave or expelled from school. Upon her

visits, Ms. Monroe would build rapport with the student's family and help the students with their assignments as needed. In Ms. Monroe's opinion, students should be proactive and responsible for their learning; she wants her students to be prepared and organized, and has high expectations for all of her students.

Mr. McMillian

Mr. McMillian has a B.S. in Computer Science and a M.S. in Mathematics. He obtained his certification to teach high school after receiving his master's degree, and has been teaching high school mathematics for 23 years. Mr. McMillian met the study criteria as the Black master teacher. At the time of the study, Mr. McMillian taught Math 2 and 3 (Honors). I observed his 2nd block Math 3 (Honors), which contained a total of 21 students: 8 White, 7 Black, 5 Hispanic, and 1 Asian. When he was in grade school, Mr. McMillian was frequently the only Black student in many of his classes. He does not feel race plays a part in his teaching and that he has grown as a teacher through the years with his experience. Outside of previous test scores and pre-tests to learn the academic ability of students, Mr. McMillian does not use any strategies in class to learn about his students. However, similar to Mr. Pryor, he listens to conversations among students. As far as teacher education and professional development, Mr. McMillian does not feel that his education classes were beneficial to his learning how to teach diverse students and felt that they were a waste of his time. In addition, many of the workshops mandated from the county were not helpful to him either, because either the mathematics workshop facilitator did not show, or strategies were not age appropriate for high school mathematics classrooms. Mr. McMillian did not recall any workshop or training that helped with how to teach diverse students. However, his

current school, School C, had faculty meetings every Tuesday during the school year where a colleague facilitator taught them different pedagogical techniques that Mr. McMillian found very helpful.

Mr. McMillian's class was held in a two-door modular trailer on a community college campus. In his carpeted classroom decorated with motivational and mathematical concept posters, Mr. McMillian's students sat at tables in groups, similar to Ms. Monroe's, and his desk was in one of the back corners. Like Mr. Pryor, there was a table near the front that Mr. McMillian used as a work station with his laptop connected to his SmartBoard. On the opposite wall, there was a whiteboard that Mr. McMillian frequented with his students. When computers are needed, Mr. McMillian used laptops he kept locked away when they were not in use.

On a typical day, Mr. McMillian started the class with a warm up projected on the SmartBoard for students to complete. Either substituting or following the warm up was a multiple choice SAT/ACT word problem. After he took a volunteer or called on a student to work out the problem, Mr. McMillian reviewed the problem and began instruction which was from slides on the SmartBoard. Mr. McMillian transitioned between the SmartBoard and the white board for working out warm up and check point problems during instruction; however when a new concept was taught, the white board was primarily used for Mr. McMillian and his students to work out examples. The students were encouraged to explain their process while or after they have written their solution on either board. To instantly check for understanding as a class, Mr. McMillian sometimes had his students use small individual white boards where they displayed their solutions for each example problem they did in their

groups during instruction. Mr. McMillian asked to see the boards as a class, and each student held up their boards. If he saw a lot of different solutions, Mr. McMillian worked out the problem on the board or had a volunteer to do so. Mr. McMillian concluded class by asking his students to tell him one thing they learned that day. A few students raised their hands and provided facts about the day's lesson.

Mr. McMillian's methods were very traditional, similar to Mr. Pryor; however Mr. McMillian did not use a textbook. He walked around helping groups closely monitoring their work progress while giving them feedback and answered questions. Mr. McMillian's students have been strategically seated, and he strongly encouraged them to help each other. Like Mr. Pryor, it is Mr. McMillian's expectation that the students read through the online notes prior to class to avoid spending too much time in class doing something they could do on their own. Mr. McMillian would rather spend class time on more in-depth problems when students are in class.

Mr. Ferguson

Mr. Ferguson has a B.A. in Fine Arts, an M.A.T. in Mathematics, and has been teaching high school mathematics for three years. Mr. Ferguson met the study criteria as the Black novice teacher. He taught Math 1, Math 3, and Pre-calculus during the time of the study. I observed is 4th block Math 3, which has a total of 21 Students: 7 White, 8 Black, 2 Hispanic, 2 American Indian, and 2 Multi-Racial. As a self-proclaimed pro-Black individual, Mr. Ferguson mentioned many different experiences that he occasionally uses as attributes in the classroom that far exceed his years of teaching. Mr. Ferguson is the first Black man to teach at School C, which has been open since 2008. Mr. Ferguson talks to teachers and

people in the community to learn who his students are. Before teaching high school mathematics, Mr. Ferguson was a sixth grade substitute teacher. Through this experience, he learned the importance of communicating with parents. During his current teaching assignment, Mr. Ferguson and his colleagues were asked to read Jensen's (2009) *Keeping Poverty in Mind* on his own time as part of their sensitivity training. In addition, Mr. Ferguson recalled a class about preparing to teach culturally diverse students during his graduate coursework.

Frequently found greeting his students as they came into the classroom, Mr. Ferguson stood outside his modular trailer smiling, laughing, and speaking with students. Similar to Ms. Monroe and Mr. McMillian, Mr. Ferguson had students strategically seated at tables in groups according to their ability level. The students' warm up was projected onto the SmartBoard as they entered the classroom. Students were encouraged to quickly get started and work through their problems as a group. Like Mr. McMillian who is next door, Mr. Ferguson had the students to do a SAT/ACT problem before beginning the day's instruction. Mr. Ferguson randomly selected a number one to four from a large envelope. The chosen number corresponded with a student in each group that was required to offer a solution or explanation to a proposed question from the warm up and/or SAT/ACT problem(s). Students were active in Mr. Ferguson's class as they debated certain arguments, or defended their methods when asked to explain their process on the SmartBoard. No two classes were the same during the five-day observation period, but Mr. Ferguson made a point to give students food for thought about issues that affected the students directly within the lesson and sometimes in general. He made it a major point not to assign homework because his

philosophy was that if students actively work in class for 90 minutes on a daily basis, then homework was unnecessary.

Similar to Ms. Monroe, Mr. Ferguson mentioned the affordance of many PBL opportunities through which his students discovered mathematical concepts related to real life situations; some projects took place within the boundaries of the classroom, while others were school wide outside of class with other students on the same grade level. For the projects completed within class, Mr. Ferguson gave his students the freedom to choose their contexts when applicable. Mr. Ferguson believes in being a critical member of society and does not accept mediocrity as the norm from his students. By offering his perspectives on racially charged current and historical events, Mr. Ferguson is not afraid to talk about race in the classroom within mathematics and in general. Not only does Mr. Ferguson feel that it is important for all people to know about their culture, and he talks about all types of issues and current events with his class. He tries to set an example, get students and their families involved in the learning process, and gives students guidance on various topics.

Mr. Ferguson speaks monotonically. In addition, one may consider the way he speaks as non-Standard American English, particularly Black Vernacular English. For instance, his ‘th’ pronunciation in words like ‘month’ sounds like an ‘f’; so ‘month’ sounds like ‘monf’. Although his principal tells him he should cut his switch on an off, how he speaks at home versus work, Mr. Ferguson is unapologetic for the way he speaks and does not believe in speaking differently for particular audiences. ‘You get what you get,’ he said during his reflective interview.

Finally, Mr. Ferguson has been known to put a lot of energy into teaching, and does not accept excuses from his students. He feels that he is a positive Black male role model for his students and strives to excel at teaching every day. The section that follows will discuss the qualitative results for each research question, highlighting how each emergent theme noted in Chapter 3 relates to each study participant.

Qualitative Results

Qualitative results focus on the analysis of descriptive data of some phenomenon not easily measurable. Quotes from preliminary interviews set the tone for results from the observations. Therefore, I used quotes from the teachers' preliminary interviews in order to emphasize what was found during observations. Although teachers will be described separately on each major theme first, they will then be cross analyzed to reveal any similarities or differences in their beliefs pertaining to race and experience level.

Each research question has a major section to follow that describes each teacher's position within each theme. For each theme, the teachers will be presented in a parallel order: Pryor, Monroe, McMillian, and Ferguson. Below, I provide a description of how teachers integrate students' FoK into instruction, the first aim of this study.

Research Question One: FoK Incorporation

After reviewing the references from the interviews and connecting them to the observations, I found three emergent themes. While watching each teacher's classroom observations, I kept in mind the teaching strategies they revealed during the interviews. Many of the strategies mentioned during the interviews were not observed; I had to resort to

strictly using the observed teaching strategies rather than what the teachers discussed during their interview. The themes for this section (see Table 10) are essentially the teaching strategies that teachers used to incorporate their students' FoK from their students' self-reported surveys: Contextual Problems, Dialogue, and Discovery. Description of the themes can be found in Chapter 3. Within the descriptions below, I will discuss how each participant exhibited behaviors from each theme while using their responses to related interview questions to support claims.

Contextual problems. One observed method used by teachers to incorporate their students' FoK was through contextual problems. The four main activities where contextual problems were implemented during math lessons in the study were warm up, homework, classwork, and projects (see Table 10). I collected and analyzed artifacts used during class as part of each classroom observation. I did not observe projects in action; however two out of four teachers mentioned them during their interviews as their means of incorporating real life or relevant situations for students. Further, past projects were connected to present concepts. Below I discuss what teachers do to incorporate students' FoK as it relates to contextual problems.

Pryor. Mr. Pryor stressed the importance of problem solving as a prized skill to have for future employers. During his observations, Mr. Pryor afforded students many opportunities to solve contextual problems. First, he taught them concepts they needed to know in order to be successful at solving problems. He then solved a few problems during instruction. After going through the process a few times, Mr. Pryor called on random students or asked questions chorally for students for input to solve a problem. After repeating

a similar process with different contexts, he asked if they were ready to solve one on their own. Mr. Pryor circulated the room helping students along the way as needed. After some allotted time, they solved the problem as a class. For homework, students were assigned problems out of an online version of School A's previously assigned Algebra 2 text book. The syllabus for Mr. Pryor's Math 3 (Honors) class has all the homework laid out for the entire school year, mostly from the text book. He supplemented his instruction with worksheets and pre-written notes which he projected on the Smartboard. Typically after concepts were taught and contextual problems were solved, the following day's warm up had a similar problem for students to practice the previously learned concepts with different contexts.

Over the five-day observation period, there were a total of 28 contexts used by Mr. Pryor during classwork, homework, and warm up. Some observed situations within contextual problems that Mr. Pryor incorporated were car and calculator depreciation, home appreciation, exponential decay of the temperature of cooling coffee, exponential growth of a musical artist's fan club members, length of time for cleaning a house, seagull population, half-life, pH of food items, and compound interest. When these contexts were compared to student surveys FoK, approximately half were aligned where eight matches were from students of color. Most situations from the contextual problems did not relate to the out-of-school activities reported from the students. However, there were many interdisciplinary contextual problems afforded to them.

Monroe. To learn about her students, Ms. Monroe informed me that she had her students did a survey at the beginning of the year. In so doing, she got a list of different interests that she incorporated into contextual problems. She provided an example:

I will constantly throw them into word problems with something they like to do. So if Brooke's playing softball maybe we'll talk about how, do some type of word problems about system of equations. She hit this many, she struck this many people out, she walked this many people, and then the next game she did this.

Over the course of the semester, Ms. Monroe's class compiled a book of different word problems that they planned to send off for publication soon. From the surveys she gave her students, she knew that a particular student was very artistic. She asked him to draw the cover of the book, and to make contributions to any sort of art project going on locally. I observed students creating their own contextual problems after Ms. Monroe solved a few problems with her class. Ms. Monroe strategically assigned partners, and they collaborated to create contextual problems with the freedom to choose their own situations for the problems. Then they exchanged problems with others for peer critique and for them to solve the problems, which eventually would be contributions to their future publication.

While solving contextual problems, the typical strategy Ms. Monroe used was read aloud, where either she or an appointed student would read the problem aloud. She paused and asked them questions related to the language within the problem and what action to perform to solve the problem. Drawing pictures and asking what certain words or phrases meant before proceeding toward the solution were frequently observed strategies used while solving word problems. Some contexts that were used for word problems were a hedge with

a sculpture in the middle, painting a wall, and Burger King sandwich sales. For painting a wall, the length and width were linear binomial expressions for students to multiply together, find the quadratic area of the wall and door, then subtract the door's area to find the paintable portion of the wall. At one point, Ms. Monroe noticed that her students did not understand, so she drew a different rectangle on the wall that represented another hypothetical wall where she used concrete numbers for the area and shaded in the portion to represent the paintable area. By subtracting the numbers, students were able to properly set up the original problem with variables to find the painted area. During our reflective interview, we watched this video segment of her teaching this problem to the students. I asked Ms. Monroe about how this connected to relevant situations to her students' lives. Her reply:

One day they will have to paint a wall...and they'll have to go to Lowe's and decide 'how much paint do I need to buy because of the size of this wall?' Are they going to remember this particular lesson? Probably not. I mean I don't know. But at the same time I've heard a lot of them the older they get, after having math for so many years here, they say 'Oh well this is real-world.' They remember little things like this that they did. They probably won't remember this but a lot of the hands-on activities that people are writing down on their surveys they remember...This is an authentic situation that they could do. I wish I had a wall we could've actually painted it. Then I think it would help them understand the whole we gotta subtract these things better than not. But I improvised really quickly and did a really short okay let's just use numbers and see what we can do here. And Jackson said 'Oh you're going to subtract.' Right, so we're going to subtract polynomials too.

For the Burger King problem, students were given polynomials that represented how many Whoppers and chicken sandwiches were sold. Students were asked to find the total number of sandwiches sold by adding the polynomials together, and find the total sold after 28 days by substituting 28 in for the variable. It is noteworthy that School B is walking distance from a Burger King and many students go there after school to eat and socialize. Moreover, Burger King is one of few fast food restaurants in the county.

I compared all contexts used in class to those out-of-school activities indicated on the student surveys. There were eight total contexts observed for Ms. Monroe in the five-day observation period, where seven of the eight contexts matched to students' of color out of school activities. Although Ms. Monroe used fewer contexts than Mr. Pryor, a majority of her contexts matched with the out-of-school activities of students of color.

McMillian. As an attempt to make contextual problems relevant for students, Mr. McMillian used the names of his students or "ethnic names" in the problems: "I take a word problem and change it and put their name into the problem so it's something that is more realistic to them." I will expand on this notion in one of the third research question themes on addressing race in the classroom.

They would go over the problem together as a class with him or an appointed student. The appointed student was required to explain their thinking while at the board showing his or her work. There was minimal homework assigned, one of which included two contextual problems: a cake cooling exponentially and half-life Phosphorus 32. Other observed contexts were pH of food items and intensity levels of earthquakes. During class, Mr. McMillian used the Smartboard to display a slide show for students with contextual problems after reviewing

notes on a mathematical concept. There were a total of seven contexts over the observation period, where none of them aligned with the FoK of students of color. Similar to Mr. Pryor, Mr. McMillian used interdisciplinary contexts, but there was minimal to no connection made to students' of color FoK.

When teaching students about exponential logarithmic functions, Mr. McMillian solved a contextual problem on earthquakes. This particular problem generated some dialogue on an earthquake that occurred near School C a couple of years ago. The teacher also mentioned the movie *Ten*, but many students could not recall the movie. This was similar to how Mr. Pryor made a rather dated movie reference to the movie *Little Big League* in a contextual problem and none of his students knew what he was talking about. While discussing earthquake intensity, Mr. McMillian used an analogy. He stated that the difference between a low and a high intensity level earthquake could be thought of as throwing a small pebble across a pond versus a tsunami heading toward them. When teaching geometric sequence and series, Mr. McMillian provided an external context to the problem about a king in hopes to give an application. All in all, the contexts discussed during class had either minimal to no connection to students' lives.

Ferguson. The observed contexts in Mr. Ferguson's class were during warm up and classwork. In particular, these contexts were baseball, car depreciation, and compounded interest problems. During an interview Mr. Ferguson provided examples of some of his typical strategies when making problems and projects relevant for his students:

Oh, I change problems around and make it relatable. I'll talk about issues like diabetes any kind of medical issues that are big in our...population. We had a project

where we were talking about rates and I had them create an exercise plan. I showed them how to calculate blood pressure, then I brought a blood pressure machine in because I have high blood pressure. I let everybody learn how to take their blood pressure on the machine so they can see where they are for their age. Some of these kids have high blood pressure and they're not even teenagers yet. I just think the overall way that I speak to them is relatable. That's just pretty much how I teach the class. I mean, I don't feel like I do anything special. I do a lot of hands-on activities because I know I'm not the most exciting person when I talk...

None of the projects were observed, however, Mr. Ferguson gave examples of projects where he made problems relevant for students. Many contexts used in class were not observed, but came from an investigation students conducted with logarithmic functions and their inverses. Mr. Ferguson and some of his students recalled projects during class, one being the birthday project on quadratic functions. He likes to include culture in their projects and allowed students to bring in their own culture and background. On a parabola project, he challenged his students to research parabolas around the world:

We had people in Japan and England and all over the country. 'Cause the first thing they wanna go find a picture of a rollercoaster from [local amusement parks]. I was like you got the whole world at the click of a button and you wanna go somewhere in [state name]? So I just banned [state name] from the research...And that forced them. Like one girl went to Mexico, and we found some pretty cool stuff that I don't even think they knew about...One guy did one in Russia...it's pretty neat. 'Cause every year I see different stuff. There was one, it was an underwater aquarium. The top of

the building was a curve but then you can actually go under the water, so you were like the fish in the tank. And the fish were looking at you. So it's like a glass room and you're in there (Laughter). It's an aquarium but you're actually in the ocean and you just see the fish swimming around you.

Mr. Ferguson incorporated other ideas about home life into his contextual problems and used them as talking points to learn student study habits, for instance. He saved these conversations for when he talked to the parents to let them know how their child felt and to develop a strategy to help him or her be successful.

Mr. Ferguson and an English teacher at School C collaborated to develop a project which revolved around *A Raisin in the Sun*, a play based upon a Black family's experience in the 1950's that debuted on Broadway in 1959 described later. The students in his class read the book in their English class. Mr. Ferguson altered the story line to include one of the characters getting a small business loan, and all students were assigned different roles to portray the different points of view within the book. Although this project took place during a different class block, Mr. Ferguson talked about this project during his interview and hopes to extend this project to his other classes. There are also school wide projects where students were divided by grade level and given a community problem or crisis. Mr. Ferguson and the rest of the math department were responsible in creating this crisis:

So our crisis is we're going to evacuate a community in [city name], which is an impoverished community. The bulk of the city has been evacuated but these people have no form of transportation. And it's just to help them understand that the concept

of teamwork; how people have to come together to help versus ‘Oh, we’ll just leave ‘em there to die.’ It’s sort of like Hurricane Katrina...

Out of a total of 17 contexts used in Mr. Ferguson’s class, 12 of them related to students of color. Therefore, a majority of his contexts made a connection with students’ of color out-of-school activities.

The next theme describes how teachers incorporated students’ FoK was classroom dialogue.

Dialogue. Another observed method used by teachers to incorporate their students’ FoK was through instructional and non-instructional dialogue. In particular, storytelling, the use of analogies, and general inquiry were observed from teachers in the study. Some teachers had conversations during class related to real life scenarios or student interests, some instructional and non-instructional in nature. Below I report observed teacher behaviors that incorporated students’ FoK related to the dialogue theme.

Pryor. A few years prior to the study, School A adopted a program where the teachers asked individual students the question “Tell me something good.” The students are expected to give a brief statement about whatever was on their mind. Mr. Pryor used this as insight on their hobbies, interests, sports, and other activities they like to do outside of school. Mr. Pryor eavesdropped on student conversations to understand more about their lives, and sometimes applied this information in class:

So knowing what they have an interest in, I can sometimes tie it into a specific example in class. And I try to do that with everybody so that no one feels left out. It’s

not possible for everything but kids love it when you tie something directly personal to them.

During an observation, Mr. Pryor checked homework from his students while walking around the room. He asked one student how his baseball game went. They had a brief conversation about the highlights of the game in passing. Mr. Pryor inquired, “Did you play? Did y’all win?” There was another brief dialogue between Mr. Pryor and a different student. He wished her luck on her upcoming track meet. Later during the observation, Mr. Pryor taught the class compound interest formulas where A_0 represented the initial amount. He directly asked the same student on the track team about this notation: “What does A_0 mean? Clair, I know you run track. When you start, what does the clock say?”

Mr. Pryor also told a brief story about his experience with buying a house to explain how interest rates work with his students after a contextual problem on house appreciation. This story transitioned into a class discussion involving students and their questions about why cars depreciate while houses and land appreciate, as well as a television show a student connected to compounded interest. Mr. Pryor spontaneously mathematized the scenario for the class in order to make sense of the situation.

At times, students may have sidebar conversations with Mr. Pryor about random ideas that are irrelevant to the lesson. For instance, during instruction, one male student told Mr. Pryor about how he rode his motorcycle during the past weekend. It is noteworthy that Mr. Pryor rode his motorcycle to work on a daily basis. Although they have a common interest, there was no connection to the lesson made at this time. Further, the student had bad timing with sharing this information and it seemed that he was trying to derail the lesson or be a

distraction. However, Mr. Pryor acknowledged what the student said and may use this informal knowledge at a later time.

An instance of instructional dialogue Mr. Pryor used was a pizza analogy when describing the difference between small and large denominators, and what that means for identical numerators: “If you had a pizza and had to divide into 1000 pieces, would you get much?” In sum, Mr. Pryor used formal and informal dialogue in the form of storytelling, conversations, and analogies in order to connect with his students, both directly and indirectly linking to the mathematics.

Monroe. While teaching, some topics discussed in Ms. Monroe’s class engendered student ideas not related to mathematics. For instance, Ms. Monroe argued that although the conversations are not directly linked to mathematics, the students might need advice to help them with future goals or personal lives:

I tend to get off topic a lot when I teach talking about their personal lives...Like today for instance, we’re doing exponential growth and decay problems and there was a ...question about exponential...the squirrel problem. How [name of state] has a lot of squirrels. So I went off on this topic about when I was in college. I went to [name of university]. We had so many squirrels, they were getting in the dorm rooms. Then I took about five minutes to say somebody said, ‘Oh, well I really want to go to [name of university]. What can I do to get there?’ Little tangents like that. Granted, it’s not technically related to the instruction, but I take the instruction to get there and still get to know about them, and kind of guide them where they need to go.

I did not observe any behavior relating to such tangents, but Ms. Monroe recalled this occurrence during our interview. She was involved in her students' personal lives beyond the classroom by visiting homes and went to student events outside of school hours. Conversely, her students also came to some of her events: "Some of these kids showed up at my wedding a couple years ago at my hometown..." Through the dialogue between Ms. Monroe and her students, there is a mutual exchange and trust between them and their families, and they know she cares about them.

McMillian. During class, students in Mr. McMillian's class were expected to work in ability groups, where they were grouped according to ability level. He strategically placed the students in groups, seating them in a mixture of high, medium, and low performing with the intention of the high and medium performers helping the low performers. Students were asked to discuss problems and asking questions in their group while he circulated from group to group making sure the conversations are on task and productive. After an allotted amount of time, Mr. McMillian would call on a volunteer to come to the board, where the student was asked to explain their process. It was very important that the students seated would listen and ask questions of the students speaking, and that the student who has the floor modeled appropriate mathematical language. Mr. McMillian would ask him or her questions and made sure they stated the rule or mathematical law that was involved in a particular solution as the student explained their work on the whiteboard. Although Mr. McMillian tended to language by having students explain themselves and their work, their dialogue, instructional or otherwise, did not focus on their funds of knowledge or cultural resources.

Ferguson. Between classes, Mr. Ferguson had conversations with his current students as they entered his classroom. In addition, he also interacted with his former students during class changes. Before introducing a new concept, Mr. Ferguson gave his students some food for thought about decibels, how intensity levels are measured, and statistics on hearing loss in teenagers. After he appointed a student to read a passage aloud, Mr. Ferguson asked his students how many of them have a particularly popular brand of headphones or headphones in general. The food for thought was about the popular brand of headphones causing deafness because of their intensity level. This dialogue transitioned into other topics such as wearing ear protection because of other loud noises in careers, particularly a police officer. He asked if any of them ever heard a gunshot, and many of them have. Some heard gunshots in their neighborhoods, and others have been hunting before. On the other end, they discussed the threshold of hearing and they learned that this would be like a cat purring. Some students revealed that they loved cats; one student in Mr. Ferguson's class reported cats as one of her interests on the student survey I gave them prior to the study.

Concerning instructional dialogue, I observed Mr. Ferguson using two analogies during class. For the first instance, Mr. Ferguson recalled the term *asymptote*. He analogously compared a graph's asymptote to crossing over into the next county. He explained that they do not see a line but they know there is a boundary there. For the second instance, Mr. Ferguson had students learning about circle theorems. Similar to Mr. Pryor, Mr. Ferguson used pizza as his other analogy. He explained the term overlapping angles to a student by telling her that if she imagined the angle like a slice of pizza and any slice smaller than a given slice would be included in the same slice. This same lesson included debates on

circles where students had to convince their classmates of why a given theorem they just discovered was true. Generally, Mr. Ferguson gave his students several opportunities to make sense of problems during the observation period. In sum, Mr. Ferguson used instructional and non-instructional dialogue such as debates, analogies, and food for thought to teach his mathematics lessons with meaningful connections.

Mr. McMillian's idea of making a problem relevant to students was doing a name transplant within the problem. In contrast, Ms. Monroe and Mr. Ferguson intentionally used authentic contexts from their students' lives to make problems relatable.

