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A Case Study Exploring The Relationship Between Culturally Responsive Teaching And A Mathematical Practice Of The Common Core State Standards

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A CASE STUDY EXPLORING THE RELATIONSHIP BETWEEN CULTURALLY RESPONSIVE TEACHING AND A MATHEMATICAL PRACTICE OF THE COMMON CORE STATE STANDARDS

by

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ABSTRACT

This collective case study explores the nature of the relationship between teachers' use of culturally responsive teaching (CRT) practices and students' engagement in constructing viable arguments and critiquing the reasoning of others (SMP3). This study was informed by the Common Core State Standards Initiative related to developing mathematically proficient students through the use of student engagement practices consistent with the standards for mathematical practice. As a means to support teachers' facilitating specific student engagement practices, professional development was provided. This study is situated in the growing body of research associated with student engagement and cultural identity. The case of two teachers was defined from interviews, classroom observations, journal prompts, and student artifacts. Data was collected before, during, and after professional development following a cross-case analysis. Four themes emerged: (a) shift in teacher practice; (b) depth and breadth of the knowledge of culturally responsive teaching and standard for mathematical practice three; (c) teacher reflection and reception; and (d) classroom management. The findings suggest that the shift in teacher practice can be supported by professional development focused on reflective practice. This shift is impacted by classroom management and teachers' depth and breadth of their knowledge of CRT and SMP3.

This work is dedicated to my family: (1) to my mom (Shirley) and dad (Sylvester) for their eternal love and unlimited sacrifices for me and my siblings; (2) to my brother (Melvin) and two sisters (Charlotte and Angela) for their continued encouragement; (3) to my nieces and nephews for keeping a smile on my face; (4) to my step-son (Christopher) for his kind words and thoughts of consideration; and (5) to my son, Kenneth, who is the reason behind everything I do, for his endless sacrifices and words of encouragement; and (6) finally, to my husband, Mark, who inspired me to pursue my doctorate degree, for his unwavering support, words of encouragement and empowerment, and understanding of the process.

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CHAPTER 1: INTRODUCTION

National Focus on Mathematics and Science

Technological innovation continues to drive the nation's economic engine and has raised the quality of life for many Americans (Stine & Matthews, 2009). The United States has enjoyed decades of prosperity and has emerged as the world's leader in innovations, a post that it has savored since its inception. However, reports on key indicators suggest that America's pre-eminence as the world's economic and technical innovation leader has been called into question (Jackson, 2004; 2007; Stine & Matthews, 2009). Advancements in information technologies have fostered a climate of unprecedented competition for America's mathematicians and scientists at all levels and across all industries. In fact, many of the high-quality jobs that have been generated the last few decades have gone to professionals living in non-U.S. countries (Stine & Matthews, 2009). The Rising above the Gathering Storm (RGS) Committee reports that many of the domestic, technical jobs have been taken by new immigrants and foreign workers who have moved to the United States in recent years (2005). In the past, American citizens only had to compete with neighbors who lived in the same community or region for good-paying jobs in technology fields. Now, Americans have to compete with professionals from countries all over the world (RGS, 2005).

Despite an increase in production of science, technology, engineering, and mathematics (STEM) professionals, the demand for technical talent remains strong both domestically and abroad (Stine & Matthews, 2009). In fact, the industry's demand for highly trained technical professionals has increased exponentially in recent decades (Darling-Hammond, 2006; Stine & Matthews, 2009). Yet, the response has fallen short of producing the number of qualified

workers that are needed (Darling-Hammond, 2006; Jackson, 2007). Amid concerns about the loss of high-tech jobs to foreign competitors, American business and political leaders have placed a high premium on enhanced mathematics and science skills for U.S. students at all levels (RGS, 2005). Enhanced mathematics and science skills are essential to future professionals if American business and industry are to remain competitive in the decades to come.

In response to the demand for mathematically proficient students, the Council of Chief State School Officers (CCSSO) and the National Governors Association (NGA) collaborated to create a set of mathematics standards, called the Common Core State Standards for Mathematics (CCSSM) (CCSSO & NGA, 2010). These standards, recently adopted by 45 states, are intended to allow US students to thrive in this climate of global competiveness. Moreover, these standards will help to maintain consistency among mathematics instruction across states. The CCSSM consist of two types of standards: (a) standards for mathematical content and (b) standards for mathematical practice. The standards for mathematical content provide a set of grade-specific standards for grades K-8 which define "what students should understand and be able to do in their study of mathematics" (p. 4). For grades 9-12, the standards are topic-specific (e.g. Algebra, Geometry, Statistics) and they identify what students should know to be college and career ready. The goal is for more focus and coherence; however, the intervention and strategies for obtaining this goal differs for students and teachers of varying abilities (CCSSO & NGA). Therefore, the standards for mathematical practice provide a set of systematic habits that teachers must develop in their students in order to gain focus and coherence in their mathematics learning. These practices rest on "processes" defined by the National Council of Teachers of Mathematics' (NCTM) Process Standards and "proficiencies" defined the National Research Council's (NCR) strands of mathematical proficiency (CCSSO & NGA). NCTM (2000) outlines

these processes in their five process standards: (1) problem solving; (2) reasoning and proof; (3) communication; (4) connections; and (5) representations. Similarly, NRC (2001) outlines these proficiencies in their five strands of mathematical proficiency: (1) conceptual understanding; (2) procedural fluency; (3) strategic competence; (4) adaptive reasoning; and (5) productive disposition. Together, the aforementioned processes and proficiencies provide the basis for the Standards for Mathematical Practice. There are eight practices namely:

1. Make sense of problems and persevere in solving them;
2. Reason abstractly and quantitatively;
3. Construct viable arguments and critique the reasoning of others;
4. Model with mathematics;
5. Use appropriate tools strategically;
6. Attend to precision;
7. Look for and make use of structure; and
8. Look for and express regularity in repeated reasoning (CCSSO & NGA, pp. 6-8).

The Common Core State Standards were developed with input from teachers, school leaders, and experts in education in order to provide a comprehensible framework to prepare K-12 students for college and the workforce (CCSSO & NGA). The standards were informed by the top performing and most effective models from across the United States and around the world (CCSSO & NGA). According to CCSSO and NGA, the Common Core State Standards were designed to:

1. Align with college and work expectations;

2. Include challenging content and application of knowledge through higher-order thinking skills;
3. Build on the strengths and lessons learned from current state standards;
4. Reflect best educational practices used in top performing countries, so that all United States students are prepared to operate and succeed in the global economy and society; and
5. Support sound research and evidence.

If the Common Core State Standards Initiative meets with success, students will demonstrate increased proficiency in mathematics. Furthermore, an increased number of students will graduate from high school better equipped to enter technical professions.

Population Trends

As educators transition to implement the Common Core State Standards, it is important to consider trends and patterns in student performance. More specifically, when preparing students to succeed in the global economy and society, special consideration must be given to the performance of US students in comparison to students from other countries around the world (Larson, 2011). In 2007, the Trends in International Mathematics and Science Study (TIMSS) reported that US fourth-grade students' average mathematics score was lower than eight Asian and European countries, and US eighth-grade students' average mathematics score was lower than five Asian countries. This issue is further compounded by the fact that America's population is growing increasingly diverse (Gonzales, 2009). According to the US Census Bureau (2010), non-Hispanic Whites comprise 64% percent of the nation's population. This represents a 1.2% decrease over the past 10 years. Both the Black and Hispanic populations have increased at a faster rate than the total population. "More than half of the growth in the

total population of the United States between 2000 and 2010 was due to the increase in the Hispanic population" (Ennis, Rios-Vargas, & Albert, 2010, p. 2). Estimates from the Bureau indicate that people of color will comprise about 43% of the US population in 2025 and about 54% of the US population in 2050. As a result, the number of students of color in American schools will continue to rise. "Between 1989 and 2009, the percentage of public school students who were White decreased from 68 to 55 percent, and the percentage who were Hispanic doubled from 11 to 22 percent" (Aud, Hussar, & Kena, 2011, p. 2). With this steady increase, by 2020, the number of culturally diverse students in US classrooms will be around 46% (Banks, 2001; NCES, 2011c). "Increases in public school enrollment are expected for Blacks, Hispanics, Asians/Pacific Islanders, and American Indian/Alaska Natives, and a decrease is expected for Whites" (National Center for Education Statistics (NCES), 2011c, p. 3). As these trends continue, policy makers and educational leaders are not only concerned about raising the bar for all students, but are particularly sensitive about factors that impact the mathematics performance of culturally diverse students. Much of the concern revolves around the fact that national assessments show that schools are failing to meet the needs of culturally diverse students (Ladson-Billings, 1997; NCES, 2011a; 2011b; 2009).