Discovery. The final observed method used by most teachers to incorporate their students' FoK was through discovery. This theme refers to moments during class where teachers allowed students to think aloud on an idea or do some out-of-class research on a mathematical concept. I excluded Mr. Pryor and Mr. McMillian from this section of the analysis because there was no supporting evidence observed for this theme. Below I describe how each teacher incorporated discovery into their math lessons.

Monroe. Ms. Monroe used students' FoK through mathematics vocabulary and the utilization of relevant items in her students' lives. For instance, when discussing polynomials, Ms. Monroe introduced the terms monomial, binomial, and trinomial to her students. Instead of directly teaching the terms and their definitions, she asked the class for any words they could think of with the same prefixes. Once students brainstormed and gave responses aloud, Ms. Monroe quickly defined the given words in hopes that students associated familiar words with unknown ones through common prefixes. When recalling this incident during the reflective interview, Ms. Monroe argued:

it makes some connections. It helps them make connections to helping know what it means because they know what part of that word means in another word or something... Taking words and picking apart their parts, like snippets of the words and what those mean specifically.

She also used the Spanish word *nombre* (Spanish for ‘name’) and linked it with the meaning of *nomial* as in binomial. Most students at School B have to take Spanish and many in her observed class have taken or were currently taking Spanish. In addition, there was one Spanish speaking student in the class.

Another instance of brainstorming was when Ms. Monroe was working on a contextual problem that involved a cylinder. She asked about what cylinders they could think of in real life. She later had them to create their own word problems where some included cylinders. By allowing her students to think of words and shapes for a meaningful connection, Ms. Monroe was able to use discovery as a way to incorporate what students know to something she was trying to teach them.

Ferguson. After Mr. Ferguson’s lesson on logarithms, he let students work in groups on an investigative activity where they analyzed the relationship between log functions and their inverses. Students had to answer reasoning questions and find the intensity of selected sounds, many of which were common sounds students have heard, according to what was reported on many of the student surveys. Through this activity, students were able to not only find the intensity of sounds that some of them hear every day; they were also able to compare and contrast these sounds to determine which were safe without ear protection. Another incident of brainstorming was when students were asked to answer the question “What is a

circle?” This question was displayed on the Smartboard and volunteers came up to write their responses. This brainstorming session generated discussion about the importance of the circle before they were taught several circle theorems. When answering the question, some students put items up that were shaped like a circle.

In the next section, I report the qualitative findings for the second research question related to the association of experience to teachers’ incorporation of FoK.

Research Question Two: Role of Experience

The second research question is “Does the experience of high school mathematics teachers play a role in incorporating students’ FoK? If so, in what ways?” As stated earlier, experience does not merely mean the years of teaching experience like the selection criteria for the study, but also experiences like workshops, classes, seminars, and training. Experience may also be non-teaching experience, something the teacher experienced outside of the context of the classroom that helped shape them into the teachers they are. Three primary types of experience emerged from the original coding as being relevant to the teachers’ classroom implementation in terms of addressing diversity and/or students’ FoK: Non-teaching Experience, Teaching Experience, and Teacher Education. These themes were developed from the codes for the preliminary interviews.

Non-teaching experience. From within the teacher experiences codes were four subcodes: teaching experience, non-teaching experiences and beliefs, role model, and no excuses (see Table 10). The non-teaching experience sub-code emerged as a primary theme here because it addressed each teacher’s experiences such as their hobbies, interests, or previous jobs that have in turn helped them in the classroom. These experiences may also

include events in their lives that may have impacted their teaching behavior in a diverse setting. Below I will address the non-teaching experiences of each teacher in the study as they relate to the first research question.

Pryor. Alongside formal learning experiences are other experiences that Mr. Pryor brings into the classroom that he could potentially share with his students. Mr. Pryor has hobbies and interests that he has incorporated into the classroom: “Yes...we do archery, any type of shooting I’m into.” He never explained who he included in “we.” However he mentioned during the preliminary interview that a student in his class was also into archery. Further, Mr. Pryor has shareable real life experiences like buying cars and houses that he can implement in teaching mathematics.

Monroe. Similar to her students, Ms. Monroe grew up in a rural area. She shared this with them as a means of making a connection with them. After being in the county of School B for a few years, Ms. Monroe realized that their situation is slightly different than hers was growing up:

The longer I’ve been in this county, even though my county considered rural and low income, it is not what I’ve experienced here. Over the past couple of years, I’ve gotten to realize that I was a lot more privileged growing up than I realized.

Upon realization of the differences between her and her students, Ms. Monroe became involved in the community to learn more about them and their hardships. This experience has helped her understand what some of her students endure when they leave school:

...I still have high expectations but I understand that this child has no home life and is literally living from car to car and that they might've not done their homework last night because they were too busy worrying about if they had a place to sleep.

Through the discovery of the abundance of homeless students that attend School B, Ms.

Monroe found that some of her students are the "sole breadwinners" for their families:

We've had a lot of homeless kids actually. Literally just bumming rides and a place to sleep every night...they are working all night long. I had one kid who was a prison guard or did something at the prison and he worked all night long. Came in...he was constantly falling asleep because he was staying up all night because that's how his family was paying the bills. Now I understand that more.

Through these experiences, Ms. Monroe has an understanding that she did not have before.

She shows empathy by assigning little to no homework, and giving them extra time to turn it in due to difficult circumstances and other obligations. Also, she treats students equitably that are struggling to pay bills for their home and maintain their household by working at night.

The traditional way that Ms. Monroe learned math in school (i.e., taking notes and doing problems) was how she thought she was supposed to teach. Being involved in her community helped her create a learning environment that was more engaging, hands-on, and project-based for her students. Further, these experiences have helped her gain trust and respect with her students, because she confronts community issues in the classroom. In turn, students learn the necessary skills for survival beyond their present situation. Ms. Monroe argued:

I think my experience...has helped me not necessarily to incorporate word problems or anything like that that talks about these problems but to get to know them on a

level where they trust me and respect me enough to learn what they need to learn to pass the test, to pass the class, to graduate to move on with their life and become successful.

McMillian. During the interview, Mr. McMillian did not reveal any non-teaching experiences that he has used to teach diverse students, but he did make a general statement about being able to incorporate experiences. When Mr. McMillian talked about experiences in class, it was only an extension of how they possibly could use a taught concept, but there was rarely any application. Unlike Ms. Monroe, there was no connection to how Mr. McMillian and his students were raised; however he states that his understanding stems from what he has seen over the years:

So I do understand; I did see it but I didn't live that type of life. A lot of these kids are actually living that life. Now as an adult I've been around it a lot and most of my life but growing up, no. As far as teaching, in some ways I can relate to the kids because of other things I've seen kids do throughout the years. So yes I can relate to that.

Although Mr. McMillian stated that he can relate, he explicitly mentioned that he did not live "that type of life," referring to the dysfunction that he has seen his students go through and talk about with him.

Ferguson. Mr. Ferguson shared some of his experiences that occurred before he began his teaching career. These experiences, shared below, are those from his upbringing at home and in school. Like, Ms. Monroe, he began from when he was in high school:

I mean parents, drinking, smoking, smoking weed as a teenager, having sex with girls while I was in high school. Kind of being anti-social; I wasn't interested in going to

the prom or anything like that. Being in fights. Just being in different violent environments.

He felt that being able to recall these experiences helped him with his students and their social issues. Similar to Mr. Pryor, Mr. Ferguson tries to expose his students to other real life issues through his instruction: “buying a house...managing money from a regular job, planning your life out, and ... bills after college...” Like Ms. Monroe, Mr. Ferguson tries to get the community and parents involved to help the students be successful in his class. For instance, Mr. Ferguson encourages parents to come out to the parent teacher conferences and forms relationships so that they build an alliance to help the student achieve the goal of passing his class. Before teaching high school mathematics, Mr. Ferguson took a non-linear path toward his current teaching assignment. He imparts this knowledge when appropriate through his mathematics lessons for students:

I’ve taken so many different courses in life. When I went to college, I started out majoring in biology, then I switched to accounting, then I switched to art. Then I started cooking. I graduated from college, I started cooking; I did that for about 4 years. Then I joined the Army; did that for about 4 years. Then I went and tried to get an MBA. A year into that then I switched over to education. I have all these experiences that I didn't understand why I was doing them at the time but now I can share those with these kids, and if I didn't share them it would be a waste of experience.

Mr. Ferguson has encountered different situations and people through all of his experiences. These exposures have made him more tolerant and aware of issues in life. He mentioned that

he has encountered racists and homosexuals while working in restaurants and being in the military. Two major takeaways that Mr. Ferguson applies from the military were the importance of knowing your soldiers and being part of the solution without complaint:

If your leadership fusses at you, if you want to be the type of person that just trickles it on down and just fusses at everybody else and then they go blaming on somebody else; you can do that. Or you can be the type of person that they made you aware of what the problem is so when it comes down to you, you fix it down low versus just complaining about it. That's the biggest thing I take from the military. I take that everywhere.

“Everywhere” includes the classroom, as Mr. Ferguson mentioned that the administration and county have requirements for him to achieve during the school year. In sum, Mr. Ferguson’s non-teaching experiences have made him knowledgeable in many areas to be able to incorporate into his teaching and be able to answer questions for students. Further, his experiences have prepared him to deal with leadership and to know his students well.

The section above discusses non-teaching experiences that the teachers in the study have that potentially shaped the way they teach their students. Mr. Pryor’s hobbies and interests are aspects he can relate to with his students; however none of his students in the observed class indicated an interest in archery on their surveys, for instance. He has discussed buying houses and cars with a mathematics lesson, and in turn shared how it related to his experiences. Mr. McMillian has talked about life experiences indirectly within the lesson with application. Mr. McMillian was only able to relate to his students as far as what he has seen with other students in previous years but not through experiences. In

contrast, Ms. Monroe and Mr. Ferguson were able to relate to their students because of their similar backgrounds. Further, Mr. Ferguson has had many experiences to draw on to benefit his students. Through his plethora of previous jobs and college courses, he is able to better equip students for their forthcoming experiences, talk about numerous topics, and show them how math is used in different situations to make it more relevant for his students.

Teaching experience. The following theme addresses experiences the teachers in the study have had or learned from within the classroom and how these experiences have impacted their teaching over the years. The years of experience stated for each teacher was at the time of the study.

Pryor. In his 25th year of teaching high school, Mr. Pryor has taught in two rural counties his entire career. He has been at his current school for 20 years, and believes his experience plays a role in how he teaches his students. Mr. Pryor stated, “I know what students are gonna do right, I know what they’re gonna do wrong. I know what kind of questions they’re gonna have.” In sum, he affirmed that his experience positively helps students “translate their prior knowledge into what is actually happening.”

Monroe. Ms. Monroe was in her fourth year of teaching at her original placement school. Although she credited other experiences, Ms. Monroe’s teaching experience has played the biggest role in helping her teach diverse students: “It has helped me the most.” Unique from the other teachers in the study, Ms. Monroe was a part of the Teach for America (TFA) program. In the very beginning, Ms. Monroe claimed that she did not know how to act in a diverse environment. As a White individual, she was never in the minority position until she began teaching in the TFA program, and then at her current placement school, both

having a high population of minorities. The teaching experiences are what Ms. Monroe cherishes the most as far as helping her have meaningful interactions with her diverse students.

McMillian. Mr. McMillian has been teaching mathematics in several counties for a total of 23 years. Similar to Mr. Pryor and Ms. Monroe, Mr. McMillian acclaimed his experience to helped him teach diverse students. However, his response revolved more around economic diversity rather than cultural or racial diversity. Teaching has been a learning experience for Mr. McMillian; he realized how much he did not know as the years of experience began to accumulate:

The more I started teaching the more I realized I didn't know. As I started experiencing more I was able to bring things in more into the classroom to show the kids how to relate to different areas of their life.

According to Mr. McMillian, teachers gain more experience, finely tune their craft, and develop different teaching strategies. Through these adjustments come a higher quality and more knowledgeable teacher, which is similar to Mr. Pryor's thinking. Mr. McMillian also discussed the association of experience and confidence. He claimed that his students observe his level of confidence to judge whether they will be able to, say, solve a problem:

Experience breeds confidence in a lot of situations. So as long as you have an air of confidence in what you're doing, the kids are okay. The second you get confused or you get lost they go into 'I can't do it. If you can't do it, why would you expect me to do it?'

Ferguson. In his third year of teaching at School C, Mr. Ferguson mentioned experience as the factor that guides how he teaches a given lesson. However, unlike the other teachers in the study, Mr. Ferguson used a baking metaphor to discuss how lessons may vary depending on who is teaching it. When asked if experience played a role in how he teaches diverse students, Mr. Ferguson answered:

I think so because everyone's experience guides the direction of their lesson. I could go on a little database and pull lessons for days, but when I give that lesson, I'm going to put my twist on it and add my spices to it. It's like baking a cake or baking a ham; somebody can give you the meat and the ingredients, but you still gonna put your own twist on it. There's no way around it; it has to happen like that. That's why you did it and not someone else.

He also stated that knowing his students helped with making a lesson more suitable for them, instead of implementing it in its original form. Mr. Ferguson believes that experience plays a role in how he teaches in a diverse environment, particularly in the way a lesson is taught. Like all the other teachers in the study, Mr. Ferguson noted the importance of making necessary changes to improve math lessons for students from year to year.

The teachers in the study have varying views about the impact of their experience with teaching diverse students while using their FoK. Mr. Pryor saw his experience as a predictor for what students will do from year to year. Also, Mr. Pryor does not adequately address how this helped diverse students. Mr. McMillian and Mr. Pryor, both master teachers, possess the same philosophy: a teacher's experience yields a higher quality and more knowledgeable teacher. Just as Mr. Ferguson credits his non-teaching experiences to helping students relate

math to their lives, Mr. McMillian contrarily believes that his experience in the classroom has helped him do so, similar to Ms. Monroe's thinking. In sum, all teachers in the study have expressed that their experience does play a role in how they teach mathematics to diverse students, relating their FoK into the instruction. It is not clear whether more years are better because where the novice teachers lack in teaching experience, they make up in life experience and getting involved with the community.

Teacher education. Beyond each teacher's experience inside and outside of the classroom they have had to shape their teaching philosophies, the Teacher Education theme describes education opportunities that teachers revealed that have helped them teach diverse students to include but not be limited to college courses, professional development, conferences, and workshops. In some cases, teachers shared how the education experiences were helpful or not with teaching diverse students.

Pryor. Mr. Pryor has a B.S. in Mathematics Education. In the 20 years Mr. Pryor has taught in his current school system, he only recalled a maximum of four workshops related to culture. He noted what he took away from the trainings:

We have had trainings in this system based at cultural differences. It sounds like I didn't pay attention (Laughs) based on my previous answers but what I took away from that was to try to teach them all where they are. Meet them where they are and do the best I can.

We have had workshops about, I mean not many just but how...cultural differences...

As an extension, I asked Mr. Pryor whether any of these cultural trainings were content specific: "It wasn't linked to math. No, it was just 'Here, these are the cultures. These are the make-up of your community. These are your school..." There was no other professional

development that Mr. Pryor mentioned that helped prepare him to teach in a diverse environment.

Monroe. Ms. Monroe has a B.S. in Psychology. In her last year of undergraduate studies, Ms. Monroe was recruited for the Teach For America (TFA) program. She described her summer teaching assignment and how TFA supports teaching in diverse environments. Although associates of TFA are advocates for closing the education gap between minority students and their White counterparts, Ms. Monroe did not feel prepared after her TFA training:

Teach for America did not prepare me at all. You're in the program for two years teaching at your placement school. The second year you're in the program, you take classes at [university name] to get your teaching licensure. I took two classes. I made a 100 in both classes. I don't feel like I'm a better teacher because of those classes, but now I have my teaching license.

She goes on to express that TFA helped her improve her interactions with different races, but not teaching mathematics. Also, the mentor assigned to Ms. Monroe in her first two years was not very helpful due to his lack of experience; he only taught for two years before becoming a TFA mentor. There have been other learning experiences for Ms. Monroe that she credited for helping her teach diverse students. Ms. Monroe talked about diversity in learning styles, and how project-based trainings and teacher observations have helped her in doing so:

As far as learning styles go, probably the [name of PBL trainings] that have helped us with the PBL. But a lot of it is literally just what have I observed other teachers doing

that I really like and I think that might work in my room. But let me change it a little bit. What have I heard other teachers at different schools? This school? I can get advice from somebody who's four years my younger and that might work in my classroom. A different subject might work.

Note that Ms. Monroe teaches at a PBL school. Consequently, the county sends her and her colleagues to an annual conference to learn teaching strategies that are suitable for their PBL environment:

They send us to the [name of annual conference] every summer. It's a national conference. The county sends the new teachers to that so they can learn PBL, how to do projects. Math, it's really hard to do projects in, so they teach us how to do something called problems, which are like small mini projects. That's been very very helpful once I learned that.

The PBL trainings seemed to provide Ms. Monroe with the appropriate tools and skillset needed for teaching in this type of environment. In contrast, professional development in general for the county has not been as helpful: "To be honest, professional development seems to go in one ear and out the other. They just tell it to you and then they expect you to take all these resources you just learned and go implement it." Further, Ms. Monroe does not find that professional development is applicable to what she teaches. She argued, "When we would go to professional development for this county, a lot of it was just how can you teach this content and just like hammer it in." Similar to Mr. Pryor, Ms. Monroe discussed different learning styles that she must cater to in the classroom. She wants to be able to go to a training to learn strategies on how to appropriately accommodate these learning styles in her

classroom. The ultimate learning experience for Ms. Monroe is through teaching her students every day.

McMillian. Mr. McMillian has a B.S. in Computer Science and a M.S. in Mathematics. When he went back to school for his master's degree, Mr. McMillian got his teaching certification in mathematics education. Mr. McMillian was a substitute teacher before becoming a math teacher. After his student teaching, Mr. McMillian finished up his cooperating teacher's class when she fell sick. I asked Mr. McMillian about his education experiences while being a teacher and whether any of them helped him with teaching math in a diverse environment. He mentioned a workshop that was not grade level appropriate and the facilitators were not helpful with explaining how it would apply to high school math. Mr. McMillian categorized most professional development opportunities offered through the county as "a waste of time," and he rarely comes across a meaningful workshop:

Every now and a again I'll get a good workshop when I get something out of it. But most of the workshops I got, there's not because I go to workshops and they'll say 'Now this works great in math! It's excellent. I can't do it but I'm told it works.' Then you're wasting my time.' And I've had too many of those workshops, 'Well the math person they're not here today.' Then why are you here? It's frustrating especially in math when everybody wants to say 'It works great in this field; it works great in your field.' 'But you're not showing me anything.' Telling me doesn't help. Telling me how good...I know math works with scientists and I know it will get me to the moon, but if don't tell me how to use it, it's useless.

Mr. McMillian recalled the education courses taken while getting his teaching certification. Like the workshops, he did not find much usefulness in them. He highlighted an instance of something learned from one professor:

I'll be honest, my certification, those education classes didn't teach me a thing...The ones at [university name] didn't help me one bit. I did take one at [university name] and they were teaching stuff like 'the way you need to teach your kids is this. If you make a classroom rule; you punish yourself in front of the kids. (Laughs) You should raise your child the same way. If you tell your kid they can't have any snacks or anything after 10 o'clock, if a child walks in and see you at 10 o'clock with a snack, you need to punish yourself for that.' I'm like, not in my house. That's the kind of education I was getting at [university name]. I was like that's a waste of my time.

On the other hand, Mr. McMillian did get more out of workshops, namely those at the National Council of Teachers of Mathematics (NCTM) conferences: "I got more out of some of the workshops that I signed up for like NCTM. I'll go to some of the conferences. I might get something out of that." Another helpful experience that Mr. McMillian mentioned was during the faculty meetings at School C, at which time there are lessons on different teaching strategies. He described one that has helped him develop student grouping strategies: "The last one we had Mrs. Lengel actually teaches different types of grouping techniques. She actually teaches different techniques that can help the kids, different ways to group...the grouping with her has helped a whole lot." Prior to this training on grouping strategies, Mr. McMillian avoided cooperative learning activities with students because either students were distracted by their peers or one student would do the work. At the time of the study, Mr.

McMillian's class was in ability groups where each group had different abilities from low to high with the intention of the high achievers helping the lower students.

When I asked Mr. McMillian about any training on how to teach mathematics in diverse environments, Mr. McMillian was uncertain that any were offered because he has never seen any. In particular, Mr. McMillian talked about teaching students with a language barrier and not having any training on making accommodations for these students: "Most of them haven't been useful to me and as far as the language barrier; I never had any that did anything like that."

Ferguson. Like Mr. McMillian, Mr. Ferguson substituted before teaching high school mathematics. In particular, Mr. Ferguson substituted sixth grade math which gave him the educational experience to get parents involved. Mr. Ferguson has a B.S. in Fine Arts and a M.A.T in Mathematics. As far as his school providing training on diversity, administration requested the teachers at School C to read a book on poverty: "The only thing I ever recall is having us read this book called *Keeping Poverty in Mind*. I refused to read it. I mean there's all different levels of poverty but what you gonna tell me in that book?" Mr. Ferguson was very critical toward the contents of this book because of his upbringing and knowledge of poverty outside of the US: "They were talking about teaching with poverty in mind, but if you've never left America, you don't even know what poverty is."

Mr. Ferguson recalled a graduate course he took while obtaining his M.A.T. degree on preparing to teach culturally diverse students. For this course, Mr. Ferguson had to do a field experience and compare and contrast a student from a different culture to himself. Although this was a requirement for graduation and a learning experience, Mr. Ferguson never

explicitly stated whether the course was helpful in teaching diverse students. I asked him about any similar training provided by the school system and he emphatically stated, “No, I know for a fact they haven’t sent me to any.” His answer consistent with Mr. McMillian makes sense because as they teach at the same school. Like Ms. Monroe, Mr. Ferguson believes that experience is the best teacher, as he learned the most about teaching by figuring out what to do through hands-on experience.

In summary teacher education is one of the main experiences which shape a teacher and what he or she knows. I would argue that teacher education is the formal knowledge base for their practice. The courses, professional development, conferences, and workshops experienced by teachers have the affordance to improve their practice or keep it the same. Three out of four teachers in the study attended the same NCTM conference during the study; one of them presented some research on robotics. For the sake of confidentiality, I will not provide specifics. None of the teachers reported any workshops during this conference or any other conference related to teaching mathematics to diverse students. Mr. Pryor recalled a few over the last 20 years of being in his school district, while the others recalled none. Mr. Ferguson did take a graduate course during his M.A.T. program on cultural differences. Mr. Ferguson and Mr. McMillian’s school district encouraged them to read a book on poverty, in hopes to shed some light on economic diversity.

Ms. Monroe has held her TFA program experiences dear with helping her hone her teaching skills. She also has attended PBL workshops every year that helps her effectively implemented projects into her lesson. By being involved with the community, like Mr. Ferguson, she is able to learn more about her students to incorporate their FoK into her

lessons. As far as workshops for school district, majority of the teachers spoke negatively on them, stating that they were a “waste of time,” “in one ear and out the other,” or just non-applicable. The teachers also do not get a say in what they need as far as professional development and are mandated to attend whichever ones the district sees fit. Collectively, the three themes (i.e., Non-Teaching Experience, Teaching Experience, and Teacher Education) explain the experiences of a teacher and provide ways that experience plays a role in how they incorporate diverse students’ FoK. Similarly, the section that follows discussed how race plays a role in this incorporation.

Research Question Three: Role of Race

The third research question for the study is “Does the race of high school mathematics teachers play a role in incorporating students’ FoK? If so, in what ways?” To qualitatively answer the third research question on the role of race, I present these three major themes: Personal Experiences with Race and Racism, The Role of Race in Teaching and Learning, and Addressing Race in the Classroom.

Personal experiences with race and racism. The sections that follow within this major theme highlight personal experiences that each teacher participant has had with race and racism. This background information sheds light on how they conceptualize race toward answering the research question of whether he or she considers race as a factor when incorporating diverse students’ FoK.

Pryor. Through the years, Mr. Pryor has made mistakes by unintentionally using offensive language. Later after discovering the offensive nature of his comments, he chooses his words differently. “Yes, there’s been learning experiences for me through the years where

I've stepped on somebody's toes culturally or racially and it causes me to learn what I can say what I can't say." I probed Mr. Pryor for more details about these experiences, but he could not recall any further information. One may assume Mr. Pryor was either not comfortable with talking about his personal experience with race or racism, or genuinely could not remember to provide further detail. As far as his students, Mr. Pryor prevents and, if needed, corrects inappropriate behavior from his students to correct other students when they offend their peers deliberately or otherwise. By educating his students, Mr. Pryor is able to help them understand and appreciate other cultures. There was an incident that Mr. Pryor recalled during his class where a student spoke out against something derogatory that was said about her Asian culture. After the student confronted her peer, Mr. Pryor asked if there was anything else that they, him included, should know so that they may become more educated on her culture and not be offensive. I will discuss the specific incident in a later section on addressing race in the classroom.

Monroe. Growing up in a very rural area similar to her students, Ms. Monroe revealed some sensitive facts about race and racism. When asked how her race plays a role with FoK incorporation of diverse students, she emphasized her racist upbringing: "I was brought up very, very, very, very racist to be honest..." Ms. Monroe was very transparent during the interview, and told me that she is the same way with her students. When she was in high school, her family did not want her making friends with Black people: "When I would meet somebody in high school, my grandparents'd say, 'Well, are they Black?' Not 'Are they White?' Just they could not be Black." Not only did her family not want Ms. Monroe associated with Black people growing up, they also did not want her teaching them.