The poor mathematics proficiency of many diverse students threatens the health and stability of America's economic future (Jackson, 2007; Larson, 2011). According to Jackson (2007), a larger number of American future scientists and engineers must come from the "new majority" comprised of women, African-American, Hispanic, and other under-represented students that sit in America's classrooms. Thus, focusing attention on the trends in mathematics achievement of this "new majority" becomes of great interest.

Achievement Gap

Long before the Supreme Court ruling of *Brown vs. Board of Education* (1954), America's schools toiled with the obligation of educating African American students (Anderson, 2005; Carter, 2003; Carter, Hawkins, & Natesan, 2008; Green, 2001; Haycock, 2001). Despite the integration of America's schools and the intentions of *Brown vs. Board of Education*, the achievement of African American students continues to lag behind that of White students (Anderson, 2005; Carter, 2003; Green, 2001; Haycock, 2001). In 2001, Congress passed the No Child Left Behind Act (NCLB) with the purpose of improving the academic performance of all students, especially marginalized students (under-achieving African American and Latino students as well as students from low socio-economic backgrounds) (NCLB, 2001). Most importantly, this educational reform emphasized the need to close the achievement gap between minority and non-minority students. However, national assessments show that this gap persists (NCES, 2011a; 2011b).

Over time, trends of this achievement gap between minority and White students have been documented using standardized assessments from NCES. Data from the 2005-2011 National Assessment for Educational Progress (NAEP) reveal that the gap in academic performance between White and minority fourth and eighth grade students in Mathematics remains steady (see Table 1).

Table 1: NAEP Average Scale Mathematics Scores of White, Black, and Hispanic 4th grade and 8th grade students

	Grade 4			Grade 8		
Year	**White**	**Black**	**Hispanic**	**White**	**Black**	**Hispanic**
2005	246	220	226	289	255	262
2007	248	222	227	291	260	265
2009	248	222	227	293	261	266
2011	249	224	229	293	262	270

In 2005, NAEP reported the composite mathematics score for White 4th grade students as 246 while the composite scores for Black and Hispanic students were 220 and 226 respectively. Likewise, White 8th grade students scored 289 while Black and Hispanic students scored 255 and 262 respectively. In 2011, NAEP reported the composite mathematics score for White 4th grade students as 249 while the composite scores for Black and Hispanic students were 224 and 229 respectively. Likewise, White 8th grade students scored 289 while Black and Hispanic students scored 255 and 262 respectively. Although the performance of Black and Hispanic students has improved over 6 years, suggesting that the gap has narrowed, Whites have improved also so the gap remains. In the report Condition of Education 2011, published by the National Center for Education Statistics, Aud, Hussar, and Kena (2011) write:

> White, Black, and Hispanic 8th grade students' scores increased between 2007 and 2009, yet neither the 2009 achievement gap between Black and White 8th-grade students (-32 points) nor the achievement gap between Hispanic and White 8th grade students (-26 points) was measurably different from the corresponding gaps in 2007 or 1990 (p. 48).

Results from the 2011 mathematics assessment yielded a similar analysis; the 25-point gap between White and Black students and the 20-point gap between White and Hispanic students in 2011 were not statistically different from the gap in 2009 (Larson, 2011; NCES, 2011b). These reports suggest that over the past decade, the achievement gap still remains and continues to be of concern as educators and policy makers strive to develop mathematically proficient and technical students through the use of the Common Core State Standards so that they are able to compete globally.

Efforts to Eliminate the Achievement Gap

Research related to examining the complexities of this gap is twofold: there exist 1) theories that provide explanations of this gap and 2) theories that suggest ways of eliminating this gap (Powell, 2009). Theories that attempt to explain the achievement gap can be summarized into what Banks (2001) calls deficit thinking.

> Deficit thinking exists when educators interpret differences as deficits, dysfunctions, and/or disadvantages. Consequently, many minority students quickly acquire the "at risk" label and the focus on their shortcomings or weaknesses rather than their strengths" (p. 374).

This way of thinking hinders the ability and willingness of educators to recognize the strengths of students from culturally diverse backgrounds. While these theories are important in understanding the achievement gap, they do not provide substantive suggestions for eliminating the gap. They do, however, provide some insight that might inform efforts to help narrow the gap.