Her family questioned her motive, and disapproved of her teaching assignment: "...[M]y family is just, you know, 'Well, what are you doing there? That's not where you need to be.'"

Ms. Monroe discussed a pivotal point concerning her students, her grandparents, and race. Due to her experiences and interactions like college and her teaching placements at predominantly Black schools, Ms. Monroe's views on race and racism began to alter from those of her family. Ms. Monroe does not hold the beliefs from her upbringing: "I have come to love each and every single one of my kids no matter what their color is. Some of these kids showed up at my wedding a couple years ago at my hometown..." Because most of Ms. Monroe's students are Black, she was reluctant to have her grandparents visit her classroom. "How are they going to treat these kids?" she asked herself before their visit. Surprisingly, Ms. Monroe found that her grandparents and her students interacted well and race was not an issue for any of them. She believes that they have changed her grandparents' viewpoints.

McMillian. Mr. McMillian shared what he heard growing up about race and compared his generation to that of his students. According to Mr. McMillian, he observes more economic bias among his students than that pertaining to race:

[T]hey don't see color as much as my generation did. Growing up, I used to always hear people talking about Black this, White this, Indian this or something like that. You don't hear that much from the kids nowadays as far as really honing in on the prejudices because of color. A lot of prejudices now come from things other than color with these kids. More finances than actual than race-based.

Mr. McMillian grew up in a military family that did a lot of moving around, and he found himself surrounded by predominantly White classmates until he got to high school.

Noticeably different from his fellow classmates of color, Mr. McMillian did not think the other Black males were presenting themselves appropriately: “By the time I got there, I was so different from the people I was around, it was like ‘Why are they acting so stupid?’” In particular, Mr. McMillian witnessed unfamiliar fashion trends (i.e., clothes and haircuts) and behaviors (i.e. walking and talking) of his Black male peers. He experienced culture shock that he did not know could happen within the same race; he did not know that other Black people could be so different from himself or others he knew.

Ferguson. Mr. Ferguson was raised in Virginia, and felt that his upbringing may have been different from his students. However, he uses his innate knowledge about being a minority to help his minority students. Out of all the teachers in the study, Mr. Ferguson provided the most information about his personal experiences with race and racism. Openly admitting to being pro-Black and sometimes labeled as a racist, Mr. Ferguson would often digress with storytelling, many dealing with racial issues. He shared scenarios about his life as well as occurrences during teaching. Within many of the stories, Mr. Ferguson critiqued history and the treatment of Blacks:

I just recently went to Savannah and went to a civil rights museum. I knew some things from Black voting rights, but I didn't know that they used to keep a jar of marbles and they would ask you. There would be colorful marbles in there and they would ask you ‘How many red marbles do you see?’ And no matter what number you gave ‘em you were wrong. And they keep a bar of soap in there, and they ask you ‘If you lather

yourself up with this bar, how many bubbles will it make?’ Who’s gonna answer that correctly? Who was gonna count the bubbles to see if it was correct? But those are the kinds of things they do to Black people just to keep us from moving forward.

On top of sharing facts on Black history, I discovered that Mr. Ferguson has had his share of experiencing racial slurs during his military career and life in general: “I’ve been called a nigger before, a jigaboo, all that stuff...” In addition, he was a witness to other people of color receiving similar treatment:

[L]ast year on the last day of school, a White boy called a Black girl...a ‘nigger B’...The first year that I worked in this county, I heard a girl call another woman a ‘colored woman.’ I was like people don’t talk like that where I’m from. I mean, I know of it but I never heard anyone call a Black person colored before. That one just messed me up a little bit.

I have discussed each teacher’s experience with race and racism as revealed during their individual preliminary interviews. Next I will discuss the role of race in teaching and learning for each teacher.

The role of race in teaching and learning. The theme of the role of race in teaching and learning discusses the teachers’ perspectives on how their race contributes, hinders, or does not influence their ability to incorporate diverse students’ FoK. The interview responses from this theme and the next will essentially answer the third research question.

Pryor. When discussing the role of race, Mr. Pryor began talking about how he views students upon first meeting them before discussing how his race played a role in teaching and learning: “I try to go into the class and seeing everybody as just gray. Everybody’s the

same...I try to treat them all the same.” His response was highly reminiscent of literature on dysconscious racism that education researchers continue to discuss (Ladson-Billings, 1994). He admitted to not being very knowledgeable about different races. Without having the same experiences as a particular race, Mr. Pryor thought that understanding a different race outside of his own was virtually impossible:

Oh yes! As an old White man, it’s kind of hard for me to understand a 15-year old Black female. I got a better chance at understanding him than a 15-year old Black female, but that’s hard. That’s hard for me. Same thing for all the other cultures. If you’re not me or I’m not you, I can’t...‘I haven’t walked a mile in your shoes,’ to use that quote.

Although Mr. Pryor’s responses indicated difficulty with him as a White male understanding other races, he was fairly neutral in his response on whether his race was a significant factor in teaching diverse students: “I don’t know that my race being White has helped me or hurt me in anything as far as mathematics instruction.” In sum, Mr. Pryor does not feel that his race plays a role in teaching mathematics to diverse students.

Monroe. Similar to her aforementioned personal experiences, Ms. Monroe discussed the pivotal moments in her teaching where she felt her race was once upon a time a hindering factor. She in turn understood what it felt like to be a minority and empathized with her students:

When I started I felt so out of place because I’ve never been put in the shoes of being a minority in front of people. I think that experience helped me understand what other people who are different than somebody else feels based on gender, race, religion,

whatever. And that has helped me I think become a better teacher and understand my kids better.

Ms. Monroe mentioned being colorblind in the classroom but this is different from Mr. Pryor's "gray" vision; Ms. Monroe talked about and addressed race in the classroom. Her thinking seems to be more about setting race aside to learn together, regardless of race:

I think I'm very blind when it comes to that but I mean that positively. It doesn't matter... I don't think that, I don't know if race necessarily... Your color does not matter; I'm going to help you just like I'm going to help anybody else.

In the beginning of her teaching career, Ms. Monroe thought she had to act a certain way in her newly found diverse environment and was afraid of offending her students by saying or doing the wrong thing: "I think race probably hindered me maybe my first year but now I don't think it has an impact at all. It hindered me because I was unfamiliar with other cultures especially in this community and being a minority." Ms. Monroe has become comfortable with her students to where she visits their homes. She feels that she speaks to all of her students the same despite her earlier reluctance, and there are no barriers in the way she treats one race of students over another. When talking about her change in beliefs since her first year of teaching, Ms. Monroe wanted her interactions with her students to be different than how she was brought up. Her passion and sincerity were evident when she began to cry while talking about her belief change:

I think it may have affected the way I taught my first year because I was so new to this diverse environment but I think throwing me into that pot quickly made me realize that 'Girlfriend, you were brought up not in the way that I would want to be

brought up now.' I don't know. I don't think it doesn't affect me. I've completely changed to the point where I love everybody...the exact same (tears up) and you're gonna make me cry.

Similar to Mr. Pryor, Ms. Monroe discussed not having the same experiences as her students of color, and how this fact does not help her incorporate their FoK. However, she does not feel that this has been an issue in her classroom. In sum, although Ms. Monroe felt that race was an issue her first year of teaching, she does not feel that it is any more.

McMillian. When I asked Mr. McMillian whether his race played a role in teaching mathematics, he talked about his race in terms of being a role model. He offered his perspective as well as the contradicting argument of what other people believe:

To be honest, I don't think my race plays a part at all. A lot of people say 'You're a Black role model so the kids will look up to you.' I have just as many White kids looking up to me as I do any other race, Black, Indian race or any other race.

Mr. McMillian revealed that since he has all races of students that look up to him, he does not feel like a Black role model and it has more to do with personality. He also stated his belief that teaching math has nothing to do with race: "I don't feel that color has anything to do with math." He later explained that race cannot be used as an excuse for not being able to do something and how students should work through their deficiencies. Mr. McMillian did not do well in mathematics at an early age because his family moved around so much and he had gaps in his math knowledge. He empathetically tells his students that story and how they should be able to overcome any academic deficiency by applying themselves. He does not let

them use race as an excuse. In sum, Mr. McMillian does not feel that race plays a role in teaching and learning mathematics.

Ferguson. As the first Black man to teach at School C, Mr. Ferguson felt like he was being closely watched by administration. His thinking was they were waiting on a reason to reprimand him or to see him perform poorly, but his resilient attitude helped him overcome adversity:

Everything I did for the first couple years here, I felt like I was under a microscope and people were always criticizing me and everybody wanted to see me fail. I think the biggest part my race had to deal with it was I had a point to prove, because people wanna see me fail and I don't have time for that.

Mr. Ferguson continues to feel watched closely by administration, as he is more innovative in his teaching strategies than other teachers at his school. He does not fit the norm and stands out pedagogically, which makes him a target for criticism. Mr. Ferguson realized that Black people do not prosper in the school's community and he tries to create rigorous lessons that are exciting and fun for students to keep them engaged to ultimately pass and graduate. He claimed that the school system pushes Black students through to avoid dealing with them. Like Mr. McMillian, Mr. Ferguson does not allow his students of color, to make excuses for themselves. He challenges them and does not accept mediocrity as their personal standard:

Black people don't really thrive in these areas. We already know there's going to be a struggle from the start and that people just push us through because they don't feel like dealing with us. I just have patience...this is what I do every day. It's a process

but I don't give up on them. And they cry and complain and wine but they're used to someone accepting those excuses and not pushing them.

In sum, Mr. Ferguson feels like his race plays a role in teaching and learning mathematics in a diverse environment. Looking across all teachers, Mr. Ferguson was the only one who felt that his race played a role in the way he teaches diverse students while using their FoK. Ms. Monroe felt that her race played a role once upon a time but does no longer. The master teachers, Mr. Pryor and Mr. McMillian felt that race had nothing to do with their teaching. However, Mr. Pryor did mention how difficult it was to empathize with his students of color, particularly, Black females. Next I will discuss how the teachers addressed race in the classroom.

Addressing race in the classroom. There were some mentions of addressing races in terms of diffusing offensive behavior from students and as part of instruction or projects. When a teacher did not have any instruction or projects to discuss, I asked for a hypothetical scenario for a way that he or she may address race in the classroom.

Pryor. When I first asked Mr. Pryor about how he addressed race in the classroom, he recalled one specific and one general scenario of a student getting offended, and his response to it. Mr. Pryor tries to prevent or diffuse offensive behavior, while also striving for cultural understanding when opportunities arise. For his specific example, he mentioned his Asian student:

I know that the Asian is very sensitive about her culture. I can't think of a specific example. I know that she has voiced her opinion several times throughout the

semester when another student has said something possibly derogatory about her Asian culture...probably not meaning to. They just don't know.

Mr. Pryor allowed the Asian student to stand up for herself and took the opportunity to learn about her culture. He asked her if there was anything else that they should know in order to prevent any offensive behavior from happening. He generalized how he addresses offensive behavior from students:

If it comes up, oh yea, I'll deal with it. I'll talk to them about what I know to the best of my ability.... If I see another student maybe can help me prevent them, help them understand what this other cultures about and maybe not offend. Or maybe celebrate something that they do.

Further, Mr. Pryor mentioned that his Honors students do not culturally or racially offend others as much as his other classes. He felt it may have more to do with their exposure to and understanding of different cultures.

After Mr. Pryor's discussion on addressing offensive behavior in the classroom related to race, I redirected the question by asking him how he would incorporate race within a mathematics lesson. He replied, "I would not touch that with a ten-foot pole, personally. I would never try to incorporate race into mathematics instruction." I asked Mr. Pryor for a reason why he felt this way:

I think for me that would just be a landmine of problems...Fear of offending people and fear of retribution legally through whatever channels might happen. Probably nothing would happen but it's possible. All you have to do is have one parent with

one phone call to the right person and your career is either over or you're not going to be happy. That's probably why I'd never instigate it initially.

Since Mr. Pryor never incorporated race into mathematics instruction, I asked him to give me a hypothetical scenario of how he thought it would look. He found great difficulty in doing so and asked for an example. I shared some examples from literature (i.e., racism in mortgage rates and fast food in high poverty neighborhoods). He thought aloud about what a mortgage rate lesson would look like:

I like that, it's very mathematical. There are numerous tools on the internet that would give you property values. We could have a project. Find one wealthy area of town. I guess you would say the White neighborhood. Find several houses, list their square footages, find out what the property value is worth, and then do the same thing in a poor neighborhood, maybe a Black or Hispanic. Find the same size dwelling. Find out what is its property value and from there mathematically there's not a whole lot more you could really do with that. I think socially, you could talk about that for months. But mathematically, I don't know that there's a whole lot more you could do other than compare them and I don't know what to do beyond that.

After thinking through the example I gave him, he came up with two on his own: analyzing prison and college populations. For prison populations, he discussed how collecting data on race and doing some basic statistics would be the extent of the project. For college populations, he discussed tuition, race distribution, and whether these would impact who attends. After reflecting on his ideas and what he actually does with his students, Mr. Pryor acknowledged the difficulty with incorporating race in the classroom: "That's really

hard for me, I don't do that. I don't use...it's hard for me to incorporate your race into, bring that into [the] classroom.”

Further in his reflection, Mr. Pryor has given these projects some thought to potentially try in the future: “You're making me think about these things now. I like this...No, I never really thought about that.” In sum, Mr. Pryor discussed addressing race as it relates to offending others. Moreover, he has avoided addressing race for fear of offending others and backlash from parents and administration. In opposition of his belief on addressing race, he gave some thought to the idea of incorporating race into mathematics instruction.

Monroe. A teacher mentor at School B disseminates articles to their teachers addressing race, and Ms. Monroe shares them with her students. Although some articles may address a particular race, Ms. Monroe feels that it is important to discuss them with all students and not just the targeted race:

One of our Teach for America mentors sends us articles on race a lot because it always seems like there still is this educational gap, right? And we'll talk about that in the classroom. How is this going to affect your future? But I don't think it affects the way I teach because I could have an entire class of, you know, we have a large Native American population. I'm going to teach them the same way that I would teach the others and I'm going to bring up the same issues. So if there's a race issue that's going on, I feel like everybody deserves to know about this issue, not just the people it affects...

Other than discussing articles with her students, I asked Ms. Monroe how she addressed race in her mathematics lesson. She described a project she did with her statistics class examining failure rates in schools based on races, predominant races in the schools, and their impact on the failure rates: “You might be the cream of the crop here, but you go somewhere else, you’re just back down just because who are you comparing yourself to here. I don’t know. It really opens their eyes.” Ultimately, Ms. Monroe noted that the students are in school to learn mathematics, not to be disrespectful to others different from themselves. In sum, Ms. Monroe addresses race by having discussions with her students revolving around literature and projects in the classroom. She is very honest and open with her students and has created a safe learning environment for students to share their experiences and discuss topics related to race.

McMillian. When I first questioned Mr. McMillian about addressing race in the classroom, he argued that math has no color: “In math usually I don’t address race because I mean math doesn’t have any color to it whatsoever. Math is universal. There is no race barrier in math to me.” He transitioned his argument to talk about addressing offensive behavior, like majority of Mr. Pryor’s discussion on race: “The only time I usually address race is when someone is being...someone supposed to be picking at someone else because of race or sex or anything like that.” After his response concerning offensive behavior, I asked him how he addressed race in his mathematics lessons. He described his attempt at making word problems relevant to his students by including names of his students, considered a “superficial attempt” (Aguirre et al. 2012b, p. 180):

Actually I do that now. A lot of times when I try to do math problems, I used to use basic names like John, Susan, whatever. Now I use names from different races whether they're Asian names, ethnic Black names. I try to pick names that the groups that I'm teaching see something that they can relate to. A lot of times I actually use the names of the kids in my class. I take a word problem and change it and put their name into the problem so it's something that is more realistic to them.

I asked Mr. McMillian if we could extend our discussion beyond transplanting names and address race in the mathematics that he teaches. I provided him the same examples as Mr. Pryor, racism in mortgage rates and the abundance of fast food restaurants in high poverty neighborhoods, and I also gave him the example of getting a loan from a bank and interest rates. Like Mr. Pryor, Mr. McMillian never thought about including race into these types of problems:

I never looked at it as telling the kids about the race aspect... Now that I can see because a lot of times even though they shouldn't do it, based on your race where you're living a lot of times that will determine, and I never thought about saying this to the kids, but that can determine what type of loan you're going to get, whether it's high interest or low interest. I know it's supposed to be based on your credit score but always that might not be necessarily true. But at the same time because of your economic status that could also ruin your credit where you're at too and that itself can change what your loan or interest or whatever else you're gonna get. So I never looked at it as telling the kids about the race aspect but what I do tell the children is what you do now [affects] what you do in the future, especially when...they get older.

Mr. McMillian addressed race in the classroom when offensive behavior occurs among students, and superficially in contextual problems. He thought he was including race in mathematics by including more “ethnic names,” rather than John or Sue, for instance. Like Mr. Pryor, he has now given some thought to how race could be addressed in more meaningful ways.

Ferguson. Because Mr. Ferguson is passionate about his race and culture, he does background research to look for ways to incorporate these topics into his mathematics lessons through projects. He models this for his students and gives them freedom to bring their background into their projects. Similar to Ms. Monroe, Mr. Ferguson discusses racially motivated issues in class and feels that all of his students need to know, not just the race under discussion:

I feel awkward sometimes when I bring issues out and it’s like a handful of White kids in the class. But they need to know just as much as the Black kids need to know. And they’ll try to tune me out, but this message is for everybody.

Mr. Ferguson confronts inappropriate behavior as it relates to race. He recalled an incident in class where a girl talked about wanting to sing Negro spirituals. He asked her if she knew the reason why slaves sung those songs and she replied no. He continued to educate her on the reason for Negro spirituals as an attempt to keep these types of comments at bay:

I should have just ignored her comment. But I can’t; I’m too sensitive to that stuff. So any time anything comes up about race or someone says something about Black people, I’m correcting it, and I’m hitting them with facts. And I try to sneak stuff in my lessons here and there.

The consequence for outwardly using offensive slurs in Mr. Ferguson's class is to read the

Willie Lynch Letter:

Some of the kids were getting sick from reading that letter when it was talking about tarring a man up and putting feathers on him and setting him on fire and tying him to a horse and ripping him in half. But I'll tell 'em, 'Y'all need to know about this stuff. It ain't no secret.' It burns me up just to read about it but I feel better knowing that people are aware. I plan on hitting these things, like you said racism in mortgage rates and things like that.

One particular project where Mr. Ferguson addressed race in the classroom was his *Raisin in the Sun* project. He did assigned students a cross-curricular project with one of the English teachers at his school since the students read the book in their English class. In addition, students watched the play in class to make the story come to life for them. Through a math lesson that addressed issues that Black people faced in the 1950s, Mr. Ferguson stated that he wanted to "hit every little piece of racism" that he could touch, unlike Mr. Pryor who "would not touch it with a ten-foot pole."

For the *Raisin in the Sun* project, every student in the class was a character in the book: Walter (Mama's son), Ruth (Walter's wife), Bennie (Walter's sister), Mama (Bennie and Walter's mother). The mathematics comes in with the investment of the \$10,000 insurance check that Mama gets upon the death of her husband. Walter wanted to invest it in a liquor store, but Mama wanted to help Bennie with her college tuition and buy a house. Mr. Ferguson altered the story a little bit to include Walter going to the bank to get a small

business loan. In the process, Walter gets denied by several banks and eventually gets approved with an extremely high interest rate.

Prior to the *Raisin in the Sun* project, Mr. Ferguson's class did an activity to describe where they will be in 10 years. He linked this activity with the project; students were denied what they wanted to do from the activity according to their character in the book:

But when I take them back to these characters, every time they want to do something I'm going to deny them because everybody's going to become Black. And there going to have to deal with that stuff. I'm just going to try to run away with it and see how it goes. Hopefully it'll open some eyes.

In sum, Mr. Ferguson wants his students to be critically conscious of race issues currently and historically. Aside discussions on historical events, Mr. Ferguson also addressed current racial issues concerning events around Mike Brown, the Ferguson riots, and Loretta Lynch. He meaningfully mathematizes issues in order to raise awareness while showing students that mathematics is not situational in the classroom. As it relates to race, Mr. Ferguson stated that if he can turn an issue into a math problem, he will.

All of the teachers discussed correcting offensive behavior in the classroom. My novice teachers, Mr. Ferguson and Ms. Monroe, mentioned how they incorporated race into their math instruction, while my master teachers, Mr. Pryor and Mr. McMillian, had difficulty doing so. As a testament to how different two teachers are in particular, Mr. Ferguson recently collaborated and developed a highly racial project based on the play *Raisin in the Sun*. He has expressed a desire to mathematize more racial issues as they arise, currently or historically. On the other hand, Mr. Pryor had no desire to discuss race in the

classroom. He avoided race in order to keep peace with parents and administration, and to evade from offending others. However, with some probing, Mr. Pryor was able to come up with a hypothetical scenario for how he could address race in his classroom. Further, Mr. Pryor and Mr. McMillian gave the idea of including race in mathematics some thought for future implementation. Ms. Monroe talked about race in casual conversation with her students related to academic performance in journal articles and real school data.

The qualitative section of the findings for the study described the themes for each research question as they related to the participants. Interview responses were used to supplement what was observed as appropriate. For the first research question, Contextual Problems, Dialogue, and Discovery were methods that teachers used to incorporate their students' FoK. The primary data source to answer research question one was the observations. For research question two, I discussed Teaching and Non-Teaching Experience and Teacher Education in order to answer whether teachers believed their experience played a role in how they incorporate FoK. Lastly, for research question three, the major themes were Personal Experiences with Race and Racism, The Role of Race in Teaching and Learning, and Addressing Race in the Classroom. The primary sources for the data to answer these latter research questions were the individual preliminary interviews. The next section will quantitatively report what was found in the study for each research question.

Quantitative Results

Descriptive Statistics

Previously I qualitatively described how teachers incorporate students' FoK, and how teacher experience and race play roles in how they do so in math instruction. This section includes the quantitative report related to each of the three research questions. I provide some descriptive statistics and statistical analysis using the data sources from the study where appropriate.

One of the criteria for the study was for the participants to have an ethnically diverse classroom. The following graphs in Figures 5 through 8 illustrate the race distribution of each teacher's class in the study. I also referred to a chart of this data earlier in the Methods chapter.

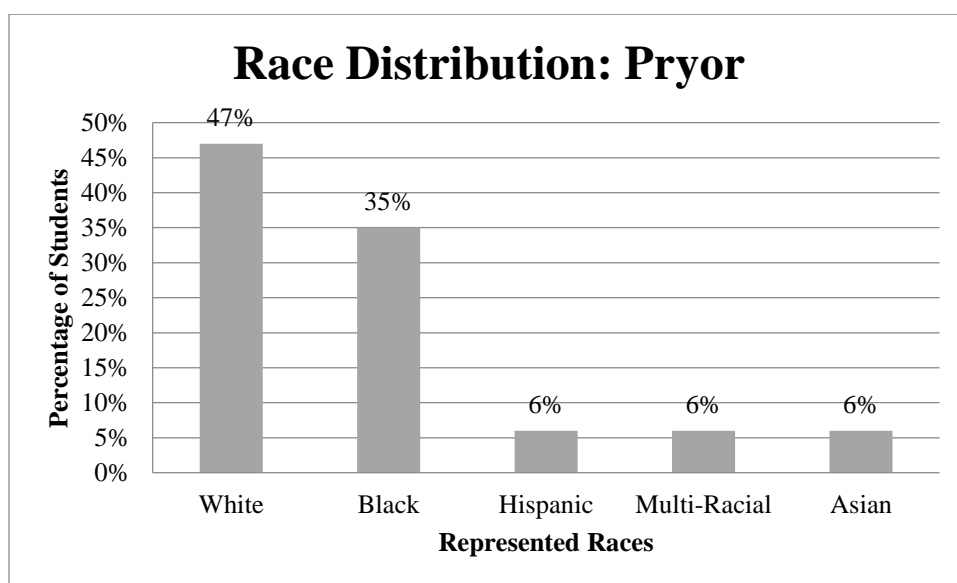


Figure 5: Race Distribution of Pryor's Class

Almost half of the students in Mr. Pryor's class were White and over one-third was Black. The Hispanic, Multi-Racial, and Asian student percentages are six percent each. There were no American Indian students or students in the Other race category, with a very small percentage at School A.

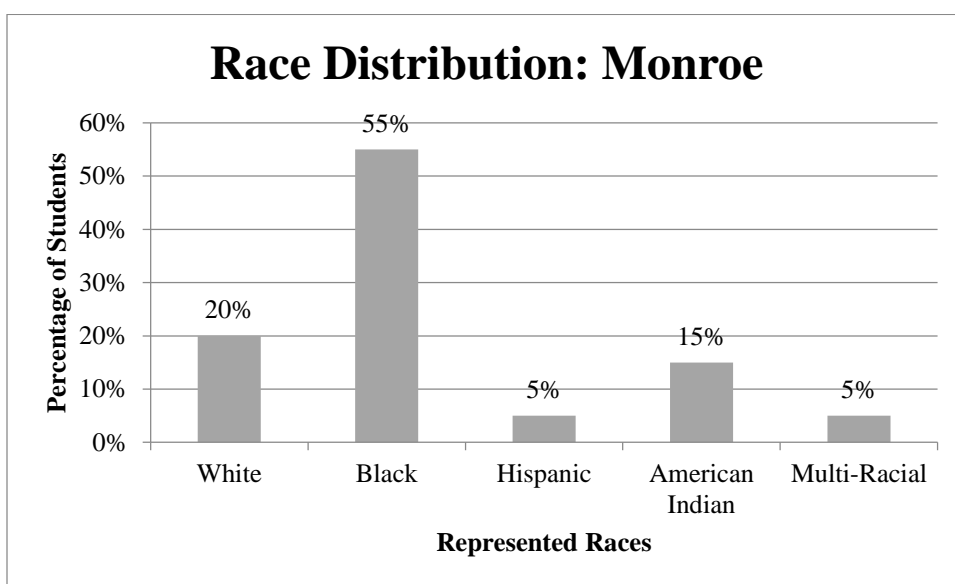


Figure 6: Race Distribution of Monroe's Class

Over half of the students in Ms. Monroe's class were Black and 20% were White. This class had the leading amount of American Indians over all classes at 15%. Only five percent of the class was Hispanic and Multi-Racial, the smallest percentages of all classes for these race categories. There were no Asian students represented in Ms. Monroe's class.