When examining suggestions for eliminating the gap, one prevailing school of thought is that diverse student achievement is adversely affected by what Tyler et al (2008) refer to as "cultural discontinuity" (p. 280). The theory of cultural discontinuity refers to the mismatch between students' home and school cultures. Schools replicate the broader society in its rules and structure (Delpit, 1988). As a result, some minority students struggle with going between their home and school culture as there is no relevance. Delpit describes this as the "culture of power" in the classroom (p. 24). Malloy and Malloy (1998) write:

> …the culture of power in our schools [are described] as coming from the power of the teacher, textbooks, curriculum developers, school districts, and society. Children of the middle and upper class come to school with these tools to participate in this culture, whereas children from other families, minority and poor, operate within viable cultures that do not carry the same power codes or rules (p. 249).

Delpit describes these codes and/or rules as "presentation of self," that is students' ways of doing, communicating, expressing, interacting, writing, and socializing (p. 283). The powers of these codes/rules are derived from the culture that is in power or in control, which is often known as the dominating culture. As a result, students from the non-dominating culture struggle with participating within this dominating "culture of power" (p. 283).

This system of teaching may contribute to the underachievement of culturally diverse students by ignoring the influence of culture on learning. Ladson-Billings (1995a, 1995b) explains that this mismatch is exemplified in the labels that teachers place on non-mainstream students as well as through teachers' instructional practices and strategies. This theory of cultural discontinuity incorporates the notion that achievement of diverse students can be

improved by minimizing or offsetting the cultural gaps between teaching methods and students' ways of knowing, thereby narrowing the achievement gaps between White, Black, and Hispanic students.

Engagement Gap

While examining research related to the achievement gap, research which focuses on student engagement becomes of interest. Many studies have shown a positive correlation between engagement and achievement (Connell & Wellborn, 1991; Fredricks, Blumenfeld, & Paris, 2004; Marks, 2000). Marks (2000) explains, "Engagement in the classroom leads to achievement and contributes to students' social and cognitive development" (p.154). As students progress through K-12 education, studies show that student engagement declines, especially in the high schools, where engagement reaches its lowest levels (Marks, 2000; National Research Council and Institute of Medicine, 2004).

Measuring levels of student engagement assists in recognizing students who are at risk for dropping out of school (Fin, 1989; Fredricks, Blumenfeld, & Paris, 2004). Fredricks and colleagues stated, "For many students, dropping out of high school is the last step in a long process of disengagement" (Fredricks, McColskey, Meli, Montrosse, Mordica & Mooney, 2011, p. 3). According to the latest data from the National Center for Education Statistics, Blacks and Hispanics have higher dropout rates than any other race/ethnic group. In fact, research demonstrates that low levels of engagement are more prevalent among minority students (Yazzie-Mintz, 2006; 2009). Yazzie-Mintz (2009) highlighted that both White and Asian students reported higher levels of engagement across three dimensions than Black or Hispanic students. Fredricks, Blumenfeld, & Paris (2004) described student engagement dimensions as: (a) behavioral; (b) emotional; and (c) cognitive. Each of these dimensions will be described in

greater detail in the next chapter. The aforementioned research highlights the potential for another gap in schools: the "engagement gap" (Yazzie-Mintz, 2009, p. 17).

A number of in-school factors contribute to disengagement, which in turn result in students dropping out of school. These factors include alienation, no content relevance, and boredom (Bridgeland, Dilulio, & Morison, 2006; Yazzie-Mintz, 2009; 2006). In 1992, Newmann and others proposed a theory of student academic engagement, which comprise three components: (1) strong intrinsic motivation and competence; (2) school and self identity; and (3) student created work. With the need to develop mathematically proficient students, increased interest has been given to student engagement to address low academic achievement, student boredom and alienation, as well as high dropout rates (Fredricks, Blumenfeld, & Paris, 2004; Fredricks, McColskey, Meli, Montrosse, Mordica & Mooney, 2011; Marks, 2000). Attention to student engagement may provide insight on narrowing the achievement gap.

Rationale

The theory of cultural discontinuity and its relationship to student engagement provided insight in the framing of this study. There exists a strong need for educators to understand the connection between culture and learning. Gay's (2000) framework of culturally responsive teaching (CRT) offers a possible solution to the challenges associated with cultural discontinuity. CRT is described as "using the cultural knowledge, prior experiences, frames of reference, and performance styles of ethnically diverse students to make learning encounters more relevant and effective for them" (p. 29). It encourages students to bring their ways of communicating, interacting, doing, and thinking into the learning process (Gay, 2000; Ladson-Billings, 1994a). Research on the use of instructional practices consistent with CRT highlights teachers' ability to validate and affirm students' cultural differences and to use those differences as a catalyst for

learning (Gay, 2000; Ladson-Billings, 1994a; National Center for Culturally Responsive Educational Systems (NCCREST), 2006; Villegas & Lucas, 2002). A detailed analysis of CRT instructional practices will be provided in the next chapter. CRT offers a framework for addressing cultural discontinuity by validating the cultures of students through the use of instructional practices that capitalize on the cultures of students. According to the National Research Council (2004), "classroom instruction is the proximal and most powerful factor in student engagement in learning" (p. 9). Thus, the use of CRT practices may have an impact on student engagement. Schussler (2009) explains that by making connections between students and the topics of instruction, teachers increase students' interest in learning thereby supporting engagement.

When considering the Common Core State Standard's SMP, students will need to engage in these mathematical practices in order to gain focus and coherence with mathematical topics (CCSSO & NGA, 2010). These practices promote problem solving, reasoning and sense making, and application (NCTM, 2011). According to the aforementioned studies (NRC, 2004; Shussler, 2009), student engagement increases when students feel connected to the topic of instruction. Therefore, the use of CRT practices may prove useful in engaging students in the Common Core State Standard's SMPs. For the purposes of this study, the researcher focused specifically on one of the standards for mathematical practice, constructing viable arguments and critiquing the reasoning of others (SMP3) as it lends itself well to the use of cultural context in mathematics instruction. This practice promotes classroom discourse where students engage in mathematical talk (Cobb & Yackel, 1995). In order for teachers to facilitate this type of engagement, they must create a classroom culture where all students are comfortable in

communicating about mathematics (Heibert, Carpenter, Fennema, Fuson, Wearne, Murray, Oliver, & Human, 1997).

Problem Statement

The national focus on mathematics and science highlights the importance of improving the mathematics performance of all US students. However, as the nation grows more diverse, improving the performance of culturally diverse students becomes increasingly important. Over the last decade, national assessments consistently highlight the fact that White students continue to out-perform Black and Hispanic students indicating the existence of a persistent gap between the achievement of White and minority students. When looking at student engagement, White students report higher levels of engagement than Black and Hispanic students, indicating another gap. As educators transition to the Common Core State Standards, particular interest must be given to addressing both the "achievement gap" and this "engagement gap".

This study explored mathematics teachers' use of culturally responsive teaching practices to engage diverse students in practices consistent with the Common Core State Standards for Mathematics. More specifically, the researcher focused on teachers' use of CRT to support students engaging in constructing viable arguments and critiquing the reasoning of others which is known as Common Core State Standard's Standard for Mathematical Practice 3 (SMP3).

Research Questions

The purpose of this study was to explore the relationship between the use of culturally responsive teaching in teacher practice and student engagement. The following questions guided the direction of this study:

1. What is the nature of the relationship between teachers' use of CRT practices and students' engagement in constructing viable arguments?
2. What is the nature of the relationship between teachers' use of CRT practices and students' engagement in critiquing the reasoning of others?

Definition of Terms

The following terms were used in this study, and for the purposes of this study, were defined as:

Diverse – A particular group composed of distinct or unlike elements or qualities (http://www.merriam-webster.com/dictionary/diverse).

Culture – "The ideations, symbols, values, and beliefs that are shared by a human group" (Banks, 2010, p. 444).

Cultural Competence – "The ability to successfully teach students who come from cultures other than your own" (Diller & Moule, 2005, p. 2). "It entails mastering certain personal and interpersonal awarenesses and sensitivities, learning specific bodies of cultural knowledge, and mastering a set of skills that, taken together, underlie effective cross-cultural teaching" (Diller & Moule, 2005, p. 5).

Culturally Responsive Teaching (CRT)- "Using the cultural knowledge, prior experiences, frames of reference, and performance styles of ethnically diverse students to make learning encounters more relevant and effective for them" (Gay, 2000, p.29).