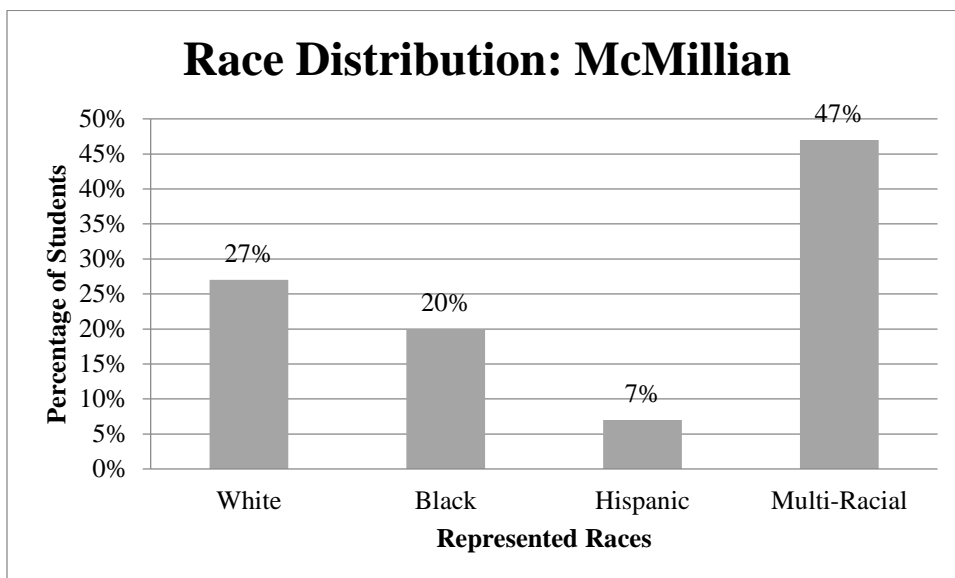


Figure 7: Race Distribution of McMillian's Class

The students in Mr. McMillian's class were less than 30% White and 20% Black. His class had the largest percentage of Multi-Racial students at 47%. Mr. McMillian had the least number of represented races in his class for the study with no Asian or American Indian students.

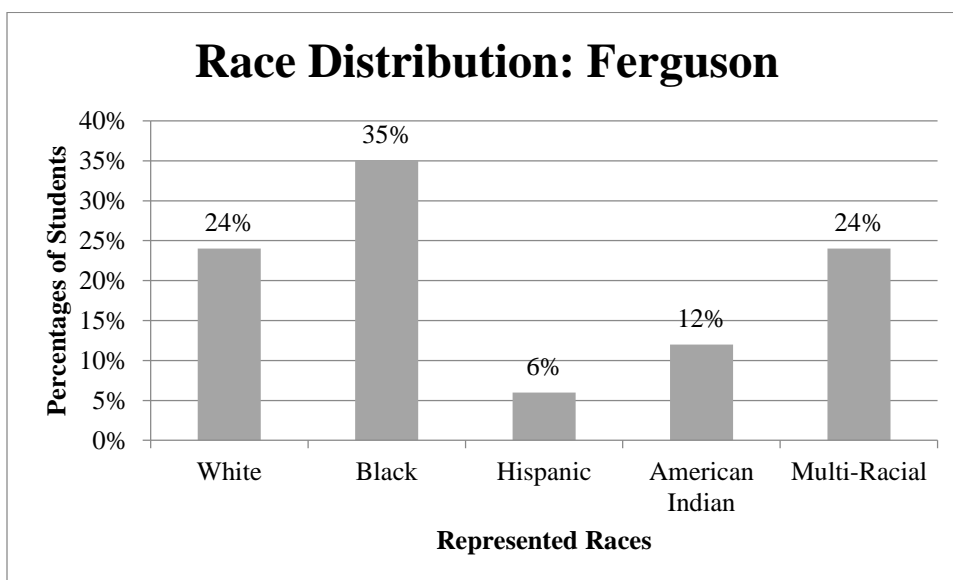


Figure 8: Race Distribution of Ferguson's Class

Over one-third of the students in Mr. Ferguson's class were Black, and over 20% was White. With over 10% of the class American Indian and 24% Multi-Racial, Mr. Ferguson did not have any Asians in his observed class. There was seven percent American Indian and nine percent Multi-Racial representation within School C at the time of the study.

All races were not represented in all classes. Those not represented were in each class were not surprising; there were less than 10% of all unrepresented races at each school at the time of the study. Note that the Multi-Racial category includes students of two or more races, and some races that did not appear to be represented. In Figures 5 through 8, comparisons were made among teacher participants on their race distributions across observed classes. Mr. Pryor had the greatest amount of White students totaling 47%, where as Ms. Monroe had the least at 20%. Ms. Monroe had 35% more Black students than Mr. McMillian. Each class only had one Hispanic student. Mr. Pryor and Mr. McMillian did not have any American Indian

students in their classes. Although minimal at six percent, Mr. Pryor's class was the only one with Asian representation in the study. Although all teachers have White, Black, Hispanic, and Multi-Racial represented in their classes, each of them have no representation of either American Indian or Asian students.

Further exploration of the data on the participants includes tabulations of each class's gender, grade, and collective race distributions. From Table 12, one can observe that approximately one-third of Mr. Pryor's class was male. Ms. Monroe and Mr. McMillian's classes are fairly even with males and females, while Mr. Ferguson's class only had two males.

Table 62
Gender Distribution by Teacher

Class	Number of Males (%)	Number of Females (%)
Pryor	6 (35%)	11 (65%)
Monroe	9 (45%)	11 (55%)
McMillian	8 (53%)	7 (47%)
Ferguson	2 (12%)	15 (88%)

Note that Mr. Pryor and Mr. McMillian's observed classes were both Math 3 Honors; Mr. Ferguson had Math 3 and Ms. Monroe had Math 2. Each class contained at least two grade levels of students ranging from ninth to twelfth. Table 13 illustrates the frequency distribution and percentages of students per grade level in each observed class. A majority of Mr. McMillian and Mr. Ferguson's classes were 9th grade, while Mr. Pryor had no 9th graders. All teachers had students in the 10th grade, which made up majority of Mr. Pryor and

Ms. Monroe's classes. Ms. Monroe was the only teacher who had all grades represented, and the only teacher who had a senior (see Table 13).

Table 13
Grade Level Distribution by Teacher

Class	9 th Graders	10 th Graders	11 th Graders	12 th Graders
Pryor	0 (0%)	9 (53%)	8 (47%)	0 (0%)
Monroe	2 (10%)	15 (75%)	2 (10%)	1 (5%)
McMillian	12 (80%)	3 (20%)	0 (0%)	0 (0%)
Ferguson	11 (65%)	6 (35%)	0 (0%)	0 (0%)

Student Survey Results

The students in each class were surveyed on general demographics (i.e., gender, race, fluent languages spoken, and grade level) and more specific questions about how their math teacher helped them, the frequency of real world problems given in class, their FoK (i.e., out of school activities, chores, and interests), and whether their teacher used their FoK to help them learn mathematics. Note that in this study, out-of-school activities and fluent languages spoken are major components of FoK; these items are being collected from students to form a baseline of FoK from each class. Because I am investigating how teachers are incorporating diverse students' FoK, the FoKs reported by the students were aggregated by race for each observed class. Even though the surveys do not specifically answer the research questions, the results significantly relate to the teachers use of FoK in the classrooms.

Tables 14 through 17 represent the self-reported FoK by the major categories that were on the student survey for students: sports, church, clubs, interests, and chores. For

instance, say we are looking at the Sports by Race in Table 14. If a student indicated that he or she played sports on the survey, they were instructed to check the box next to sports and list specifically the sports they play (see Appendix I: Student Survey). I have only included the most popular three (four in case of a tie) types of each FoK. Some categories were themed based on similarity. For instance, ‘music’ may include listening to music, play an instrument or writing song lyrics. I have listed the three most prominent themes and one for ‘miscellaneous’ for unique categories that did not fit with the others. The miscellaneous categories are for those FoK that only involved one or two people in that class. As a result, race was only attached to the popular FoK themes mentioned and not to particular topics within each miscellaneous category. The quantities in each cell represent the number of students of a particular race from a teacher’s class that indicated he or she was involved with or had an interest in a particular activity. Let us take the White row and the swim column in Table 14 for Mr. Pryor’s Class. The swim column can be found under the major theme of Sports. The number two represents the two White students in Mr. Pryor’s class who stated that they were either on the swim team or enjoyed swimming on their survey. Reading across the entire White row, there was a total of 69 responses (far right column), which represents the grand total of all interests from the White students in Mr. Pryor’s Class. The row at the bottom of Table 14 gives the total of students of all races who indicated that they had that interest. For instance, there are three in the swim column, so there were three students (two White and one Asian) in Mr. Pryor’s class that enjoyed swimming or were on the school’s swim team. All other tables of FoK follow a similar format (see Tables 15 through 17).

Table 74
 Funds of Knowledge by Race for Mr. Pryor’s Class

Race	Sports					Interests			Church		Clubs			Chores				Total		
	Band/Cheer/ Dance/Color	Soccer	Track	Swim	Misc.	Fine Arts	Hunting/ Fishing	Misc.	Attends	Activities	Pep Squad	Student Council	NHS/Key Club	Misc.	Kitchen	Bedroom	Bathroom/ Laundry		Pet Care	Misc.
White	4	2	1	2	2	4	4	7	4	4	4	4	4	5	8	4	2	3	1	69
Black	1	1	2	0	5	5	1	3	3	1	2	1	1	0	5	1	2	2	5	41
Hispanic	2	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	4	7
Asian	0	0	0	1	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	2
Total	7	3	3	3	7	10	5	10	7	8	6	5	5	6	13	5	4	5	10	

The marching band, cheerleading, dance, and color guard were compiled into the Sports FoK theme for Mr. Pryor's class. With a three-way tie, the most popular sports were soccer, track, and swimming. Miscellaneous sports include golf, softball, basketball, football, and wrestling. Within the Interests theme, fine arts include art, painting, dance, poetry, music, and writing. Miscellaneous interests were hanging with friends, lifting weights, math tutoring, and computers. For Church, many students either listed the name of their church, their religious denomination, or what activities they are specifically involved in at the church. The activities included youth group and choir. Consequently, I either categorized these listings as attends or activities. For Clubs, I combined Key Club and National Honor Society. Miscellaneous clubs for Mr. Pryor's class were the Fellowship of Christian Athletes, anime club, sportsmen club, and environmental club. Kitchen chores included dishes, cooking, and taking out the trash. Miscellaneous chores include basic chores, cleaning, sibling care, check mail, cut grass, and driving errands.

Table 85
 Funds of Knowledge by Race for Ms. Monroe’s Class

Race	Sports			Interests				Church		Clubs		Chores				Total		
	Band/Cheer	Baseball	Basketball	Misc.	Athletics	Music	Reading/ Writing	Misc.	Attends	Activities	Various Clubs/ Organizations	Various Committees	Misc.	Kitchen	Bedroom		Bathroom/ Laundry	Misc.
White	0	1	0	1	3	0	2	5	3	0	1	1	0	1	1	1	3	23
Black	3	0	1	2	6	1	1	6	4	2	2	1	0	6	4	1	1	41
Hispanic	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	2
American Indian	1	2	1	1	2	0	1	1	0	3	4	0	1	0	0	1	0	18
Multi- Racial	0	0	0	0	4	2	0	1	0	0	1	0	0	0	1	0	0	9
Total	4	3	3	5	8	3	4	13	7	5	8	2	1	7	6	3	4	

Similar to Mr. Pryor's class, the marching band and cheerleading was compiled into one category under the Sports FoK for Ms. Monroe's class (see Table 17). There was a tie for the most popular sports between baseball and basketball. Miscellaneous sports include track, tennis, soccer, and volleyball. Within athletics under the Interests theme, students listed very unique activities to include horseback riding, jumping on the trampoline, and dancing in pow-wows. However, some were generic like participating in sports and playing outside. Although not a popular activity as in Mr. Pryor's class, hunting and fishing were listed under athletics in Ms. Monroe's class but were placed in the miscellaneous category. Miscellaneous activities within Interests include US History, traveling, thinking, fixing phones, cooking, eating, and shopping. The church activities that were different from others mentioned earlier were choir, usher, and praise team. The Clubs FoK was very sparse; I compiled them all into various clubs/organizations and committees. For clubs and organizations, there were the Native American Youth Organization, Title VII Indian Education Program, student ambassador club, art club, music club, culinary club, and Iris club. Yearbook and prom committees were the two types within the various committees. One student mentioned that he worked at a chicken and barbecue restaurant. Note that there is a high American Indian population at Ms. Monroe's school and many FoK are culturally specific, unlike other classes.

Table 96
 Funds of Knowledge by Race for Mr. McMillian’s Class

Race	Sports			Interests			Church		Chores			Total	
	Rugby/Soccer	Volleyball	Misc.	Reading/ Writing/ Academics	Music/Arts	Misc.	Attends	Activities	Kitchen	Bedroom	Bathroom/ Laundry		Misc.
White	2	4	3	4	6	5	2	1	2	2	1	3	35
Black	0	1	5	0	1	1	1	3	2	2	1	1	18
Hispanic	1	0	0	0	0	1	0	1	3	1	1	1	9
American Indian	0	1	0	0	0	0	0	0	0	0	0	0	1
Multi-Racial	0	1	0	1	1	0	0	0	1	0	0	1	5
Total	3	6	8	5	8	7	3	5	8	5	3	6	

After combining rugby and soccer, the top sports in Mr. McMillian's class were Rugby/Soccer and Volleyball (see Table 16). The miscellaneous sports included wrestling, basketball, softball, step team, cheerleading, and marching band. Although cheerleading and marching band were popular in Mr. Pryor and Ms. Monroe's classes, they were categorized miscellaneous for Mr. McMillian's class. Academics within the reading/writing/academics category were astronomy and science. Arts within music/arts category included listening to music, playing the piano singing, dancing, drawing, and graphic art. Miscellaneous interests were sleeping, eating, recreational activities with friends, video games, planting flowers, and volunteering with autistic children and the library. For Church, activities included youth group, choir, and ushering, like Mr. Pryor's class; one unique activity included volunteering for Bible school. Chores were similar to the others with some of the miscellaneous ones including household chores, vacuum, and pet care. Note that clubs were not included for Mr. McMillian because there were only two: wrestling club and dance club. Similar to a student in Ms. Monroe's class, a student in Mr. McMillian's class has a part-time job.

Table 107
 Funds of Knowledge by Race for Mr. Ferguson’s Class

Race	Sports				Interests				Church		Chores			Total	
	Rugby/Soccer	Marital Arts	Volleyball	Misc.	Athletics	Music	TV/Movies	Misc.	Attends	Activities	Kitchen	Bedroom	Bathroom/ Laundry		Misc.
White	0	1	0	2	1	4	0	3	0	1	0	1	0	1	14
Black	1	0	1	0	2	1	2	3	1	1	4	2	0	5	23
Hispanic	0	0	0	0	0	1	3	0	0	0	1	0	2	0	7
American Indian	0	0	1	3	1	0	1	4	1	0	3	0	1	2	17
Multi-Racial	2	2	1	0	4	2	0	3	0	0	4	2	1	2	23
Asian	1	0	0	0	0	0	0	0	1	0	0	0	0	1	3
Total	4	3	3	5	8	8	6	16	3	2	12	5	4	11	

Mr. Ferguson's table (see Table 17) resembles Mr. McMillian's table (See Table 18) with no column for clubs; they are at the same school on a community college campus with minimal clubs at the school. Unlike Mr. McMillian's students, two students in Mr. Ferguson's class listed debate for their club affiliation. For Sports, the miscellaneous column includes all sports that were not the top three popular for this class: basketball, golf, horseback riding, and softball. For Interests, miscellaneous includes video games, reading, cats and dogs, shopping, social activities (i.e., texting, social media, and hanging out with friends), baking, doing hair, eating, and sleeping. All church activities and categories within chores were similar to the others.

Finally, when asked about language fluency on the student survey, only seven percent of all students reported speaking a different language fluently other than English: one student in Mr. Pryor's class (Spanish), one in Ms. Monroe's class (Spanish), one in Mr. McMillian's class (Spanish), and two in Mr. Pryor's class (one German, and one Spanish). Due to this sparse amount of students speaking another language, there was minimal to no communication among students and teachers using a language outside of English. Consequently, I will not report results from the dimension 6 analysis in this study.

Results from Statistical Analysis

Research Question One: FoK Incorporation

The first research question is "How are high school mathematics teachers in diverse classrooms connecting instruction to students' cultural/community funds of knowledge?" In the qualitative analysis section of the study, I highlighted how teachers are incorporating

students' FoK by discussing their various implementation methods. In this section, I report the quantitative findings, including statistical differences of whether or not the contexts used in the classrooms aligned with students' FoK. In other words, I am reporting on the matches between teacher contexts and students' FoK as it relates to race to find out whether any teacher favored one race category over another. Further, I report whether students (racially categorized as White and non-White) felt their FoK was used to help them learn mathematics, and summary statistics from the observation analysis on dimension 7 from the CRMT tool. I report on categorical and continuous data separately.

Categorical Data Analysis for RQ1. Students in the study were asked whether teachers used anything from their out-of-school activities in their instruction. As described in chapter 3, a spreadsheet was imported into SAS with the variables from the surveys including teacher, student race, FoK used in class, and "FoK help." The binary variable "FoK help" was entered in as a value of one (1) or zero (0); a value of one was entered if students indicated something has been used from their out-of-school activities previously listed and a zero otherwise. Controlling for teacher, I ran a Fisher's exact test to learn whether there were any differences between White and non-White students. Every teacher had a p -value of greater than 0.05, hence there were no significant differences among race as far as FoK implementation according to student surveys. This means that no teacher caters to either race category, White and non-White, more than the other according to the student surveys. I noted that only a few students reported that their teachers use their FoK in the classroom with only two out of 17 students (one White, one non-White) in Mr. Pryor's class, three out of 20 in Ms. Monroe's class (all non-White), none in Mr. McMillian's class, three out of 17 (one

White and two non-White) in Mr. Ferguson's class. To triangulate this result, the next section reports data analysis from two other data sources: observations and student surveys.

Dimension 7: Observations. Out of the dimensions chosen for this study, the dimension on FoK (Dimension 7) is the most appropriate to analyze in order to seek results for the research questions. Specifically, Dimension 7 describes how well a lesson helps students connect mathematics with relevant or authentic situations in their lives. The ratings from the rubric may be considered either categorical or continuous; however for the purpose of this study I will be analyzing this data as categorical with the five categories being the rubric scores. Using the chosen dimensions from the CRMT tool, I analyzed each observation day and gave it a score one to five. Each score corresponds to a descriptor of the tool (see Appendix L: Dimensions 6 through 8 of the CRMT tool), but here I report the results using the numerical values only. As a reminder, Table 18 describes Dimension 7 providing the guiding question a rubric with descriptors for each score. Figure 9 shows scores for each observation day for each teacher. For each observation day, each teacher was rated one to five on their lesson for each dimension of the CRMT tool. As stated earlier, I am only reporting on Dimension 7.

Table 118
Dimension 7 of CRMT Tool

Dimension Name	FoK/culture/community support
Guiding Question	How does this lesson help students connect mathematics with relevant/authentic situations in their lives?
1	No evidence of connecting to Ss' cultural FoK (parental/community knowledge, S interest). Lesson incorporates culturally neutral contexts that "all students" will be interested in.
2	There is AT LEAST ONE (1-3) instance in connecting math lesson to community/cultural knowledge and experience. Lesson draws on students' knowledge and experience. Focus is with one S or a small group of students.
3	There is AT LEAST ONE (1-3) sustained episode of sharing and developing collective understanding about math that involves connecting to community/cultural knowledge. Or, brief episodes of sharing and developing collective understandings occur sporadically throughout the lesson.
4	There are MANY (4 or more) sustained episodes of sharing and developing collective understandings about math that involves connecting cultural/community knowledge (e.g., Students experiences are mathematized, connections with math work; math examples are embedded in local community/cultural contexts and activities – i.e., games).
5	The creation and maintenance of collective understandings about math that involves intricate connections to community/cultural knowledge and permeates the entire lesson. This would include hook/intro, main activities, assessment, closure and homework. Students are asked to analyze the math within the community context and how the math helps them understand that context.

Using the data from Figure 9, Table 19 displays the summary statistics from Dimension 7 for each teacher to include means and percentiles. Mr. McMillian has the minimum mean score over all, while Mr. Pryor has the maximum. The novice teachers (Monroe and Ferguson) had the same mean score; however Ms. Monroe has the greatest

standard deviation, indicating more of a spread among her scores for each day. In opposition, Mr. McMillian had the least standard deviation which means less of a spread and more consistent scores around his mean of 1.80 units. According to the rubric, Mr. Pryor's mean score is approaching three units, and is in the category where his lesson contained at least one sustained episode of sharing and developing collective understanding about mathematics that involved connecting students' FoK. This sustainment may also be considered having occurred sporadically throughout the lesson. All other teachers' mean scores were at or approaching two units, the category where the lesson contained at least one instance in connecting the lesson to students' FoK, focused with a student or small group of students (see Table 18). The difference between these categories is how often teacher address FoK and the number of students involved during the lesson.

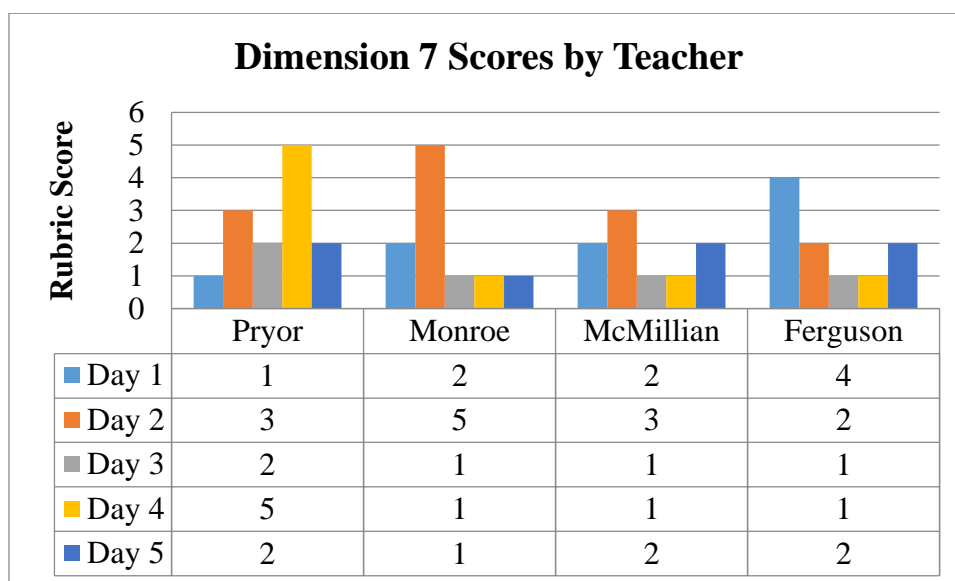


Figure 9: Dimension 7 Scores by Teacher

Table 19
Summary Statistics of Dimension 7 Data by Teacher

Analysis Variable : dim7 dim7									
Teachers	N Obs	N	Mean	Std Dev	Minimum	25th Pctl	Median	75th Pctl	Maximum
1	5	5	2.60	1.52	1.00	2.00	2.00	3.00	5.00
2	5	5	2.00	1.73	1.00	1.00	1.00	2.00	5.00
3	5	5	1.80	0.84	1.00	1.00	2.00	2.00	3.00
4	5	5	2.00	1.22	1.00	1.00	2.00	2.00	4.00

Figure 9 highlights teachers' scores for Dimension 7 for each observation day. Notice that only a maximum score of five was scored twice during the entire observation period for all teachers: Ms. Monroe's day two and Mr. Pryor's day four. A score of five means that the day's math lesson was saturated with connections to community and cultural FoK. On day five, all teachers with the exception of Ms. Monroe scored a two. On days three and four, all teachers with the exception of Mr. Pryor scored a one, which means that there was no evidence of connecting to students' cultural and community FoK or students' interest. This may also include lessons that incorporate culturally neutral contexts that interest "all students." The section that follows describes the results found from student surveys, particularly whether students felt they have had their FoK incorporated by their math teacher during class.

Help using FoK: Student Surveys. Students were asked whether their teacher used their out-of-school activities to help them learn math. If the student listed something from their out-of-school activities, then I gave an entry of '1'. If the student listed something that was not listed in their activities, stated 'nothing', or left this question blank, then I gave an entry of '0'. Therefore, the categorical variable 'FOK_Help' was put against student race

categories White and not White. For instance for the cell intersected at the zero value for the White row and the zero value for the FoK_Help column for Mr. Pryor's class, there is a value of eight (see Table 20). This value represents eight students of color who either stated that their out-of-school activities were not used in class, or left this question blank. However, reading the next column on the students of color row, there was one student of color that stated the teacher used something from his or her out-of-school activities.

Table 120

Table (left) and Fisher's test (right) of FoK Help by Student Race for Mr. Pryor

Table 1 of White by FOK_Help			
Controlling for Teacher=1			
White(White)	FOK_Help(FOK_Help)		
	0	1	Total
0	8 47.06 88.89 53.33	1 5.88 11.11 50.00	9 52.94
1	7 41.18 87.50 46.67	1 5.88 12.50 50.00	8 47.06
Total	15 88.24	2 11.76	17 100.00

Fisher's Exact Test	
Cell (1,1) Frequency (F)	8
Left-sided Pr <= F	0.7941
Right-sided Pr >= F	0.7353
Table Probability (P)	0.5294
Two-sided Pr <= P	1.0000

Note: A value of zero for White means non-White; a value of one for White means White. A value of zero for FOK_Help means teacher did not use FoK to help students learn; a value of one for FOK_Help means teacher did use FoK.

Only two students in Mr. Pryor's class (one per race category) that stated something from their out-of-school activities was referenced in class to help them learn mathematics (see Table 21). The other 15 students (88.24%) either stated that teacher used 'nothing' from

their out-of-school activities to help them learn mathematics, or they left this question blank. Either way, they are all given a value of zero for the table and tabulated as a ‘no.’ The Fisher’s exact test shows that there is no significant difference ($p=0.99$) in the way White and non-White students have their FoK incorporated. According to the student surveys, neither race category has their FoK used to learn mathematics.

Table 131
Table (L) and Fisher’s test (R) of FoK Help by Student Race for Ms. Monroe

Table 2 of White by FOK_Help			
Controlling for Teacher=2			
White(White)	FOK_Help(FOK_Help)		
	0	1	Total
0	13 65.00 81.25 76.47	3 15.00 18.75 100.00	16 80.00
1	4 20.00 100.00 23.53	0 0.00 0.00 0.00	4 20.00
Total	17 85.00	3 15.00	20 100.00

Fisher’s Exact Test	
Cell (1,1) Frequency (F)	13
Left-sided Pr <= F	0.4912
Right-sided Pr >= F	1.0000
Table Probability (P)	0.4912
Two-sided Pr <= P	1.0000

Note: A value of zero for White means non-White; a value of one for White means White. A value of zero for FOK_Help means teacher did not use FoK to help students learn; a value of one for FOK_Help means teacher did use FoK.

Ms. Monroe had four White students at the time of the study, none of which stated any FoK incorporation in their mathematics learning (see Table 21). However, 15% (three out of 16) of non-White students stated something from their out-of-school activities that was used to help them learn in Ms. Monroe’s class. However there were no statistical differences

($p=0.99$) in the race categories getting their FoK incorporated into the mathematics instruction.

Table 14
Table of FoK Help by Student Race for Mr. McMillian

Table 3 of White by FOK_Help			
Controlling for Teacher=3			
White(White)	FOK_Help(FOK_Help)		
	0	1	Total
0	11 73.33 100.00 73.33	0 0.00 0.00 .	11 73.33
1	4 26.67 100.00 26.67	0 0.00 0.00 .	4 26.67
Total	15 100.00	0 0.00	15 100.00

Mr. McMillian's table (see Table 22) indicated no FoK has been incorporated for any race from the column of zeros. Consequently, there were no statistics given because an entire column is zeros, particularly 1's for FOK_Help which means none of the students in this class stated that the teacher used their out-of-school knowledge or interests to help them learn math. All 15 students either stated that nothing from their out-of-school activities was used to help them learn mathematics, named something that was not listed on their out-of-school activities, or left this question blank.

Mr. Ferguson had three out of 17 students (see Table 23) that provided an out-of-school activity that related to their previously listed FoK on their survey that Mr. Ferguson

used to help them learn mathematics: two non-White students and one White student. Over 82% of the class stated that there was nothing from their out-of-school activities used to help them learn mathematics, and the Fisher's exact test reveals there is no statistical difference ($p=0.99$) with different race categories having their FoK incorporated into mathematics learning in Mr. Ferguson's class.

Table 153

Table and Fisher's test of FoK Help by Student Race for Mr. Ferguson

Table 4 of White by FOK_Help			
Controlling for Teacher=4			
White(White)	FOK_Help(FOK_Help)		
	0	1	Total
0	11 64.71 84.62 78.57	2 11.76 15.38 66.67	13 76.47
1	3 17.65 75.00 21.43	1 5.88 25.00 33.33	4 23.53
Total	14 82.35	3 17.65	17 100.00

Fisher's Exact Test	
Cell (1,1) Frequency (F)	11
Left-sided Pr <= F	0.8794
Right-sided Pr >= F	0.5794
Table Probability (P)	0.4588
Two-sided Pr <= P	1.0000

For each teacher in the study, I reported whether their students indicated his or her teacher has ever used their out-of-school activities to help them learn mathematics. The race categories were White and non-White because there were small amounts of particular races and many zeros in the table, making it difficult to perform valid statistical tests. Race categories had to be combined in order to obtain p -values. McMillian's class did not produce a p -value due to the low number of respondents of each race category. With the exception of

Mr. McMillian, I reported a Fisher's exact test for all teachers because of some of the cells in the table being less than five. Next I will analyze the alignment of each teacher's contexts used in class to their students' FoK.

FoK Implementation: Observations. I compiled all contexts used in each class during the observation period. After totaling these quantities, I placed them against students' FoK reported on the surveys. If I found commonalities between the two, I considered it a match. For instance, if a teacher used cooking within a contextual problem, and there were students that listed cooking, eating, or any related topics on their survey as their chores or out-of-school activities, I called this a 'match.' I also kept race attached to each out-of-school activity to be able to learn whether there was a particular race group's FoK favored over another. Conversely, there were incidences where a teacher's context did not match with either race group or was exclusive to one race group. This would be considered 'not a match.' See the data in the two by two table below for Mr. Pryor's class (see Table 24). Unlike all other quantitative data in the study, the match tables (see Tables 25 through 28) that follow were entered manually into SAS because of the need to find relative matches like baseball and softball, for instance. If cells had values of five or more, I used chi square test to obtain a *p*-value; otherwise, I used Fisher's exact test to sustain validity.

Table 164
Incidence of Context/FoK Matches by Race for Mr. Pryor

Student Race	Match	Not a Match	Total
White	5	23	28
Not White	8	20	28

There was one contingency table created for each teacher to illustrate the numbers of matches and non-matches by race group. Out of the four tables, I was only able to obtain a valid chi square test result on Mr. Pryor's class (see Table 24) because all of the cells had a count of five or more, unlike the others (Tables 25 through 28). The chi-square test showed that there was no statistical difference ($p=0.3424$) between races when it comes to teacher's contexts matched with students' FoK. In other words, there is an equal distribution of FoK implementation among White and non-White students in Mr. Pryor's class. There were 8.93% of the matched contexts related to White students, while 14.29% related to students who were not White. However over 50% (nine out of 17 surveyed) of his class is White.

Note that five out of eight matches from the 28 contexts used during Mr. Pryor's observation period matched with both White and non-White students. It is also noteworthy that out-of-school activities were matched generously. For instance, a particular musical artist was mentioned in a contextual problem one day during observation. This context was a match to students who listed dance or music on their survey. No one listed this artist or his musical genre specifically, and all that listed dance and music may not like this particular musical artist. However, due to the nature of the responses on the surveys, there is no way to know from the data collected which students liked his music, if any. There may be other matches made throughout this section in the same manner.

Table 175
Incidence of Context/FoK Matches for Ms. Monroe

Student Race	Match	Not a Match	Total
White	0	8	8
Not White	7	1	8

For Ms. Monroe's class, there were no matches among White students' FoK and teacher's contexts used in class; all of the matches occurred in favor of non-White students (see Table 25). Fisher's exact test was used as an alternative to chi-square to obtain a p -value because of the values in the table less than five. There was a statistical difference ($p=0.0014$) in the match count for Ms. Monroe's observed classes between races. Overall, 43.75% of the contexts used in Ms. Monroe's class related to students of color. Note that only 20% (four students out of 20) of her class is White. One may assume that Ms. Monroe was catering to the majority of the class by using contexts that favored most of her class.

Table 26
Incidence of Context/FoK Matches for Mr. McMillian

Student Race	Match	Not a Match	Total
White	4	3	7
Not White	0	7	7

Similar to Ms. Monroe's class, the data for Mr. McMillian's class has a zero value for a cell (see Table 26). However, instead of all of the matched contexts favoring non-White students' FoK like Ms. Monroe, Mr. McMillian's context matches favored White students' FoK. After running a Fisher's exact test, there was no significant difference indicated ($p=0.0699$) in matches by race. Considering the 15 students surveyed from Mr. McMillian's class, almost 30% of the FoK matched with teachers' contexts related to White students; the remaining 70% of contexts used in class related to neither White or non-White students. The seven contexts that were used during the observation period did not generate a statistical difference, but it is worth highlighting that none of the matches made were in favor of the non-White students, which made up over 60% of the class.

Table 187
Incidence of Context/FoK Matches for Mr. Ferguson

	Match	Not a Match	Total
White	5	12	17
Not White	12	5	17

Mr. Ferguson had a total of 25 context and language uses throughout the five-day observation period. Out of those 25 instances, 17 of them were matched to either White or non-White students: five for White and 12 for non-White students. The chi-square test showed a significant difference ($p=0.0164$) between race groups and frequency of matches. Two-thirds of Mr. Ferguson's class represented students of color, and 70% of the contexts

used matched with this race group. Like Ms. Monroe, one may assume Mr. Ferguson was also catering to the majority of his class with the contexts used as most of them matched with students of color. Although Mr. Pryor and Mr. McMillian's data showed no statistical differences between matches and race groups, Mr. Pryor's class had close to a fair share of matches among them, and evidence shown above where Mr. McMillian's contexts used did not match with any students of color.

After reviewing notes from video analysis and student surveys, I found some matches between teacher contexts implemented during class and students' FoK. These matches were categorized by race to test whether each teacher incorporated one race category's FoK over another. Ms. Monroe and Mr. Ferguson, the novice teachers in the study, incorporated non-White FoK over White FoK. This was revealed through the significant p -values when I ran a chi-square test for each teacher. This result is aligned with my anticipated hypothesis. The section that follows will provide continuous data analysis related to the first research question.

Continuous Data Analysis for RQ1. The continuous variables of interest for the first research question are the ratings for the statements from the student surveys (even though the values were discrete 1-10, there are enough values they are treated as continuous). While the qualitative component for the first research question helps answer the implementation methods of FoK, this quantitative portion will help determine how often the FoK incorporation is done according to the students' perspective. Students rated five statements one to 10 on how often they experience particular scenarios. See Figure 10 below for the scale for rating the statements. Even though the data is actually discrete (numbers 1 to 10), I

considered it continuous for the results reporting. Out of the five statements, I chose to analyze the first three because of their appropriateness to help answer the research questions. Each statement under study will be restated and individually analyzed below.

Statement One: Student Surveys. The following comparative analysis for statement one, ‘Real-world problems are a regular aspect of what my math teacher uses to teach me,’ helped me understand the differences among all teachers according to the ratings given by students. All classes have means for statement one that ranged from five to six on the gradient scale (see Figure 10) of the student survey. Therefore, each class felt that their math teacher *sometimes* used real-world problems as a regular aspect of their mathematics class.

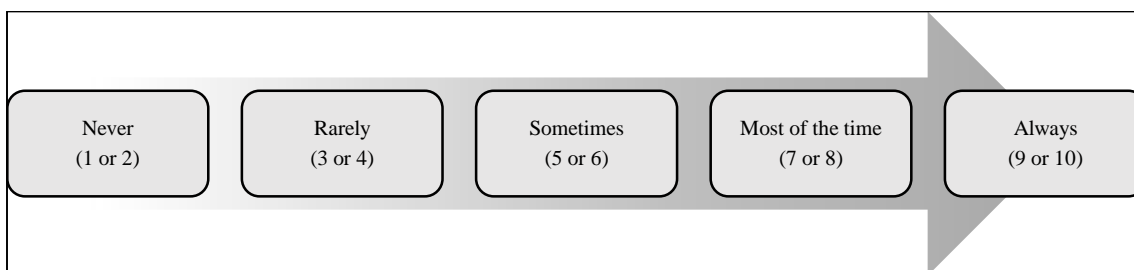


Figure 10: Possible Ratings for Statements on Student Surveys

Table 28 below provides the mean, standard deviation, and the five-number summary for each teacher. From teachers one to four, the teachers are Mr. Pryor, Ms. Monroe, Mr. McMillian, and Mr. Ferguson, respectively. To get a sense of the distribution of responses by teacher, boxplots are included directly below the tables. Boxplots show the five-number summary with endpoints displaying minimum and maximum, and the three lines of the box are 1st quartile, 2nd quartile (median), and 3rd quartile. I also explained if there were

differences by race. In sum, no students of any race category for any teacher's class differed on the means of statement one. No significant differences among races were interpreted as most individuals of each race group agreed that their math teacher *sometimes* used real-world problems as a regular aspect of their mathematics class. *Sometimes* is indicated by the arrow above in Figure 10, since all means in Table 28 display means of approximately five to six. The box plot in Figure 11 displays the data in Table 28 for statement one.

Table 198
SAS Results for Summary Statistics for Statement One

Analysis Variable : stmt1 stmt1									
Teacher	N Obs	N	Mean	Std Dev	Minimum	25th Pctl	Median	75th Pctl	Maximum
1	17	17	5.24	2.31	1.00	4.00	5.00	6.00	10.00
2	20	20	6.45	1.85	3.00	5.00	6.00	7.50	10.00
3	15	15	5.80	2.11	2.00	4.00	6.00	7.00	10.00
4	17	17	6.41	1.62	3.00	5.00	6.00	8.00	9.00

Note: Teacher 1 (Mr. Pryor), Teacher 2 (Ms. Monroe), Teacher 3 (Mr. McMillian), and Teacher 4 (Mr. Ferguson)

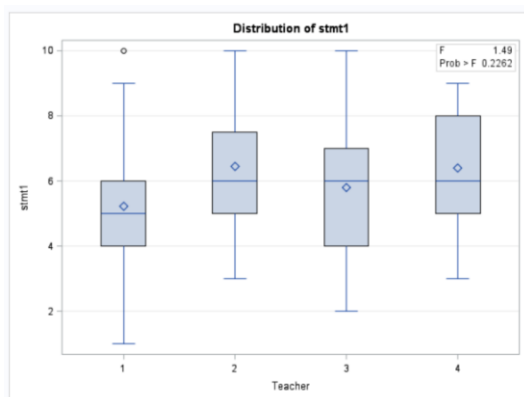


Figure 11: Box plot of Distribution of Statement One

Statement Two: Student Surveys. The second statement that students were asked to rate on the student survey from one to 10 was ‘My math teacher uses my everyday experiences to help me learn or understand math.’ Looking at classes individually, Ms. Monroe’s class felt that she used their everyday experiences to help them learn math *most of the time* (Mean=7.25), Mr. McMillian’s *rarely* (M=3.00), and Mr. Pryor (M=5.41) and Mr. Ferguson’s *sometimes* (M=4.94). According to the summary statistics and boxplot, Mr. McMillian has the minimum mean and Ms. Monroe has the maximum mean. Mr. Pryor and Mr. Ferguson are the most similar. The box plot in Figure 12 shows the data from Table 29 for statement two.

Table 29
SAS Results for Summary Statistics for Statement Two

Analysis Variable : stmt2 stmt2									
Teacher	N Obs	N	Mean	Std Dev	Minimum	25th Pctl	Median	75th Pctl	Maximum
1	17	17	5.41	2.45	2.00	3.00	5.00	7.00	10.00
2	20	20	7.25	1.80	5.00	6.00	7.00	8.50	10.00
3	15	15	3.00	1.81	1.00	1.00	3.00	4.00	6.00
4	17	17	4.94	2.28	1.00	3.00	4.00	7.00	8.00

Note: Teacher 1 (Mr. Pryor), Teacher 2 (Ms. Monroe), Teacher 3 (Mr. McMillian), and Teacher 4 (Mr. Ferguson)

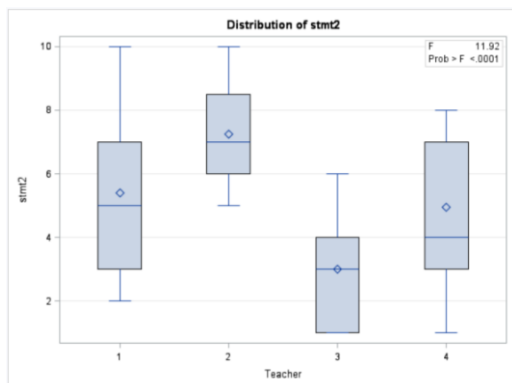


Figure 12: Box plot of Distribution of Statement Two

Statement Three: Student Surveys. On the student survey, statement three reads ‘We relate issues in my community to the math taught in this class.’ Finding differences among student races for each class will provide insight as to whether students have different perspectives of how much a teacher related mathematics learned in their class to their community. Based on means and medians on statement three, Ms. Monroe’s students felt that they have opportunities to link mathematics to their communities *most of the time*. On the other hand, all of the teachers’ students felt that they *rarely* have such opportunities. Mr. Pryor’s scores were the most spread out, ranging from one to the maximum possible score of 10 for statement three. Mr. Pryor and Ms. Monroe received the maximum score possible (10) by at least one student. On the other hand, Mr. Ferguson and Mr. McMillian did not receive the maximum score by any one student, with respective maxima of seven and six. The spread of data may imply conflicting views of students in the same class for how their teachers relate issues in my community to the math taught in class.

Table 30
SAS Results for Summary Statistics for Statement Three

Analysis Variable : stmt3 stmt3										
Teacher	N Obs	N	Mean	Std Dev	Minimum	25th Pctl	Median	75th Pctl	Maximum	
1	17	17	4.18	2.83	1.00	2.00	4.00	5.00	10.00	
2	20	20	7.10	1.86	3.00	6.00	8.00	8.00	10.00	
3	15	15	3.73	1.83	1.00	2.00	4.00	5.00	6.00	
4	17	17	2.59	1.62	1.00	2.00	2.00	3.00	7.00	

Note: Teacher 1 (Mr. Pryor), Teacher 2 (Ms. Monroe), Teacher 3 (Mr. McMillian), and Teacher 4 (Mr. Ferguson)

Observations and student surveys were the two key data sources for answering the first research question of how teachers use students' FoK in their math instruction. From the observations, I analyzed each day and assigned a score from Dimension 7 of the CRMT tool.

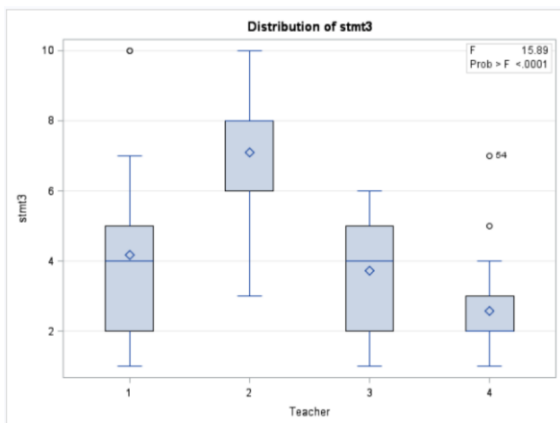


Figure 13: Box plot of Distribution of Statement Three

From student surveys, I discussed whether teachers used students' FoK to help students from two race groups, White and non-White. The first three out of the five statements from the student survey showed Ms. Monroe leading with the highest mean score for all statements. For statement one through three, she respectively had $M=6.45$, $M=7.25$, and $M=7.10$. From both observations and student surveys, match tables were created and analyzed that showed how well teachers' contexts used in class aligned with students' FoK by student race. The tables for Ms. Monroe ($p=0.0699$) and Mr. Ferguson ($p=0.0164$), the novice teachers in the study, exhibited a statistical difference in matches between White and non-White students. Both teachers had a higher number of matches for non-White students over White students.

Next, I will discuss the quantitative data analysis findings for research question two which involves the role of experience in the incorporation of FoK.

Research Question Two: Role of Experience

The second research question is 'Does the experience of high school mathematics teachers play a role in incorporating students' cultural/community funds of knowledge?' My anticipated finding here was that the novice teachers would be more likely to incorporate students' FoK. This would be indicated with higher means from statements on student surveys and Dimension 7 scores, alongside significant test results. I discuss the data analysis for categorical variables for the second research question, followed by analysis for continuous variables. Within each major section, I give rationale for why I am studying each variable to answer this research question, and conclude with the findings for each analysis section. Note that the qualitative section speaks to all experiences of teachers, but this

quantitative results section only considers experience levels categorically as master (more than 20 years) and novice (less than five years).

Categorical Data Analysis: RQ 2. The categorical variables of interest to help answer the second research question come from the observations' scores from the rubric on the CRMT tool. Since I am seeking whether experience played a role in teachers' incorporation of their students' FoK, dimension 7 was analyzed against teacher experience level. This aggregation will give insight into whether there are statistical differences between master and novice teachers in the study.

Dimension 7: Observations. Dimension 7 evaluates how well a mathematics lesson helps students connect mathematics with relevant or authentic situations in their lives. I also produced summary statistics stratified for this dimension by controlling for teacher experience found in Table 31. Out of a possible score of one to five, the means of novice and master teachers is on the lower end at 2 and 2.20 units, respectively. Their standard deviations are fairly close as well, at 1.41 and 1.23.

Table 31
Summary Statistics (L) and p -value (R) of Dimension 7 Scores by Teacher Experience Level

Analysis Variable : dim7 dim7										Fisher's Exact Test	
Experience_Level	N Obs	N	Mean	Std Dev	Minimum	25th Pctl	Median	75th Pctl	Maximum	Table Probability (P)	Pr <= P
0	10	10	2.00	1.41	1.00	1.00	1.50	2.00	5.00	0.0212	
1	10	10	2.20	1.23	1.00	1.00	2.00	3.00	5.00		0.6520

Note: For experience level, 0=Novice, 1=Master.

There is no significant difference between master and novice teachers on dimension 7 ($p=0.6520$). The mean is minimally higher for master level teachers (2.0 versus 2.2), and I interpret this to mean that master teachers' lessons are slightly more efficient at connecting mathematics with relevant or authentic situations in students' lives.

FoK Help: Student Surveys. Another data source for categorical data under study is the student survey (see Appendix I). While controlling for teacher experience level, Table 32 tabulates data from students' surveys on whether their teacher used their FoK. I conducted a chi-square and Fisher's exact test on this data, but only reported chi-square when appropriate. If there were warnings in SAS about the distribution of data violating the assumptions for a chi-square test (i.e., values in cells less than five), then I reported Fisher's exact test.

Table 202
Novice (L) and Master (R) teachers' FoK Help by student race

Table 1 of White by FOK_Help				Table 2 of White by FOK_Help			
Controlling for Teacher_Type=0				Controlling for Teacher_Type=1			
White(White)	FOK_Help(FOK_Help)			White(White)	FOK_Help(FOK_Help)		
	0	1	Total		0	1	Total
0	24 64.86 82.76 77.42	5 13.51 17.24 83.33	29 78.38	0	19 59.38 95.00 63.33	1 3.13 5.00 50.00	20 62.50
1	7 18.92 87.50 22.58	1 2.70 12.50 16.67	8 21.62	1	11 34.38 91.67 36.67	1 3.13 8.33 50.00	12 37.50
Total	31 83.78	6 16.22	37 100.00	Total	30 93.75	2 6.25	32 100.00

Note: Teacher type of 0 represents novice and 1 represents master level teachers. For rows, 0 is for the non-White students and 1 is for White students; for columns, 0 is for FoK was not used to help students and 1 is for FoK used to help students learn math.

Table 213

Novice Teachers (L) and Master Teachers (R), Student Race by FoK incorporation

Fisher's Exact Test		Fisher's Exact Test	
Cell (1,1) Frequency (F)	24	Cell (1,1) Frequency (F)	19
Left-sided Pr <= F	0.6130	Left-sided Pr <= F	0.8669
Right-sided Pr >= F	0.7957	Right-sided Pr >= F	0.6169
Table Probability (P)	0.4087	Table Probability (P)	0.4839
Two-sided Pr <= P	1.0000	Two-sided Pr <= P	1.0000

According to the Fisher's exact test results above, there are no significant differences ($p=0.99$) among experience levels as it relates to different race groups of students having their FoK incorporated to learn mathematics. The novice teachers collectively have 37 students, and close to 84% of students did not have their FoK used to help them learn math, compared to almost 94% (out of 32 students) of the master teachers' students not having their FoK incorporated into mathematics instruction. Therefore only six per cent of master teachers and 16% of novice teachers had their FoK incorporated while learning math. Looking at student race for novice teachers, five out of six students of color had their FoK incorporated, while only one of two for master teachers. In sum, although there are no statistical differences for both experience levels, there are slight differences, favoring the novice teachers for FoK incorporation according to the student survey responses.