Culturally Relevant Pedagogy – Using the following principles to meet the intellectual and social needs of minority students: 1) treating students as competent; 2) providing scaffolding so

students can build from prior knowledge; 3) demonstrating high-quality instruction; 4) possessing an in-depth knowledge of students and content; 5) extending students thinking abilities; and 6) linking content to students' cultural practices (Ladson-Billings, 1994a).

Conclusion

The need for mathematically proficient students has never been stronger. As teachers are preparing to implement the CCSSM into instruction and engage students in Common Core State Standard's SMPs, attention should be given to the performance of culturally diverse students. This study examined the use of CRT to support this implementation and student engagement. Particularly, the researcher used existing theories and frameworks to identify CRT and SMP3 in classroom settings and made conjectures about which CRT strategies seemed to support SMP3. Ultimately, the researcher hoped to inform future practice in efforts to close the achievement gap between students of different cultural backgrounds.

CHAPTER 2: REVIEW OF THE LITERATURE

Introduction

Implementation of the Common Core Initiative employs two types of mathematics standards: a) standards for mathematical content and b) standards for mathematical practice. Although CCSSM accentuates the content that students need to know at each grade level, it stresses the importance of connecting this content with the standards for mathematical practice (CCSSO & NGA, 2010; Larson, 2011). "Important mathematics includes both practices or processes and content, organized in a coherent and focused way" (NCTM, 2011, p. 4). The SMPs consist of practices that students must use as they develop mathematical understandings. They promote problem solving, reasoning and sense making, and application (NCTM, 2011). As a result of this emphasis on connecting mathematics content with specific student mathematical practices, educators must seek to understand the role of the teacher and student within the mathematics classroom as well as their roles within the learning process (NCTM, 2011). Teachers must draw upon various instructional strategies that promote autonomy in mathematics for all students. "Effective mathematics teaching requires understanding what students know and need to learn and then challenging and supporting them to learn it well" (NCTM, 2000, p. 16). Rather than subscribing to the notion that teachers transmit mathematical knowledge to students, teachers must assist students in constructing mathematical knowledge through carefully designed tasks, problems, and/or situations (Hiebert, Carpenter, Fennema, Fuson, Wearne, Murray, Oliver, & Human, 1997). Students' mathematical proficiency is shaped by the experiences provided by the teacher (NRC, 2001). However, in order to select appropriate tasks, teachers must be knowledgeable of their students and begin with tasks that are relevant to them (Hiebert et al., 1997). NCTM (1991) states that the tasks chosen must be based on: "sound and

significant mathematics; knowledge of students' understandings, interests, and experiences; and knowledge of the range of ways that diverse students learn mathematics" (p. 25). To that end, tasks must be designed so that they are relevant to all students. Each student must be empowered to work individually as well as collaboratively (Hiebert et al., 1997). It is through the interaction with mathematics that students gain a productive disposition, one of the five strands of mathematical proficiency. A productive disposition in mathematics refers to "habitual inclination to see mathematics as sensible, useful, and worthwhile, coupled with a belief in diligence and one's own efficacy" (NRC, 2001, p. 5). Students must see themselves in the mathematics and believe that they have the capability to be successful in mathematics. Teachers must be purposeful in the design of mathematics instruction that results in productive dispositions among students. However, the teacher cannot forget that "the quality of instruction depends on how students engage with the learning task" (NRC, 2001, p. 9). Understanding how students engage is key in meeting the needs of all students and the mathematics standards.

Student Engagement

The conception of student engagement surfaced in the 1980's (Greenwood, Horton, & Utley, 2002; Yazzie-Mintz, 2006; CEA, 2009). In 2009, the Canadian Education Association (CEA) described it as "a set of demographic and social risk factors attributed to individual students" (p. 7). Other descriptions of student engagement include a focus on behaviors that students exhibit within and outside the classroom (Greenwood, Horton, & Utley, 2002; Yazzie-Mintz, 2006). According to Fredericks, Blumenfeld, and Paris (2004), research on student engagement encompasses three inter-related dimensions: behavioral engagement; emotional engagement; and cognitive engagement. Behavioral engagement involves students' actions in non-academic activities, including interactions with friends and around the school (CEA 2009).