Continuous Data Analysis: RQ 2. Before analyzing the continuous variables, I wanted to understand more about the data while controlling for experience. For the first research question, each teacher was analyzed individually. Here, I am aggregating on experience to determine whether there is a significant difference between master (teacher

type=1) and novice (teacher type=0) teachers as it relates to the statement ratings provided by the students.

Table 224
Summary Statistics of Analyzed Statements by Teacher Experience Level

Analysis Variable : stmt1 stmt1									
Teacher_Type	N Obs	N	Mean	Std Dev	Minimum	25th Pctl	Median	75th Pctl	Maximum
0	37	37	6.43	1.72	3.00	5.00	6.00	8.00	10.00
1	32	32	5.50	2.20	1.00	4.00	5.00	7.00	10.00

Analysis Variable : stmt2 stmt2									
Teacher_Type	N Obs	N	Mean	Std Dev	Minimum	25th Pctl	Median	75th Pctl	Maximum
0	37	37	6.19	2.32	1.00	5.00	6.00	8.00	10.00
1	32	32	4.28	2.47	1.00	3.00	4.00	6.00	10.00

Analysis Variable : stmt3 stmt3									
Teacher_Type	N Obs	N	Mean	Std Dev	Minimum	25th Pctl	Median	75th Pctl	Maximum
0	37	37	5.03	2.86	1.00	2.00	5.00	8.00	10.00
1	32	32	3.97	2.39	1.00	2.00	4.00	5.00	10.00

Note: Teacher type 0=Novice, teacher type 1=Master

An assessment of the normality of data is a prerequisite for many statistical tests because data must assume a normal distribution in parametric testing. In particular, the Shapiro-Wilk test is appropriate for sample sizes with less than 50 samples, while also being able to handle sample sizes as large as 2000. With a sample size of 69 student surveys, the Shapiro-Wilk test is valid here. Obtaining a p -value greater than $\alpha=0.05$ for the Shapiro-Wilk test is interpreted as data having a normal distribution, and a t -test is the appropriate test for comparing continuous data by a binary group, such as the teacher experience levels:

novice and master. Alternatively, a p -value less than 0.05 indicates that the data deviates from a normal distribution normal and will require a nonparametric alternative, namely the Wilcoxon rank sum test for these analyses (Higgins, 2004; Ott & Longnecker, 2001). Later, I consider similar statistical tests aggregating on teacher race for the third research question.

Table 35
Results for Shapiro-Wilk (S-W) Test for Normality, by Experience Level

Variable	Description	S-W p -value for:		Statistical Result for Comparing Medians
		Novice (0)	Master (1)	
Stmt1	Real-world problems are a regular aspect of what my math teacher uses to teach me.	0.0292		Wilcoxon p -value=0.0593
		0.5400		
Stmt2	My math teacher uses my everyday experiences to help me learn or understand math.	0.3002		Wilcoxon p -value=0.0013
		0.0470		
Stmt3	We relate issues in my community to the math taught in this class.	0.0046		Wilcoxon p -value=0.1235
		0.0119		

Statements: Student surveys. The continuous variables used to determine whether experience plays a significant role in FoK incorporation are the ratings given by students on part B of the student surveys (see Appendix I). See the column entitled description in Table 35 for the statements that were chosen for analysis. To find the appropriate test to use for each statement, I used the univariate procedure in SAS on each statement controlling for

experience level and incorporate p -values into Table 35. The corresponding test is in the column to the right of each p -value. If one experience level resulted in a t -test and the other Wilcoxon, I used the latter for comparative consistency. As it relates to experience, the only statement showing a statistical difference is statement two (p -value=0.0013). The novice (Median=6.00) and master teachers (Median=4.00) are different according to how their students' perceptions about how often their teacher used their everyday experiences for math learning. The students in the novice teachers' class ranked this statement as *sometimes* occurring, while the master teachers' students ranked it as *rarely* occurring.

Research Question Three: Role of Race

Similar to the second research question, the third research question is 'Does the race of high school mathematics teachers play a role in incorporating students' cultural/community funds of knowledge?' I anticipated finding the Black teachers in the study making more connections between the FoK of students of color and formal mathematics learning than White teachers. Moreover, my anticipation was that there will be a statistical difference in the quantity of FoK incorporation into mathematics by the Black teachers across all analyzed dimensions of the CRMT tool.

Categorical Data Analysis: RQ 3. The analysis for the third research question is very similar to that of the second research question; the only difference is instead of controlling for teacher experience, I am controlling for teacher race. Below I report the summary statistics for each considered dimension aggregating on race (see Table 36).

Table 236
Summary Statistics for Dimension 7 by Teacher Race

Analysis Variable : dim7 dim7									
Race	N Obs	N	Mean	Std Dev	Minimum	25th Pctl	Median	75th Pctl	Maximum
0	10	10	2.30	1.57	1.00	1.00	2.00	3.00	5.00
1	10	10	1.90	0.99	1.00	1.00	2.00	2.00	4.00

Note: For race, 0=White, 1=Black

Dimensions 7: Observations. After conducting a Wilcoxon test on the Dimension 7 data by teacher race, there were no significant difference found between White and Black teachers in the study (p -value=0.7525). This means that there is no difference between races in the degree to which they used relevant and authentic situations from their students' lives. Although there were no significant differences, I found more episodes of critical evidence of White teachers for this dimension as compared to the Black teachers in this study (2.3 versus 1.9, see Table 38). Next, I describe how FoK was used to help students to help them learn mathematics as reported by the students.

FoK Help: Student Surveys. From the student survey, the following results measure whether a difference in the quantity of help using FoK for each race group while controlling for teacher race.

Table 37
White (L) and Black (R) Teachers by Student Race

Table 1 of White by FOK_Help				Table 2 of White by FOK_Help			
Controlling for Teacher_Race=0				Controlling for Teacher_Race=1			
White(White)	FOK_Help(FOK_Help)			White(White)	FOK_Help(FOK_Help)		
	0	1	Total		0	1	Total
0	21 56.76 84.00 65.63	4 10.81 16.00 80.00	25 67.57	0	21 67.74 91.30 75.00	2 6.45 8.70 66.67	23 74.19
1	11 29.73 91.67 34.38	1 2.70 8.33 20.00	12 32.43	1	7 22.58 87.50 25.00	1 3.23 12.50 33.33	8 25.81
Total	32 86.49	5 13.51	37 100.00	Total	28 90.32	3 9.68	31 100.00

Note: Teacher race of 0 represents White and 1 represents Black teachers. For rows, 0 is for the non-White students and 1 is for White students; for columns, 0 is for FoK was not used to help students and 1 is for FoK used to help students learn math.

Table 37 is a two-part table that represents whether or not students felt that their teachers used their FoK to help them learn mathematics. The left side of Table 38 (table 1 of White by FOK_Help) contains data for the White teachers' (Mr. Pryor and Ms. Monroe) students, and the right side of the Table 37 (table 2 of White by FOK_Help) for the Black teachers' (Mr. McMillian and Mr. Ferguson) students. The rows labeled '0' (zero) and '1' (one) indicate the number of non-White and White students in the White teachers' classes (left portion in Table 37) and Black teachers' classes (right portion in Table 37). The columns of the number of zeros and ones represent whether (ones) or not (zeros) students felt their teachers used their FoK in their mathematics learning. Consider the left side of Table 38. For the first row and column labeled zero, there are 21 students in this cell. These 21 students represent those were in both White teachers' observed classes that are non-White

and their teachers did not use their FoK to help them learn mathematics. Reading the next cell over, which has four students, represent the students who are non-White in the White teachers' classes who did have their FoK used to help them learn mathematics.

Table 248

White (left) and Black (right) Teachers, Student Race by FoK Help

Fisher's Exact Test		Fisher's Exact Test	
Cell (1,1) Frequency (F)	21	Cell (1,1) Frequency (F)	21
Left-sided Pr <= F	0.4701	Left-sided Pr <= F	0.8443
Right-sided Pr >= F	0.8781	Right-sided Pr >= F	0.6060
Table Probability (P)	0.3482	Table Probability (P)	0.4503
Two-sided Pr <= P	1.0000	Two-sided Pr <= P	1.0000

According to the results above, neither of the teacher races had a significant difference (0.3482 vs 0.4503) with using FoK to help students of any race learn mathematics. Eighty-six percent of the White teachers' students and 90% of the Black teachers' students did not provide a FoK that their teacher used. For the White teachers, four students of color and one White student listed a FoK that their teacher used to help them learn mathematics. For the Black teachers, there were two students of color and one White student who indicated their teacher used their out-of-school activities to help them learn mathematics. Note that if the students responded to this question with something that was not listed in their out-of-school activities on the student survey, it was not considered a FoK; hence it counts as a '0'. Other counts toward the zero frequency were responses that did not make any sense, like 'homework' as an out-of-school activity. In sum, although there were no statistical difference between teacher races for incorporating students' out-of-school activities from the students'

perspective, White teachers had a higher percentage (13.5%) of students who stated that their teacher used their out-of-school activities when teaching mathematics. Likewise, Black teachers had almost 10% of the students who had a similar perspective.

Continuous Data Analysis: RQ 3. The analysis of continuous data followed a similar structure as in research question two. I explored the data while controlling for race, and aggregated on race to determine whether there is a significant difference between White and Black teachers’ level of incorporating students’ FoK.

Table 39
Summary Statistics on Analyzed Statements, by Teacher Race

Analysis Variable : stmt1 stmt1									
Teacher_Race	N Obs	N	Mean	Std Dev	Minimum	25th Pctl	Median	75th Pctl	Maximum
0	37	37	5.89	2.13	1.00	5.00	6.00	7.00	10.00
1	31	31	6.10	1.89	2.00	5.00	6.00	8.00	10.00

Analysis Variable : stmt2 stmt2									
Teacher_Race	N Obs	N	Mean	Std Dev	Minimum	25th Pctl	Median	75th Pctl	Maximum
0	37	37	6.41	2.29	2.00	5.00	6.00	8.00	10.00
1	31	31	4.00	2.29	1.00	2.00	4.00	6.00	8.00

Analysis Variable : stmt3 stmt3									
Teacher_Race	N Obs	N	Mean	Std Dev	Minimum	25th Pctl	Median	75th Pctl	Maximum
0	37	37	5.76	2.75	1.00	4.00	6.00	8.00	10.00
1	31	31	3.19	1.78	1.00	2.00	3.00	5.00	7.00

Note: For race, 0=White, 1=Black

The variables of interest here are the students’ ratings of the first three statements on the student surveys and teacher race. Particularly, the variables that will help me determine whether race plays a significant role in FoK incorporation are the statements’ ratings as the

continuous dependent variable and the teacher race as the binary independent variable. A *t*-test is most appropriate because there are only two categories for teacher race in this study. However, if the data deviated from a normal distribution, I used the nonparametric Wilcoxon rank sum test. I aggregated the data for each statement on race, and only used *t*-test if both *p*-values reflected no statistical difference (see Table 39); otherwise, I used the Wilcoxon test. As a result, statement one was analyzed using a *t*-test, and the others Wilcoxon.

Statement One: Student Surveys. Since statement one's variances for Black and White teachers are not equal (see summary statistics in Table 39), I used the un-pooled testing procedure (Satterthwaite method). There is no statistical difference ($p=0.6756$) between Black and White teachers. With respective mean scores of 5.89 and 6.10, both White and Black teachers fit into the *sometimes* category for statement one. Therefore, according to the students, real world problems are sometimes an aspect in math learning.

Table 40
Results for Shapiro-Wilk (S-W) Test for Normality, by Race

Variable	Description	S-W <i>p</i> -value for:		Statistical Results for Comparing Means/Medians:
		White (0)	Black (1)	
Stmt1	Real-world problems are a regular aspect of what my math teacher uses to teach me.	0.0939	0.3117	<i>t</i> -test <i>p</i> -value=0.6756
Stmt2	My math teacher uses my everyday experiences to help me learn or understand math.	0.0922	0.0132	Wilcoxon <i>p</i> -value<0.0001
Stmt3	We relate issues in my community to the math taught in this class.	0.0576	0.0160	Wilcoxon <i>p</i> -value<0.0001

Statements Two and Three: Student Surveys. According to the results in Table 40, race plays a significant role in the ratings for statements two and three (both *p*-values less than 0.0001). White teachers had higher mean scores for statements two and three, with the same standard deviation for statement two. According to the median scores on statements two and three (Median=6.00), the students in the White teachers' classroom felt like their teacher used their everyday experiences to help them learn or understand math and related issues in their community to the math taught in class *some of the time*. For Black teachers, with median scores on statements two (Median=4.00) and three (Median=3.00), the students felt that it was a *rare* occasion for their teachers to use everyday experiences to help them

learn, and relate community issues to math teaching. In sum, the ratings of statements two and three between White and Black teachers are statistically different, where the White teachers have a higher mean score over Black teachers for both statements.

The next and final chapter is the Discussion chapter where I will interpret the findings, and describe the study limitations, recommendations for future research, and the implications for mathematics education research and practice.

CHAPTER 5: DISCUSSION

The purpose of the study was to explore how high school mathematics teachers integrate the cultural and community knowledge from their diverse student populations into classroom practices. There were three goals for this exploration: (a) describe how teachers integrate students' funds of knowledge (FoK) into instruction, (b) determine how each teacher's experience has a role in the integration of students' FoK, and (c) determine how each teacher's race has a role in the integration of students' FoK. I have added to the research on what we know about knowledge bases, particularly FoK, as related to high school mathematics involving different races and experience levels of teachers. This chapter will provide a summary of the study, relate the findings to prior research, describe associated limitations, and suggest possible directions for further research.

For the first research question, "How are high school mathematics teachers in diverse classrooms connecting instruction to students' cultural/community funds of knowledge?", the teacher behaviors were found to be described with the following themes: Contextual Problems, Dialogue, and Discovery. Contextual problems were problems that teachers used to apply a mathematical concept to a real life situation, some authentic to students. These may have been presented during the warmup or classwork; however, students may have also encountered contextual problems in their homework assignments. Dialogue was any social interaction between teachers and their students that may have revolved around students' FoK. The interaction may take place during instructional or non-instructional moments in class. Lastly, Discovery was the opportunity granted to students where they were able to brainstorm and think of ideas that connect to the task at hand from their lives. All teachers showed

behaviors for all themes except in the case of Mr. McMillian for the Discovery theme. All teachers landed in different places on Aguirre et al.'s (2012b) learning trajectory for key practices for engaging students' knowledge bases (see Figure 3 in the Literature Review). Recall that the three major areas of the learning trajectory are Initial Practices, Making Connections, and Incorporating. Although this trajectory was intended for pre-service teachers, further study can explore the quality of FoK integration by indicating where the in-service teachers in this study are on the continuum-based trajectory for students' knowledge bases.

Although there was no distinction in how teachers helped students of different cultures, there was a difference found in the alignment of students' FoK and classroom contexts. Data from the White and non-White students in Ms. Monroe ($p=0.0699$) and Mr. Ferguson's ($p=0.0164$) class showed a statistical difference with the matches between students' FoK and contexts used during instruction. Students in all classes felt that their teachers sometimes used real world problems as a regular aspect while teaching them. The frequency of 'sometimes' was indicated by a mean ranging from 5.24 to 6.45. Ms. Monroe's class felt that she used their everyday experiences most of the time ($M=7.25$). The students in Mr. Pryor and Mr. Ferguson's class felt that their experiences were used sometimes with respective means of 5.41 and 4.94, while Mr. McMillian's students felt that it was a rare occurrence for him to use their everyday experiences to teach them. Ms. Monroe's class was the only one in the study that indicated that issues in their community relate to the math they learn in class most of the time ($M=7.10$); all other teachers' students reported that it was rare or it happened sometimes.

For the second research question, I found that the novice teachers used more FoK than the master teachers in the study; however all teachers in the study credited their experiences (non-teaching and teaching) as helpful for improving or refining their craft. The master teachers were more traditional in their teaching strategies with minimal to no connection to students' FoK, which was a contrast from the methods and teaching strategies used by the novice teachers. There are no significant differences among experience levels as it relates to different race groups of students having their FoK incorporated to learn mathematics.

Both experience levels had low means on Dimension 7 scores when I analyzed the observations over a five-day period. Novice and master teachers had respective means of 2.00 and 2.20, which reveals that there was at least one instance of connecting math learned in the classroom to students' FoK. As a result with such close mean scores, there was no significant difference between master and novice teachers on Dimension 7 ($p=0.6520$).

Similarly, there were no significant differences between experience levels relative to White and non-White students getting their FoK incorporated into their math learning; 84% of students in the novice teachers' classes and 94% in the master teachers' classes did not have their FoK used while they learned math in their classes. The only statement on the student survey that showed a statistical difference ($p=0.0013$) is the second statement about the math teacher using students' everyday experiences to help them learn or understand math. The novice (Mean=6.19) and master teachers (M=4.18) are different according to how their students' perceptions of how often their teacher used their everyday experiences for math learning. The students in the novice teachers' class ranked this statement as *sometimes* occurring, while the master teachers' students ranked it as *rarely* occurring.

Lastly, the results from the analysis on the third research question revealed that the White teachers in the study used their students' FoK more than the Black teachers. Mr. Ferguson was the only teacher in the study who felt that race played a role, as he desired to prove to his colleagues and administration his worth as a teacher. Ms. Monroe felt that her race did play a role but does not any longer as far as how she interacts with and teaches her diverse students while using their informal knowledge bases in instruction. After conducting a Wilcoxon test on the Dimension 7 data by teacher race, there were no significant difference found between White and Black teachers in the study (p -value=0.7525). This means that there was no difference between races in the degree to which they used relevant and authentic situations from their students' lives.

Similar to the second research question, Black and White teachers had respective means of 2.30 and 1.90, which reveals that there was at least one instance of connecting math learned in the classroom to students' FoK. Although there was no statistical difference between teacher races for incorporating students' out-of-school activities from the students' perspective, White teachers had a higher percentage (13.5%) of students who stated that their teacher used their out-of-school activities when teaching mathematics. Meanwhile, Black teachers had almost 10% of the students who had a similar perspective. Next I will describe how the study findings confirm, disconfirm, or extend knowledge in mathematics education with support from literature described in Chapter 2.

Cultural Pedagogy

It is highly probable that teachers will encounter students in their classrooms that are culturally different from themselves (Swartz, 2003; Walker, 2007). We assume these differences are not adequately addressed in teacher education programs because research has shown that teachers are not prepared to interact with or teach diverse students (Gay, 2000, 2002; Walker, 2007). All teachers in the study noted differences between their students and themselves, and how it has impacted their teaching. Mr. Pryor described how he unintentionally offended someone's culture in the past, Mr. Ferguson and Ms. Monroe never interacted with Native Americans before teaching them, and Mr. McMillian talked about the language barrier between Hispanic students and himself. As far as teacher education, Mr. Pryor recalled one particular workshop on cultural differences within the last 20 years of his career; however it did not involve any mathematical content or different ways to deliver content to diverse students. Mr. Ferguson described a previously taken graduate course on cultural diversity. Like Mr. Pryor's workshop, Mr. Ferguson's course did not include mathematical content. The other two teachers never mentioned such an experience. Mr. McMillian and Ms. Monroe had negative experiences with workshops and conferences. They each highlighted one experience not directly related to teaching diverse students that stood out in a good way; Ms. Monroe participated in PBL training that helped her incorporate more hands-on activities and her TFA experience which helped her build meaningful relationships with her students. Mr. McMillian found the weekly faculty meetings that teach pedagogical strategies useful and has applied them to his teaching style.

Culturally relevant teachers recognize the interplay of learning and culture, view diverse students' cultural capital as rich resources for the classroom, and use non-traditional means to assess what students know using teaching strategies such as poetry, rap, role play, and group projects (Howard, 2003; Ladson-Billings, 1995b; Leonard, 2008). Although behaviors of culturally relevant teaching are clearly described in the literature, its implementation in the mathematics classroom is minimal, particularly in novice teachers (Albert, 2000; Ladson-Billings, 1994). I found evidence disconfirming that novice teachers fail to implement culturally relevant teaching. The novice teachers in the study were using non-traditional pedagogical strategies to tap into different knowledge bases of their students, which constitutes as behaviors aligned with those of culturally relevant teachers.

Both Mr. Ferguson and Ms. Monroe had their students working on group projects, investigations, and role play. For instance, Mr. Ferguson's *Raisin in the Sun* project had the students in his class portray roles of different characters in a book they read in English class. They also watched the play to bring the story to life. When teaching factorials, Ms. Monroe had students to do an enactment of being at a bus stop standing in the front of the class, changing positions as many times as they could without repeating an order. For both instances, I witnessed a high level of engagement and participation from the students. On the other hand, the master teachers in the study, Mr. McMillian and Mr. Pryor, did not capture the needs, interests, or cultural backgrounds of their students, as depicted in Howard (2003). As a result, one may contend that the voices of the diverse population in these classrooms were marginalized. Mr. McMillian and Mr. Pryor were using dated notes and/or

texts with little to no adjustments to their traditional Eurocentric teaching style for the present class; this is in agreement with findings from Howard (2003) and Leonard (2008).

Instead of helping teachers finely tune lessons and reflect after lessons were implemented as a means of improvement or professional development (Rubel, 2012), I chose to ask teachers questions to allow them to reflect after watching selected video segments of their teaching.

As teachers watched themselves, they explained their intended purpose of particular actions if they could recall their rationale. Watching the video helped teachers become aware of the happenings in their classroom that they did not notice during the observation of their students; this made for a better reflection. While interviewing the teachers after their observations, they discussed how to improve their lessons based on the evaluative guiding questions from the Aguirre and Zavala's (2013) CRMT tool. For instance, when asked how their lesson helps students connect math with relevant situations in their students' lives, the guiding question for Dimension 7, teachers typically responded with how well they felt their lesson addressed this dimension followed by how they could improve at making this connection. Mr. McMillian was not clear on what I meant so I gave him music that his students may enjoy as an example to link into a contextual problem. When I mentioned rap music, Mr. McMillian quickly stated how he did not like rap music. Although Mr. McMillian and his students enjoy different genres of music, he expressed the possibility of finding ways to connect other students' interests to math instruction:

So when it comes to their music and things like that, we have no things, because I have no idea what they're talking about. Matter of fact when I listen to rap I don't even know

the things that are said. I hear the beat but I can't make out the words. So no, I don't combine that as much as I probably should.

Teachers at School B who previously taught Ms. Monroe's students spoke to her about her students before she met them in a negative manner. But she made a deliberative decision to wipe the slate clean in order to not have preconceived notions about her students. This relates to research which found that teachers can diffuse potentially negative relationships by finding ways to value the skills and abilities of students and channeling them for academic success (Ladson-Billings, 1995a; Leonard, 2003). Ms. Monroe valued her students' skills and abilities when she asked a student to draw the cover for their word problem book, and encouraged him to enter into other art exhibits. For the next section, I will connect my study to literature on funds of knowledge.

Funds of Knowledge

As described in Chapter 2, FoK uses life experiences from students that can be valued and incorporated into the classroom; much of this research was conducted in grades K-8. Here I studied four high school math classrooms to learn how teachers are connecting the students' cultures and communities into mathematics instruction, expanding the pool of literature around FoK. Examples of the use of students' FoK came from three of the teachers.

Mr. McMillian mentioned during the preliminary interview that he has replaced names in contextual problems in an attempt to make problems more relatable to his students, no matter how far removed students were from the topic. During the observations, he added context to a geometric sequence problem by supplementing the problem with a story line about a king. However, he later reflected on this lesson and admitted that the king context was not relevant

to the students' lives at all. Ms. Monroe also added names into contextual problems but took it a step further by incorporating something a particular student liked to do. She gave me an example about a system of equations and including the context of softball with a particular students' name that she knew played softball. Lastly, Mr. Ferguson allowed students to draw from their culture during projects, and asked about relevant topics in class with his food for thought discussion.

Mr. McMillian and Mr. Ferguson were also involved with their students in a school wide project where they were given a problem to mathematize. This related to the research that proposes that teachers can create projects that integrate ideas from their students' communities to math instruction (González et al. 2005; Ladson-Billings & Tate, 1995; Leonard et al., 2009). Ms. Monroe created problems and projects involving real issues in her students' community as well. During instruction, Ms. Monroe also asked for examples in their lives as it related to the math lesson. For instance, when working out a contextual problem involving a cylinder, she asked them what things could her students think of that were cylindrically shaped as a means to connect what they know to something they were learning. Similarly with language, Ms. Monroe let her students brainstorm to think of words with the same prefix as the math terms she was teaching for students to be able to associate words they knew to the vocabulary they were learning:

I hope using real stuff like that helped them connect this with stuff and I think it has. Poly-...I don't think we got into that. That's not a, you don't hear a lot of except for polygamy I guess. We didn't talk about that. That would be a good one. I'm going to write that down so I can (Laughter) say that at some point. (Ms. Monroe writes down

'polygamy') I don't think it supports English Language Learners because we don't have those. But at the same time, I do think it makes some connections. It helps them make connections to helping know what it means because they know what part of that word means in another word or something.

She used Spanish cognates analogously to explain what conjugates were with binomial expressions when factoring special cases, like difference of two squares. Spanish cognates are Spanish words that have similar spelling and meaning in English. For example, the Spanish word *inteligente* translates to *intelligent* in English. As students in Mr. Pryor's class were learning about compounded interest, students became really intrigued with how money worked with buying houses and cars and saving or borrowing money from a bank. Although Mr. Pryor had no original intention of extending the discussion on these real life and meaningful concepts to his students, he noticed their piqued interest and continued the conversation and life lesson. One student mentioned a situation he learned about concerning interest on an ancient account where a man left money to a great, great, great grandson, and Mr. Pryor immediately began to mathematize the situation for the class to see how much money would be left to the great, great, great grandson. Through this activity, they were able to model a real life situation and think critically about the situation at hand. By mathematizing real situations in their lives, students realize the useful applications of mathematics. In the next section I will discuss how literature on language negotiation affirms or contradicts the study findings.

The Negotiation of Language

Many education researchers have examined language negotiation through code-switching and code-mixing to benefit classroom learning (Aguirre & Zavala, 2013; Bose & Choudhury, 2010; Mackinney & Rios-Aguilar, 2012; Smitherman, 1998). Aguirre and Zavala's (2013) CRMT framework and corresponding tool had a two-fold dimension (Dimensions 6A and 6B) to accommodate language use and its negotiation (see Appendix L). Particularly, the dimensions focus on academic language support and scaffolding strategies for English language learners. These two dimensions are less implemented and less developed for teachers in general since most teacher evaluation and education primarily deal with mathematical thinking and pedagogical content knowledge (Aguirre & Zavala, 2013). As language is a part of one's culture, I intended to use the language dimension for the study to understand how language was negotiated during mathematics instruction.

However, unlike the Aguirre and Zavala's (2013) study, I did not have many ESL students to produce rich data to highlight the language dimension. Since foreign language was so scarcely observed with minimal dialogue among teachers and students, I broadened the scope of language to include dialects of English including African American Vernacular English (Lanehart, 1998; Pullum, 1999; Smitherman, 1998; Tamura, 2002). I then intended to define code-switching and mixing as the switching between formal and informal English found during the study. Despite my attempt to expand language for more data, there was minimal evidence to support the use of the language dimensions here. As a result, I decided to not report its findings here. For future studies, I will purposefully seek out more

classrooms where more than one language is spoken to capture more evidence to support the implementation of the language dimensions of the CRMT tool.

Critical Race Theory

In this section, I connect critical race theory, my theoretical lens, to what I found in the study; I connect each of the five tenets of the critical race theory described in Chapter 2 to aspects of the study where appropriate. Recall the five tenets according to Ladson-Billings (2013) and Delgado and Stefancic (2012): (a) racism as normal, (b) interest convergence, (c) race as a social construction, (d) intersectionality and anti-essentialism, and (e) voice or counter-narrative.

Racism as normal. Ladson-Billings (2013) has affirmed that the first CRT tenet does not simply highlight random, isolated acts of poor behavior, but it should be recognized as the normal order of things in American society. During the preliminary interview, Ms. Monroe admitted to having a racist upbringing. She accredited her experiences after leaving home for college and the TFA program for helping her to be able to positively and meaningfully interact with diverse students that she otherwise would not have been able to with back home. According to literature, many teachers do not have meaningful interactions with individuals that live in communities outside of their own (Battey, 2013; Sleeter, 2008; Walker, 2007; Zozakiewicz, 2010), but Ms. Monroe was afforded this opportunity through TFA. She was transparent with her students and openly talked about race and racism with them in the classroom through instructional and non-instructional dialogue.

Mr. Ferguson stated that some people may consider him racist as a pro-Black man. The definition of pro-Black is not well defined in literature, and the conception of whether pro-

Black means anti-White has been debated for over 40 years (Herring, Jankowski, & Brown; 1999; Paige, 1970). For a better understanding of pro-Black, I compiled the following six characteristics (African-American Forum, 2015):

- Does not succumb to Eurocentric styles with hair (i.e., no relaxing agents are applied in a woman's hair);
- Only dates or marries within their race;
- Does not discriminate against darker skin Blacks or hold lighter skin Blacks on a pedestal;
- Embraces physical features that are identified with Black people;
- Is confident in themselves, appearance, and culture; and
- Someone who is knowledgeable as well as aware of history and the reasons for the self-hate in the Black community.

I witnessed some of these pro-Black characteristics during interviewing with Mr. Ferguson. Whether Blacks could be considered racist depends on how one defines racism. Feagin and Vera (1995) argued that there are Blacks with anti-White prejudices and Black discrimination against Whites; however these instances do not dictate how society operates, nor are they rooted within the structure of traditional racism. Pilgrim (2009) defined racism in various ways with three ways where Blacks could not be considered racists and one where Blacks could be racists. According to Pilgrim, if one defines racist in one of the following three ways, Blacks *can* be racists:

- prejudice against or hatred toward another race;

- the belief that race is the primary determinant of human traits and capacities and that racial difference produce an inherent superiority of a particular race; and
- prejudice *and* discrimination root in race-based loathing.

However, if racism is defined as “a system of group privilege by those who have a disproportionate share of society’s power, prestige, property, and privilege,” then Blacks *cannot* be racists (Pilgrim, 2009). Mr. Ferguson never defined racism to determine whether he actually is a racist. Nevertheless, Pilgrim argued that individual Blacks could be racists, but Blacks as a collective did not create racism that permeates society. By Pilgrim’s argument, it is not likely Mr. Ferguson is a racist.

Interest convergence. Most CRT scholars support the interest convergence tenet, which states that there exists a racial hierarchy of White over color serving its purpose for the dominant group (Delgado & Stefancic, 2012). Further, Bell (1980) argued that racial justice is only sought by White people when there is something in it for them. Palmer (2010) used interest convergence and the right to exclude in order to frame her analysis while ethnographically investigating parents of diverse second grade students in a school with a dual-language program. The author provides additional clarity with the construct of colorblind racism (Bonilla-Silva, 2006) and normative whiteness (Hurd, 2008); the former is the unwillingness to openly acknowledge racial issues, and the latter is the expectation of assimilative integration.

Considering how Palmer (2010) discussed interest convergence to include colorblind racism speaks to the reluctance that some of the participants had while addressing race in the classroom during their interviews. Mr. Pryor felt that it would be in his best interest to not

talk about race to avoid offending students and backlash from parents and administration. He also exhibited colorblind racism since he stated that he sees gray when his students initially enter his classroom.

Race as a social construction. Delgado and Stefancic (2012) delineated the tenet of race as a social construction as a view that races are products of social thought and relations with no biological or genetic reality; instead, races are categories that society invents and manipulates. In Martin (2006), the themes that emerged were related to race as a social construction, and they were similar to ideas noted in the study. Martin's study found that Black parents considered race as a factor in their struggles with mathematics, extending to shaping their identities and their children in their community as Blacks and mathematics learners. Connecting to this research, Mr. McMillian and Mr. Ferguson talked about how they did not accept excuses from students or their parents. Mr. McMillian has had parents come to him telling him that the reason why their children were doing poorly was because they were not good math students. Mr. McMillian empathized with parents by telling them how he was a poor math student, and how things began to change for him after he applied himself to his studies. Another theme in Martin's study that was evident here was parents experiencing racial discrimination in many different mathematics contexts where they had to prove themselves competent. Similar to the parents in the study, Mr. Ferguson felt that race play a role in how he teaches mathematics because he has been ridiculed for the way he speaks and felt like he was under heavy surveillance by administration. He stated that he felt he had a point to prove as he made conscious efforts to use innovative teaching strategies with his students.

Intersectionality. The intersectionality (or anti-essentialism) principle is the belief that no individual can possess a single identity, loyalty, or allegiance, but rather overlapping ones (Delgado & Stefancic, 2012). The teachers in the study that acknowledged roles that their students have outside of being a student have made attempts to teach the whole student (Brown-Jeffy & Cooper, 2011; González et al., 2005). By nurturing different dimensions of students, the teachers were able to help students discover newfound interests and develop those already within them. Some instances where intersectionality occurred within the study were when Ms. Monroe noticed a student's artistic ability and she gave him an opportunity to exhibit his talent, Mr. Ferguson drew on students' cultures for projects, or Mr. Pryor showed appreciation by celebrating a cultural holiday with a student. However, Mr. Pryor's approach may be viewed as the infamous holidays and heroes approach to cultural integration, where culture is only appreciated in isolated events (Frankenstein, 2005; González et al., 2005). Ms. Monroe, Mr. Pryor, and Mr. Ferguson were involved in community events, showing students that teachers were not unidimensional but also members of their community. Mr. Ferguson and Ms. Monroe have mentioned some community projects that they have drawn on for students to see the connection in their math class.

Voice or counter-narrative. As described in Chapter 2, critical race theorists believe that minorities have different histories and experiences with oppression that they may be able to relay to their White counterparts (Delgado & Stefancic, 2012; Lynn & Dixson, 2013). CRT scholars use chronicles, storytelling, and counter-narratives to reveal everyday existences of racism and racial discrimination through people of color. Mr. Ferguson and Ms. Monroe exemplified the voice tenet in our conversations. They felt that historical or current

events, particularly race related ones, were for everyone to know about, not just the affected race.

Harris (1993) conceptualized whiteness as property and discusses how the legal system affords privilege and power to Whites. She told a story about how her fair-skinned grandmother passed for White and was able benefit from such affordances. In contrast, Mr. Ferguson developed a project where all students portrayed Black characters and are denied privileges they would have had otherwise. Through this experience, students became the story they read in English class to understand the social and economic aspects of being Black in the 1950s. Further, Mr. Ferguson told stories about historic Black voting rights in the US and the *Willie Lynch letter* in order to prove to students that needed to know their history in order to become an improved generation than the one before and to not succumb to ignorant behaviors.

Mr. McMillian had a similar upbringing to students in DeCuir-Gunby (2007), who used interviews to expose the counter-stories of the ways in which six Black high school students negotiated class and race identity at a predominately White school. Similar to one of the interviewed students in DeCuir-Gunby's study, he did not interact closely with other Black students his age until high school at which time he was culturally shocked. Additionally, the students around him were very different as he was previously in predominately White schools. This is an interesting revelation as Mr. McMillian did not feel that race played a role in how he taught his students or his approach to teaching any particular race.

As far as the other teachers, Ms. Monroe has shared stories about how she felt that race used to play a role, but since her experiences with TFA, she began to empathize with her

students with how it feels to be a minority and now has better relationships with her students. Mr. Pryor mentioned that it was difficult for him to relate to his Black students, even though he does not feel his race played a role in how he teaches diverse students or incorporate their FoK.

In sum, findings in the study conflicted with what was previously found in the literature.

Limitations of the Study

Because this is an MMR study, I used qualitative and quantitative measures to study the phenomena of teacher behaviors as they lend themselves to students' FoK in math instruction, and race and experience as factors in doing so. All methods of data collection have limitations, and the use of multiple methods can counteract or eliminate some of the drawbacks of certain methods, thus strengthening a study (Creswell & Plano Clark, 2011; Teddlie & Tashakkori, 2011). Nevertheless, as with any investigation, there are limitations that may arise. Particularly, there are three types of limitations: (a) study design, (b) impact, and (c) statistical or data limitations (Creswell & Plano Clark, 2011). I will define and address each type below as they were realized in the study.

Study design limitations. Limitations of a study design include procedures that may affect the outcome. As mentioned above, using MMR study design may eliminate this limitation to some extent as I did not assume one single methodology. The quantitative results for the research question answered whether or not each teacher used their students' out-of-school activities, and how many matches occurred between teachers' contexts and students' out-of-school activities. I reported the observed contexts, while out-of-school activities were reported by the students on the student surveys.

There were instances during data collection (i.e., preliminary interviews) where teachers had difficulty in answering certain questions. In some of their attempts to answer the interview questions, they struggled to answer questions or derailed the question altogether. As a result, I restated the question differently, but still ultimately got similar results. More attention to reflexivity of the data sources in the future will eliminate questions that are more research-oriented and less practical. In the future, I will be sure to have someone to interview me with the same questions I intend to ask interviewees to ensure the questions will get the appropriate responses to answer the research questions. I will use a proxy or a collection of questions closely related to my research questions in order to get the desired result.

Another limitation that may influence the outcome is the researcher. As I am an instrument in the qualitative component of my research, I may have different interpretations compared to other researchers who may replicate a similar study. Another limitation of the study design is the use of one external rater. More raters could have ultimately strengthened the study and changed the dynamic of what incidences were considered critical when watching the video segments. In turn, I may have received more feedback on how to modify the rubric.

Impact limitations. A study can suffer from limited impact due to the location or site. Said differently, if results are only conducive to a particular region or population, the study will not have much impact or applicability elsewhere. This study took place in three rural schools. Although the schools are in different school districts and counties, the fact of them all being classified as rural may spark some generalizability issues. Also, the two teachers

from the same school were both of the same race. One may believe these teachers hold the same philosophies, further questioning generalizability.

Statistical limitations. Stemming from the study design, the final type of limitation is that which one may not be able to collect as much or as good data as intended. Being able to find ideal study participants was difficult; this could undermine the results. I accepted participants on a volunteer basis based on the following criteria: teacher was teaching a Common core math class during the time of the study, teacher race and experience level, and the level of ethnic diversity was present in their classroom. None of the observed classes were as linguistically diverse as desired, which took away from the use of the language dimension of the CRMT tool, even after adjusting for informal language constructs. I witnessed minimal code-mixing and switching and, as a result, was not afforded the opportunity to adequately report on this dimension of the conceptual framework. I discuss ways to modify the framework in the next section.

I collected student data such as their interests and hobbies on the student survey; however, I did not collect data on how much time was allocated to these out of school activities. A closer look at how students spend their time may warrant different results. This area would need further study.

There were four teacher participants in the study with approximately 20 students per class. With such a small study sample, the results are not generalizable to studies with larger samples. Additionally, from the received responses on the surveys, I noticed that some of the students misunderstood the expectation. The teachers had to resubmit the surveys for students to think about the questions some more before I collected them. In addition, some of

the students left questions blank, taking away from the pool of data. With full participation and appropriately answered questions, the results could possibly have been different.

Now that I have depicted limitations encountered in the study, I will address recommendations for further research grounded in the strengths and limitations of the present study in addition to literature in Chapter 2.

Recommendations for Further Interventions and Research

Further research grounded in this study as well as in the literature from Chapter 2 is warranted. First, I would recommend the development of a more ethnographic project like other FoK researchers to have teachers visit students' homes and communities, immersing themselves in their students' lives (Aguirre et al., 2012 a, b; González et al., 2005; Moll et al., 2001). There is minimal research that studies teachers doing so for the high school level. Through this experience, I believe teachers would become more empathetic and sensitive to what their students encounter on a daily basis, and also would be able to draw on these experiences for instruction to improve student engagement and achievement. A comparative study to measure engagement and achievement before and after community visits would be something to consider.

Second, all of the teachers in the study mentioned how their school districts did not provide adequate training for teaching culturally diverse students in mathematics. Either the workshops had culture without math, or math without culture. I want to conduct action research in the form of Aguirre and Zavala (2013) and Rubel and Chu's (2012) professional development projects by helping teachers restructure tasks to be more culturally relevant. I would start out small with volunteer teachers who want to learn how to teach in a culturally

relevant way, like in Ukpokodu (2011). I would have teachers to bring tasks in with them and have them to critique their own task and each other's according the CRMT tool. I would have them to partner up where teachers who scored low and high are together so that the high scorers and help the others to make their task or lesson more culturally relevant. I want to measure achievement and engagement before and after revisions of more culturally relevant tasks to test whether increasing lesson authenticity has a positive effect on students. In an effort of making teachers more conscious of their behaviors, one could incorporate the video aspect as used in this study during debriefing sessions immediately after teaching for the highest level of recall. Further study could also include selected students to watch the video to look for major themes from dimensions. One could provide questions or indicators for students to find critical behaviors as they related to the dimensions of the CRMT tool.

While conducting this study, I intended to consider the last three dimensions of the CRMT tool (Aguirre & Zavala, 2013; Aguirre et al., 2012a) concerning academic language development, FoK, and social justice. Due to the nature of the data, I primarily focused on the FoK dimension. In further research, I plan to explore the other two dimensions in more detail and all six dimensions including mathematical thinking to confirm whether teachers are more developed with those than the dimensions that were used in this study (Aguirre & Zavala, 2013). Culturally responsive teaching occurs minimally in mathematics teaching (Kitchen et al., 2007) and all of these dimensions studied together may reveal some interesting results.

My reliability partner during this study suggested some clarifying modifications to the conceptual framework, namely the CRMT tool (Aguirre & Zavala, 2013; Aguirre et al.,

2012a). In particular, my colleague suggested putting a concrete number or number range in the descriptions for the scores for easier distinction between a score of two or three, for instance. Another suggestion offered was an explicit list of scaffolding strategies for the Dimension 6B for academic language supports for ELs. Language is a huge part of culture, as many people in the same culture share the same or similar language. Due to the nature of the data, I was not able to capture language negotiation as anticipated. I want to conduct a similar study with a different sample that has more linguistic diversity. Staying in the field longer or having natives to assist from the site under study may form a baseline of language in order to pick up on informal or foreign language can help with making sure I capture the language used between teachers and students. Further, I will interact with students more to help form the language baseline. The framework mentions 'L1' as being a home language, which typically means a foreign language that is the students' first language. Further study is needed on how to effectively modify the framework to broaden the definition of L1 to include Black Vernacular English and other English dialects, depending on the diversity of the site.

Although critical race theory framed the study, I would like to focus in on the voice tenet (Delgado & Stefancic, 2012; Ladson-Billings, 2013; Lynn & Dixson, 2013). My rationale for this desire stems from the stories I encountered during the interview. Focusing in on the stories from teachers and eventually students can share a great deal about how teachers and students perceive mathematics teaching and learning. Further research will include student interviews in a video recorded group setting to capture emotions and gestures. Moreover, a

journal in addition to interviews and observations will help tell the stories of students and what they face in the classroom and how it links to their community.

Researchers have focused more on learning in urban settings (DeCuir-Gunby, 2009; Leonard et al., 2009; Rubel & Chu, 2012) and less so in rural ones (Lipka & Adams, 2009). Arnold, Newman, Gaddy, and Dean (2005) presented empirical evidence that there is a lack of high quality rural education research studies. More quality research needs to be conducted in rural education. I would argue more longitudinal studies around math education should also be considered. In addition, a similar study can be more generalizable given more participants. There were only four teacher participants and a total of 69 students. A research team may be able to broaden the scope of settings to find whether the results here stand firm beside studies with a larger and more diverse selection of teachers.

This research may expand out of the mathematics classroom and matriculate into other contexts. While attending to language during instruction, teachers may find the use of the CRMT tool useful in the evaluation of their lessons to learn whether they are using students' language and dialects as deficits or assets in the classroom. Projects to learn how teachers are incorporating their students' FoK may be interdisciplinary in nature where teachers of different content areas collaborate on how to use a common theme or community problem to help learn and apply concepts in their respective content areas. For instance, a project linking science, technology, engineering, and mathematics (STEM) fields with students' lived experiences can help them see the importance and relevance of these fields, and in turn, motivate students to pursue STEM careers. To conclude the study, I have implications for classroom teachers and teacher educators below.

Implications

Teacher education. This study has shed light on how secondary math teachers incorporate diverse students' FoK, and ways that their experience and race played a role. In this section, I discuss teacher education for both pre-service and in-service teachers.

Pre-service teachers. For pre-service teachers, teacher educators within teacher education programs need to model culturally relevant teaching for their respective subject matter. For instance, teacher educators could demonstrate how to write a task that is culturally relevant and give them time to develop their skills in doing so before they go into the classroom. As an extension, projects could be administered where the pre-service teachers implement their tasks on a small group of grade appropriate students and get their tasks evaluated using the CRMT tool for ongoing refinement.

Another implication for teacher education is to have teachers to read more literature on culturally relevant teaching in order for more exposure and familiarity prior to teaching. To see how cultural pedagogy has been implemented into mathematics classroom, I would suggest Leonard's (2008) *Culturally specific pedagogy in the mathematics classroom: Strategies for teachers and students*. This work has a collection of different ways that cultural pedagogy has been implemented to give pre-service teachers ways to incorporate their students' culture into their mathematics lesson. Another reading I would suggest is Rubel and Chu's (2012) *Reinscribing urban: Teaching high school mathematics in low income, urban communities of color*. This would be for a teacher educator who is training teachers to be more culturally relevant, as this article describes a professional development project that help teachers become more culturally relevant in their teaching. Teacher

educators can play the role of the PD facilitator and have teachers write their own tasks or bring one in to be modified. After training them on the CureMap principles, teachers can be charged to further develop their tasks into something more meaningful for their current or potential students. By studying both practitioner and research articles, teacher educators are able to bridge the gap between research and practice.

The last implication for pre-service teacher education is for pre-service teachers to go into communities similar to those where they will be teaching. One great read to facilitate the community visits is Gonzalez et al.'s (2005) *Funds of knowledge: Theorizing practices in households, communities, and classrooms*. In this book, several authors write about their experiences as the teacher and the researcher when visiting homes of students in different types of communities. Projects are outlined describing where teachers go and how they went about collecting the data needed from the communities to create the lessons for meaningful classroom learning. The interactions in students' neighborhoods can give teachers insight and understanding of the student, and can show the student that the teacher cares. Meaningful interactions and sensitivity training should not be a clinical experience in the classroom; instead pre-service teachers should have real experiences out in the field building rapport and forming relationships prior to teaching. In addition, this experience prepares teachers by developing their skillset on restructuring and developing tasks. Next I will discuss implications for classroom teachers.

In-service teachers. Beyond teacher education programs, many teachers are not afforded opportunities to learn about cultural relevant teaching specific to their content area. Similar to the implications above, in-service teachers can visit homes and communities of their future or

current students to capture ideas to include in their instruction. The primary goal of home visits is to gather assets and knowledge bases to take back to schools and, in turn, inform instruction. Another key aspect in these visits is for teachers to not have a deficit-oriented eye and look deeper beyond potential socio-economic hardships. A couple of teachers in the study mentioned the hardships of their students. Mr. McMillian talked about how some students may not have certain economic resources like a computer to access homework assignments, so he gives them a hard copy. Also, Ms. Monroe mentioned students that work full time and were the head of their household, but had to maintain their school duties. She gave them extra time on assignments and assigned minimal homework as a way to show her understanding and empathy for their situation. However, she never lowered her expectation and held all students to a high standard.

Another implication for classroom teachers is to seek out culturally relevant workshops beyond their district. By researching what is available outside of the district, teachers can inform their colleagues and encourage them to attend more meaningful workshops together. If resources are an issue, schools can send a selected delegate to go, retrieve information, and return to disseminate among their departments. In so doing, the novice teachers could learn from the master teachers when it comes to how to use students' knowledge bases as the foundation for their instruction.

The last implication for classroom teachers is to learn their students' language, whether it is non-Standard American English or a foreign language. Teachers may consider negotiating language in the classroom with code-mixing and code-switching for better results and rapport. Students unable to speak English well are oftentimes isolated from the social groups

within the classrooms. They are shunned and treated as less than because language is associated with power. By becoming bilingual or “bidialectal” (Tamura, 2002, p. 25), teachers can help students understand the structures of both Standard American English (SAE) and their non-standard dialect or language.

Conclusion

Although the incorporation of students’ culture and interests continues to be lacking in mathematics instruction, there were instances of incorporation evident in this small study by both Black and White teachers, but primarily by the novice teachers. As the US continues to grow more culturally diverse, teachers must make a conscious effort to get to know their students to seamlessly and meaningfully incorporate their cultures into their classroom instruction. Applying different cultures in the classroom should not be isolated instances but continuous integration throughout the school year. Educators must break down barriers between their pupils and themselves to have meaningful interactions with them and not have continual socialization with their own race or culture.

In this small study, teacher race did not play a significant role in how they incorporated students’ FoK. However, the teachers attended to race in the classroom differently with the novices being more forward about discussing race and racism than the master teachers. From the results here, one may say race does not matter, but experience level does in a reverse fashion. Experience playing a negative role may be due to teacher education programs having a stronger influence on teachers now more than they did 20 or more years ago, when the master teachers began their careers.

Despite what we know about equitable teaching using students' knowledge bases as a foundation for learning, many teachers still fail to adapt culturally responsive teaching practices in their classroom instruction. Formal learning continues to be disconnected from home life for students. I contend, though, that research suggests that academic knowledge positioned in students' lived experiences and frames of reference can be more meaningful, interesting, and learned with more ease. Further, academic achievement of diverse students can be attained as learning takes place through cultural and experiential filters.

Critical self-reflection can serve as a powerful tool for teachers who desire to improve on their culturally responsive teaching practices. Teachers might utilize Aguirre and Zavala's (2013) culturally responsive mathematics teaching (CRMT) tool or other research-based documents to examine their own development of culturally responsive mathematics teaching. During the reflective interviews, I used the guiding questions from the CRMT tool to learn how the teachers in the study viewed their teaching practices. This gave me insight on how they individually saw themselves and their level of cultural responsiveness. Just as I video recorded the teachers, they could video record themselves, watch, and critique themselves according to the descriptors on the rubric.

Similarly, researchers can continue to contribute to our understanding of cultural resources teachers use, by utilizing the same framework to evaluate what is going on in classrooms. In so doing, mathematics educators (and others) can hope to improve professional development, inform teacher education programs, and in turn create more culturally responsive teachers, improving mathematics education for all students.