It also encompasses conduct associated with following rules and attending to the norms of the classroom (Fredricks et al.). Emotional engagement encompasses students' affective feelings about their school community and reactions in the classroom (Fredricks et al.). And lastly, cognitive engagement entails students' actions for learning during instruction and students' investment in learning (student participation). That is, "the work students do and the ways students go about their work" (Yazzie-Mintz, 2006, p. 2). Cognitive engagement includes "learning environments that are challenging and deeply interesting, the provision of ongoing feedback for learning" (CEA, pp. 7-9). While all of these dimensions of engagement are important, this study focused on cognitive engagement, which will be referred to as student engagement. Both behavioral and emotional engagement refer to student's non-academic actions within the classroom; however, when examining the classroom environment and the academic interactions among the people within the environment, cognitive engagement plays a major role in the learning process.

Recently, student engagement has gained heightened interest as a way to address the low achievement levels of US students (Fredericks, Blumenfeld, & Paris, 2004). Research on student engagement highlights the vital role that it plays in student learning (Voke, 2002) and identifies a positive correlation between it and academic achievement (CEA, 2009; Fredericks et al., 2004; Yazzie-Mintz, 2009). However, research reveals that a substantial proportion of students are becoming disengaged (Yazzie-Mintz, 2009). As students progress through K-12 education, studies reveal that the student levels of engagement decline (Marks, 2000; National Research Council and Institute of Medicine, 2004). Similar to the achievement gap, the 2009 High School Survey of Student Engagement (HSSSE) indicates that there exists an engagement gap (Yazzie, 2006; 2009). The HSSSE revealed that White and Asian students report higher levels of

engagement than students of other races and ethnicities. It also revealed that low levels of engagement are more prevalent among students living in low socio-economic communities, students with disabilities, as well as those from minority communities (CEA, 2009; Yazzie, 2006; 2009). A number of in-school factors contribute to disengagement. Sixty-seven percent of students report that they are disengaged because they are bored (Yazzie-Mintz, 2009). The leading reasons that the students reported for boredom included that the content was not interesting, the content was not relevant, and they had no interaction with their teacher (Yazzie-Mintz, 2010).

In 2004, Fredricks and colleagues examined research related to the antecedents of student engagement: (a) school-level factors; (b) classroom context; and (c) individual needs. Each of these ancestors contributes to research related to the impact of educational context on student engagement. Research on school-level factors focused specifically on the behavioral dimension of engagement (Fredricks et al.). On the other hand, the research on factors of classroom context and individual needs provide some focus on cognitive engagement, which is the direction for this study. Fredricks et al. associates classroom context with teacher support, peers, classroom structure, autonomy support, and task characteristics. In reference to teacher supports, Blumenfeld and Meece (1988) found that teachers who challenged students' understandings, communicated high expectations, and maintained a socially supportive environment reported higher levels of cognitive engagement. More recent studies show that cognitive engagement is heightened when students engage in discussions centered on a specific topic and interact with each other (Helme & Clarke, 2001). "Cognitive engagement is enhanced when class members actively discuss ideas, debate points of views, and critique each other's work" (Fredricks et al., p. 77). In their study, Helme and Clarke (2001) verified more occasions of cognitive engagement

during student-to-student interactions rather than teacher-to-student interactions. When examining classroom structure, Fredricks, Blumenfeld, Friedel, and Paris (2002) found that students' beliefs about classroom tasks were associated with cognitive engagement. Classroom contexts that support autonomy are characterized by open-choice tasks and shared-decision (Connell, 1990). Autonomy supported environments also exude cognitive engagement. Lastly, research related to task characteristics and cognitive engagement revealed that engagement mostly occurred when students interacted with their peers on tasks containing personal meaning and required explanations and justifications of their understandings (Blumenfeld & Meece, 1988; Helme & Clark, 2001). According to the previously mentioned studies, the context of the classroom plays a major role in academically engaging students. When examining each component of the classroom context, the following factors were emphasized: (a) a socially supportive environment; (b) challenging tasks; (c) high expectations; (d) interaction with peers; (e) relevant tasks or material; (f) required explanations and justifications; (g) engaging in debates and discussions; and (h) open choice and shared-decision making. These contextual factors promote engagement; however, they are contingent upon the individual needs of the students (Connell, 1990; Connell & Wellborn, 1991; Fredricks et al., 2008).