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APPENDICES

Appendix A: Overview of Methods Used for Study

Table A1

Mapping of Research Questions to Data Sources and Analysis Methods

Research Questions	Data Sources	Analysis Methods
How are high school mathematics teachers in diverse classrooms connecting instruction to students' cultural/community funds of knowledge?	Preliminary interview Student surveys Classroom observations	Coding using CRMT tool Fisher's exact test Chi-square test Descriptive Statistics Graphs (bar, box plots)
Does the experience of high school mathematics teachers play a role in incorporating students' cultural/community funds of knowledge? If so, in what ways?	Preliminary interview Classroom observations Student surveys Reflective interview	Coding using CRMT tool Fisher's exact test Descriptive statistics Wilcoxon (Rank Sum) test <i>t</i> -test
Does the race of high school mathematics teachers play a role in incorporating students' cultural/community funds of knowledge? If so, in what ways?	Classroom observations Student surveys Reflective interview	Coding using CRMT tool Fisher's exact test Descriptive statistics Wilcoxon (Rank Sum) test <i>t</i> -test

Appendix B: Letter to Superintendent

Celethia K. McNeil
College of Education
Campus Box 7801
Raleigh, NC 27695
919.515.2238~ckmcnei2@ncsu.edu

January XX, 2015

[county] Board of Education
Street Address
City, State, and Zip

Attn: Superintendent [his or her last name]

Re: Approval for Dissertation Study

Dear Superintendent [his or her last name]:

I am pursuing a doctoral degree at North Carolina State University under the supervision of Dr. Karen Keene in the College of Education. As part of my dissertation study, I propose to conduct observations of and interviews with teachers who use student-centered strategies. From diverse public high schools in [school district], I hope to recruit four teachers to be part of my study. I will collect and record data through teacher interviews, student surveys, and classroom observations of Common Core mathematics instruction relevant to students' lives. I am certain that this study will not pose any unusual risk to these participants. The results from this study collectively have great potential in benefitting your school district and possibly our state as it concerns the effects of the recently implemented Common Core State Standards. The confidentiality of students and teachers' identities will be protected throughout the study and will not be disclosed in the findings.

I will obtain written consent from all teachers and students for this study. Students who are 18 years old will be able to sign their own consent form. For students who are under the age of 18, I will contact their parents and have them sign an informed consent form. For your review, I have attached the consent forms that I will have teachers, students, and/or parents to complete.

The purpose of this letter is to seek your approval to conduct this study in [county] at a maximum of four high schools. Your correspondence to this matter is required in writing, and you may send this via email or written letter for your convenience. I thank you in advance for your help in this endeavor and look forward to hearing from you soon on this matter.

Sincerely,

Celethia K. McNeil
Doctoral Student at North Carolina State University

Enclosure

Appendix C: Initial Contact Email to Principals

Dear Principal [his or her last name]:

I am pursuing a mathematics education doctoral degree at North Carolina State University. I am working under the supervision of Dr. Karen Keene in the College of Education. As part of my dissertation study, I propose to conduct observations of and interviews with mathematics teachers who use student-centered strategies to teach diverse students.

I am seeking a total of 4 (four) mathematics teachers that will be teaching Common Core Math starting in January 2015, and are successful in teaching diverse students. Each teacher would need to volunteer one and a half hours of time total for two interviews: one before and one after observation. The interviews will occur during non-instructional time in February and March, before and after the 1-2 week recorded observation period, respectively. If you have teachers in mind who are successful diverse students who may like to participate in my study, please let me know, as I am accepting volunteers and recruits for participation.

Please inform the teachers that they will receive monetary compensation for their involvement. If you would like to meet with me or need more information, please do not hesitate to contact me at ckmnei2@ncsu.edu. You may also call me at (910) 515-4514.

Thanks for your consideration in this matter,

Celethia McNeil
Doctoral Candidate in the Department of STEM Education
North Carolina State University

Appendix D: Letter to Mathematics Department Chairs and Teachers

Celethia K. McNeil
College of Education
Campus Box 7801
Raleigh, NC 27695
919.515.2238~ckmcnei2@ncsu.edu

January XX, 2015

Dear Colleague:

I am a doctoral student in the department of Science, Technology, Engineering, and Mathematics Education at North Carolina State University. My research addresses high school mathematics teachers that are successful in teaching diverse students.

I am seeking a total of 4 (four) mathematics teachers that will be teaching Common Core Math starting in January 2015, and are successful in teaching diverse students. Each teacher would need to volunteer one and a half hours of time for two interviews: one before and one after observation. The interviews will occur during non-instructional time in February and March, before and after the 1-2 week recorded observation period, respectively. I will also ask that each teacher in the study watch two video segments of their teaching and do a self-evaluation to be discussed in the second interview. Your students will be asked to complete a two-part survey. Your name, biographical information, school name, and any other identifiable data will remain completely confidential in the study.

There is no risk to you personally or professionally to participate in this study. All comments are confidential and any direct quotes or generalizations will be under a fictitious name. You will have an opportunity to review transcriptions and any other collected data. Your participation and that of other teachers will assist in understanding how teachers use student-centered strategies in their mathematics instruction. Other teacher characteristics will be considered in determining whether external factors play any additional role in how the instruction takes place.

You will receive a \$50 Visa gift card for participating in interviews, observations, and surveys. If you are interested, please respond no later than February XX, 2015.

Thanks for all your consideration; I look forward to hearing from you!

Sincerely,
Celethia K. McNeil

Appendix E: Teacher Informed Consent

North Carolina State University

INFORMED CONSENT FORM for RESEARCH

Title: A Critical Examination of Diverse Students' Funds of Knowledge Inclusion in High School Mathematics: A Mixed Methods Study

Principal Investigator: Celethia Keith McNeil

What are some general things you should know about research studies?

You are being asked to take part in a research study. Your participation in this study is voluntary. You have the right to be a part of this study, to choose not to participate or to stop participating at any time without penalty. The purpose of this research study is to gain a better understanding of student-centered teaching strategies. You are not guaranteed any personal benefits from being in a study. Research studies also may pose risks to those that participate. In this consent form you will find specific details about the research in which you are being asked to participate. If you do not understand something in this form it is your right to ask the researcher for clarification or more information. A copy of this consent form will be provided to you. If at any time you have questions about your participation, do not hesitate to contact the researcher named above.

What is the purpose of this study?

The goal of this study is to explore classroom practices of high school mathematics teachers in a diverse setting.

What will happen if you take part in the study?

If you agree to participate in this study, you will be asked to participate in the following:

- Biographical information survey (5-7 minutes). This will help provide background on each participant and can be filled out any time before March 2015.
- Preliminary interview (60-75 minutes). The purpose of this interview is to understand your perception of student-center teaching strategies. This interview will be conducted by the researcher and will be audio recorded.
- Classroom Observations (1-2 consecutive weeks). After preliminary interview, the researcher will come to your class and observe while audio and video recording the same class for the observation period. You will be asked to wear a lapel mic to ensure you are clearly audible during observations.
- Reflective interview (30 minutes). The purpose of this interview is to reflect on your self-evaluation and moments that stood out during your review of the video segments.

All of the above will occur outside of the classroom time except for the Classroom Observations. The total amount of out of class time is approximately 2 hours.

Risks

There are minimal physical or emotional risks associated with participation in this study.

Benefits

There is potential for the teacher subjects to assess and improve their interactions with diverse students during mathematics instruction. Through self-evaluation, subjects will be able to reflect on their practices to develop student-centered approaches for increased student engagement and achievement. In addition, this study may inform the field about the professional development of different experience levels of high school mathematics teachers and help teacher educators design experiences to foster teachers' interaction with students and their communities for classroom learning.

Confidentiality

The information in the study records will be kept confidential to the full extent allowed by law. All data including video files, audio files, and transcriptions will be destroyed by deconstruction five years after collection. All digital and hard copy files will be stored securely by the principal investigator. Pseudonyms and anonymous identifiers will be used in oral or written reports to avoid linking you to the study.

Compensation

Upon completion of the study, you will be given a \$50 Visa gift card to use as you wish. If you withdraw from the study prior to its completion, your data will be destroyed and you will not receive any compensation.

What if you have questions about this study?

If you have questions at any time about the study or the procedures, you may contact Ms. Celethia McNeil at (910) 515-4514 or at ckmcnei2@ncsu.edu.

What if you have questions about your rights as a research participant?

If you feel you have not been treated according to the descriptions in this form, or your rights as a participant in research have been violated during the course of this project, you may contact Deb Paxton, Regulatory Compliance Administrator, Box 7514, NCSU Campus (919-515-4514).

Consent To Participate

"I have read and understand the above information. I have received a copy of this form. I agree to participate in this study with the understanding that I may choose not to participate or to stop participating at any time without penalty or loss of benefits to which I am otherwise entitled."

Please check the appropriate box:

- I agree to participate in all aspects of this study including audio and video recordings of classrooms and interviews.
- I choose not to participate in this study.

Participant's name _____ **Date** _____

Participant's signature _____ **Date** _____

Investigator's signature _____ **Date** _____

Consent for Videotape Use in Presentations

"I consent for short excerpts of video recording from this project, as judged useful by the researcher, to be used in professional research presentations and teacher professional development materials or meetings, as long as I am not identified by name in such presentations. I agree to have the videos in which I appear shared, with the understanding that I may choose to have certain video segments excluded from the set of videos that can be used in professional research presentations and teacher professional development materials at any time and without penalties."

Participant's signature _____ **Date** _____

Investigator's signature _____ **Date** _____

Appendix F: Teacher Biographical Information Survey

Name _____

School _____

Address _____

City _____ State _____ Zip _____

Phone _____ Alternate _____

E-mail _____

1. Ethnicity (please check all that apply): White Black Hispanic

American Indian Hawaiian Pacific Multi-racial

Asian If other, please specify _____

2. Gender (please check one): F M

3. What is your highest degree level and major/program? _____

4. Total Number of Years Teaching High School Mathematics _____

5. Total Number of Years Teaching in this District _____

6. At this school _____

7. List all Common Core mathematics courses you are currently teaching:

8. Choose your most diverse Common Core class. How many of your students in the class are:

White? _____

Black? _____

Hispanic? _____

American Indian? _____

Hawaiian Pacific? _____

Asian? _____

Multi-racial? _____

If other ethnicities are present, please specify them and list how many students are in each ethnic group: _____

Appendix G: Student Informed Consent

North Carolina State University

INFORMED CONSENT FORM for RESEARCH

Title: A Critical Examination of Diverse Students' Funds of Knowledge Inclusion in High School Mathematics: A Mixed Methods Study

Principal Investigator: Celestia Keith McNeil

What are some general things you should know about research studies?

You are being asked to take part in a research study. Your participation in this study is voluntary. You have the right to be a part of this study, to choose not to participate or to stop participating at any time without penalty. The purpose of this research study is to gain a better understanding of student-centered teaching strategies. You are not guaranteed any personal benefits from being in a study. Research studies also may pose risks to those that participate. In this consent form you will find specific details about the research in which you are being asked to participate. If you do not understand something in this form it is your right to ask the researcher for clarification or more information. A copy of this consent form will be provided to you. If at any time you have questions about your participation, do not hesitate to contact the researcher named above.

What is the purpose of this study?

The goal of this study is to explore classroom practices of high school mathematics teachers in a diverse setting.

What will happen if you take part in the study?

If you agree to participate in this study, you will be asked to participate in the following:

- Survey (30-45 minutes). This will help provide background on each student. Questions will also be asked about activities outside of the classroom and what the teacher does to help you learn math. The survey will be done on a provided paper form. On a scale 1 to 10, you will be given statements to rate on how well each statement applies to you.
- Classroom Observations (1-2 consecutive weeks). The researcher will come to your class and observe while audio and video recording the same class for the observation period.

Risks

There are minimal physical or emotional risks associated with participation in this study.

Benefits

You are given a chance to be heard through your responses on the survey. The answers you provide will allow the researcher to understand if you are given opportunities to have your interests and knowledge incorporated into your math learning. These opportunities will help you discover how math is used in your everyday life, now and in your future. This study will help your teachers use your knowledge outside of the classroom and the ways you learn best.

Confidentiality

The information in the study records will be kept confidential to the full extent allowed by law. All data including video files, audio files, and transcriptions will be destroyed by deconstruction five years after collection. All digital and hard copy files will be stored securely by the principal investigator. Pseudonyms and anonymous identifiers will be used in oral or written reports to avoid linking you to the study.

What if you have questions about this study?

If you have questions at any time about the study or the procedures, you may contact Ms. Celethia McNeil at ckmcnei2@ncsu.edu.

What if you have questions about your rights as a research participant?

If you feel you have not been treated according to the descriptions in this form, or your rights as a participant in research have been violated during the course of this project, you may contact Deb Paxton, Regulatory Compliance Administrator, Box 7514, NCSU Campus (919-515-4514).

Consent To Participate

"I have read and understand the above information. I have received a copy of this form. I agree to participate in this study with the understanding that I may choose not to participate or to stop participating at any time without penalty or loss of benefits to which I am otherwise entitled."

Please check the appropriate box:

- I agree to participate in all aspects of this study including video recordings of classrooms and survey.
- I agree only to do the survey.
- I choose not to participate in this study.

Participant's name _____ **Date** _____

Participant's signature _____ **Date** _____

Parent/Guardian's name _____ **Date** _____

Parent/Guardian's signature _____ **Date** _____

Investigator's signature _____ **Date** _____

Consent for Videotape Use in Presentations

"I consent for short excerpts of video recording from this project, as judged useful by the researcher, to be used in professional research presentations and teacher professional development materials or meetings, as long as I am not identified by name in such presentations. I agree to have the videos in which I appear shared, with the understanding that I may choose to have certain video segments excluded from the set of videos that can be used in professional research presentations and teacher professional development materials at any time and without penalties."

Participant's signature _____ **Date** _____

Parent/Guardian's signature _____ **Date** _____

Investigator's signature _____ **Date** _____

Appendix H: Letter to Parents of Students in the Study

RE: Permission to participate in video-recording and survey

Dear Parents/Guardians of _____High School Students:

Your student is currently in a mathematics course that is being taught by [teacher] who is participating in a research study. The study focuses on **teachers'** decision making during instruction. Classroom observations will be video recorded to capture what the teacher is saying and doing. The video camera will be stationary and will be positioned to capture the teacher and the board or screen most used for instruction. The camera will be placed to reduce the probability of capturing students' faces. Students will be asked to complete a two-part survey towards the middle and the end of the study. No student names or student work will be collected. These videos will be uploaded to a private, password-protected computer backed up on an external hard drive secured in a locked location. The videos will be used as part of the study analysis. The consent form for the research study is attached. Signatures from you and your student are needed to proceed, and need to be collected before February XX, 2015.

If you have questions or concerns, please email me at ckmnei2@ncsu.edu or call me at (919) 515-4514.

Celethia McNeil
Doctoral Candidate
Department of Science, Technology, Engineering, and Mathematics Education
North Carolina State University

Appendix I: Student Survey

Student ID: _____
 Date: _____
 Name of Course: _____

Part A. Funds of Knowledge

Directions: Answer the following questions with complete sentences. Write neatly with as much detail as possible for each question. You may write on this page or use a separate sheet of paper.

1. Ethnicity (please check all that apply): White Black Hispanic
- American Indian Hawaiian Pacific Multi-racial Asian

Please mention any others not specified: _____

2. Do you fluently speak another language other than English? yes no
 If yes, what language? _____

3. Gender (please check one): F M

4. Grade Level (please check one): 9 10 11 12

5. What activities are you involved in outside of the classroom? Examples could be activities like specific sports, hobbies, church, cultural groups, and interests.

Check all that apply and provide additional detail:

Sports (in or out of school): _____

Church: _____

Hobbies or interests: _____

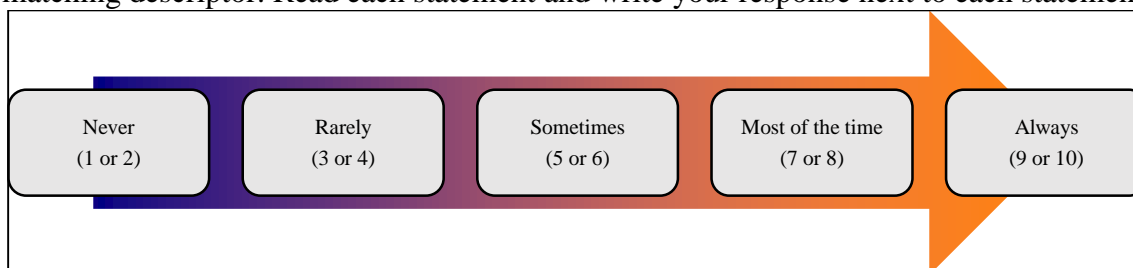
☐Clubs or organizations: _____

☐Duties, chores, and responsibilities around your home:

6. Think back over your experiences in this class during the last week.
 - a. Describe at least one key thing your math teacher did that stands out that *helped* you learn or understand math.
 - b. Describe at least one key thing your math teacher did that stands out that *did not help* you learn or understand math.
7. What did your math teacher use from your out of school activities that helped you learn or understand math?

Part B. Student-Centered Instruction and Critical Consciousness Development

Directions: The scale below will be used for this part of the survey. Every two numbers has a matching descriptor. Read each statement and write your response next to each statement.



1. Real-world problems are a regular aspect of what my math teacher uses to teach me.
2. My math teacher uses my everyday experiences to help me learn or understand math.
3. We relate issues in my community to the math taught in this class.
4. I am given opportunities to think critically about mathematics, its origin, and purposes.
5. My math teacher values the way I solve problems, even if it is a little different than his or hers.

Appendix J: Preliminary Teacher Interview Protocol *(Before any observed instruction)*

Materials: LiveScribe pen, earphones, and notebook; audio recording device

Introduction

To facilitate my note-taking, I will be audio recording this interview so I can focus on our conversation today. I will be the only one privy to the recording which will be eventually destroyed after they are transcribed. I plan for this interview to last approximately one hour. During this time, I have several questions that I would like to cover. I will ask questions about race, a topic that is usually avoided by many in education. Please try to be as explicit as possible, and feel free to express your honest thoughts and feelings regarding your responses to the questions asked.

You have been selected/volunteered to speak with me today because you have been identified as someone who has a great deal to share about student-centered teaching. My research project focuses on math teacher behaviors in the classroom, with particular interest in understanding how teachers use students' experience and knowledge during math instruction, the role of race and experience, and whether we can begin to share what we know about making a difference in teacher education programs and PD. My study does not aim to evaluate your techniques or experiences. Rather, I am trying to learn more about teaching and learning, and hopefully learn about teacher practices that help improve student learning in high school mathematics. Be mindful to give as much detail and explanation as possible for each question. Would you like to ask any questions before we get started?

Teacher's Race, Experience, and Strategies for Integrating Funds of Knowledge

1. Imagine school just started and you have students that you do not know.
 - a. What methods do you use to learn about your students' lives outside of the classroom?
 - b. How do you use this knowledge in mathematics instruction?
2. How does your experience play a part in incorporating students' knowledge, skills, and experiences from their homes and communities into your mathematics instruction?
3. How does your race play a part in incorporating students' knowledge, skills, and experiences from their homes and communities into your mathematics instruction?

4. What role do you think language (home and math), culture, family, and community play in learning and teaching mathematics?
5. How do you address race in the classroom? If you were to (or if you have to) include race into mathematics instruction, how would you go about it? Give me a scenario. (If teacher has difficulty with response, give them examples: racism in mortgage rates, abundance of fast food restaurants in high poverty neighborhoods, etc.)
6. Recall a specific time when you were successful helping your students understand a mathematics concept.
 - a. When did this happen? During class? Before School? After School?
 - b. Specifically what tools, techniques or routines did you use?
 - c. Why do you think this particular practice helped this student?
 - d. What teaching strategies do you use to teach diverse students?
7. Recall any specific academic training, personal experiences, or programs that you have had that helps with effective teaching in a diverse environment.

Conclusion

This concludes all of my questions for this interview. I will be in touch to provide you the transcriptions of your responses to make sure you agree with them. Do you have any questions for me? (If so, record his or her questions; if not proceed with closure.)

Thanks again for your responses. (End recording.)

Confirm the following before leaving teacher:

- Contact information.
- Most efficient mode of communication.
- Dates, times, and expectations of upcoming observations.
- Any planned events during observation period.

Appendix K: Reflective Teacher Interview Protocol

(After 5 days of observed instruction)

Materials: LiveScribe pen, notebook, and earphones; audio recording device

Thank you for allowing me to observe your class. I gathered some rich data that will thoroughly inform my study. The purpose of this interview is to reflect on two video segments from the observations. Any questions before we get started?

1. How did you feel the observations went?

Ask the following questions for each video segment.

2. Is there any particular event or student stood out to you? If so, what or who?
3. Can you think of any connections that you may have made that I may not have noticed?
4. Tell me about what you were thinking as you watch yourself teaching on the video.
5. How does your lesson:
 - a. use L1 [home language] to support academic language development for ELLs [English Language Learners]?
 - b. utilize scaffolding strategies to provide academic language development for ELLs?
 - c. help students connect mathematics with relevant/authentic situations in their lives?
 - d. support students' use of mathematics to understand, critique, and change an important equity or social justice issue in their lives?
6. Do feel your race and/or experience play a role in your ability to incorporate students' informal knowledge bases? Why or why not?

Conclusion

Thank you for complete participation in my study and helping me in answering my research questions. Do you have any final thoughts? (If so, record them; if not, proceed below)

This concludes the interview. (End recording)

Appendix L: Dimensions 6 through 8 of the Culturally Responsive Mathematics Teaching Tool (Aguirre & Zavala, 2013, pp. 186-189)

Table L1

Dimension 6A: Academic Language Support for English Language Learners

	1	2	3	4	5
	<i>Guiding question: How does my lesson use L1 to support academic language development for ELLs?</i>				
6A) Academic language support for ELLs	An explicit intolerance towards students' use of L1 is evident such as translation or code-switching (e.g. "We only use English in this classroom."). Students who are not yet fully proficient in English are ignored and/or seated apart from their classmates.	No acknowledgement of ELL students' needs or presence is evident. Although there is no explicit use of ESL strategies, or attention to L1 (such as explicit cognates), students' use of L1 is tolerated.	There is at least one instance of support for L1. Even if teacher does not use L1, it is evident that students' linguistic repertoires are valued and that they are encouraged to build on them (e.g. students can present in L1, students work in groups in L1, students work in groups in L1).	Sustained encouragement of L1 usage is observed at least between teacher and one, or small group, of students. Focus is on mathematical discourse.	Extensive and sustained attention to students' linguistic funds of knowledge. Sustained encouragement of L1 usage, or hybrid language (ex. code-switching) is observed among teacher and students, in a variety of interactions (Teacher-students, small group, and whole class). The main focus is the development of mathematical discourse and meaning making, not students' production of "correct" English.

Table L2

Dimension 6B: Use of English as a Second Language Scaffolding Strategy

<i>Guiding question: How does my lesson utilize scaffolding strategies to provide academic language development for ELLS?</i>					
6B) Use of ESL scaffolding strategy	No evidence of an ESL scaffolding strategy. Students who are not yet fully proficient in English are ignored and/or seated apart from their classmates.	Although there is no explicit use of ESL strategies, or attention to L1 (such as explicit cognates), students' use of L1 is tolerated. Focus on correct usage of English vocabulary.	There is at least one instance in which an ESL scaffolding strategy is used to develop academic language (i.e. revoicing, use of graphic organizers).	Sustained use of at least a couple of ESL strategies, such as the use of revoicing and attention to cognates, direct modelling of vocabulary, or encouragement of L1 usage is observed at least between teacher and one, or small group, of students.	Deliberate and continuous use of ESL strategies, such as gesturing, use of objects (realia), use of cognates, revoicing, graphic organizers and manipulatives are observed during whole class and/or small group instruction and discussions. The main focus is the development of mathematical discourse and meaning making, not students' production of "correct" English.

Table L3

Dimension 7: Funds of Knowledge/Culture/Community Support

	1	2	3	4	5
	<i>Guiding question: How does my lesson help students connect mathematics with relevant/authentic situations in their lives?</i>				
7) Funds of knowledge/culture/community support	No evidence of connecting to students' cultural funds of knowledge (parental/community knowledge, student interest). Lesson incorporates culturally neutral contexts that "all students" will be interested in.	There is at least one instance in connecting math lesson to community/cultural knowledge and experience. Lesson draws on student knowledge and experience. Focus is with one student or a small group of students.	There is at least one sustained episode of sharing and developing collective understanding about mathematics that involves connecting to community/cultural knowledge. Or, brief episodes of sharing and developing collective understandings occur sporadically throughout the lesson.	There are many sustained episodes of sharing and developing collective understandings about mathematics that involves connecting to cultural/community knowledge (e.g. student experiences are mathematized, student/parent connections with math work; math examples are embedded in local community/cultural contexts and activities – i.e. games).	The creation and maintenance of collective understandings about mathematics that involves intricate connections to community/cultural knowledge and permeates the entire lesson. This would include hook/intro, main activities, assessment, closure and homework. Students are asked to analyze the mathematics within the community context and how the mathematics helps them understand that context.

Table L4

Dimension 8: Use of Critical Knowledge/Social Justice

Guiding question: How does my lesson support students' use of mathematics to understand, critique, and change an important equity or social justice issue in their lives?

8) Use of critical knowledge/ social justice

No evidence of connection to critical knowledge (socio-political contexts, issues that concern students)

Opportunity to critically mathematize a situation went unacknowledged or unaddressed when present.

There is at least one instance of connecting mathematics to analyze a sociopolitical/cultural context.

There is at least one major activity in which students collectively engage in mathematical analysis within a sociopolitical/authentic or problem-posing context. Mathematical arguments are provided to solve the problems. Pathways to change/transform the situation are briefly addressed.

Deliberate and continuous used of mathematics as an analytical tool to understand an issue/context, formulate mathematically based arguments to address the issues and provide substantive pathways to change/transform the issue.