Connell and Wellborn (1991) proposed a self-processes model when examining the relationship between students' individual needs and student engagement, where students possess needs of relatedness, autonomy, and competence (Connell & Wellborn). Relatedness refers to the connection between the context of the classroom and the student. Students engage more when they operate in a supportive environment (Appleton, Christenson, & Furlong, 2008; Fredricks et. al., 2004). Autonomy refers to a student's personal responsibility to do well; engagement occurs when the context of the classroom allows for shared decision making and

choice (Appleton, Christenson, & Furlong, 2008; Fredricks et. al., 2004). Competence refers to a student's self-efficacy in relation to his or her ability to do the material. At this level, students engage when they believe they can (Appleton, Christenson, & Furlong, 2008; Fredricks et. al., 2004).

This model is reflected in the work of West-Olantunji, Pringle, Adams, Baratelli, Goodman, and Maxis (2008). They conducted a study to investigate how low-income, African American girls see themselves in the learning of mathematics and science as they transitioned from elementary to middle school. In addition, they also examined how the African American girls' teachers, administrators, and parents positioned them. The major themes highlighted in the study focused on positioning and pedagogy. The girls positioned themselves as outsiders in mathematics and science because they felt that the classroom environment was boring and not interactive. They also felt that the teaching practices utilized in their classroom hindered their engagement because all the teacher did was talk. One of the parents perceived that her daughter likes mathematics; however, if the teacher does not make the mathematics interesting and applicable to the students, then the students will not be interested. Under the pedagogy theme, the subthemes relevance and engagement surfaced. The adult participants (parents, teachers, and administrators) suggested that the use of hands-on activities, encouragement of creativity, and the use of applicable ideas make students enthusiastic about learning and engaging in mathematics. When summarizing the perceptions of all the participants (including both children and adults), the researchers found that all participants agreed that "in order to be engaged, students need to relate to the material, connect to their past experiences, and learn through active involvement" (p. 9). These findings speak to both the classroom context and the individual needs of students. Both are essential to supporting student engagement.

Schussler (2009) explains that by making connections between students and the topics of instruction, teachers increase students' interest in learning thereby supporting engagement. According to the National Research Council (2004), "classroom instruction is the proximal and most powerful factor in student engagement in learning" (p. 9). To that end, teachers must manage their classrooms to facilitate student engagement. In order to do so, teachers must be knowledgeable of their students' learning preferences as they play a vital role in the discourse of the classroom (Gay, 2000; Malloy & Malloy, 1998). Students' learning preferences and performance styles are linked to their cultural experiences, which impacts students' perception of themselves as members in the learning process. Banks (1993) writes, "the assumptions, perspectives, and insights that students derive from their experiences in their homes and community cultures are used as screens to view and interpret the knowledge and experiences that they encounter in school and in other institutions within the larger society" (p. 7). Instruction that capitalizes on students' learning preferences and performance styles encourages students to bring their experiences to the learning process and promote student engagement within the learning environment.

Von Glaserfeld (1995) contends that pedagogy is a compilation of a teacher's ability to interpret, identify, and integrate students' cultures within the learning process; allow students to utilize their experiences to build new knowledge; and maintain effective classroom practice. In order to promote engagement among all students, instruction must be parallel to students' learning preferences both cognitively and affectively (Berry, 2003; Gay, 2000; Malloy & Malloy, 1998). Research on learning styles has recognized that learning patterns exist among cultural groups: African Americans; Native Americans; and Mexican Americans (Berry, 2003; Bert & Bert, 1992; Cox & Ramirez, 1981; Hale-Benson, 1986; Hillard, 1989; Shade, 1989;

Vasquez, 1991). Specific to this study, learning preferences are defined according to the aforementioned studies (Berry, 2003; Bert & Bert, 1992; Cox & Ramirez, 1981; Hale-Benson, 1986; Hillard, 1989; Shade, 1989; Vasquez, 1991), which will be outlined in the following sentences. African American students: (1) value verbal expressiveness over written demonstration of knowledge; (2) utilize both holistic and analytic reasoning (Hillard, 1976; Stiff & William, 1988); (3) are taught interdependence rather than individualism (Hale-Benson, 1986; Willis, 1992); and (4) rely on personalistic stimulation of learning rather than inanimate or object stimulation (Shade, 1989). Berry (2003) writes:

> The discontinuity between the learning preferences of African Americans and the culture of schools (i.e. instructional methodologies and style) leads to errors in determining students' intellectual potential, learning abilities, and communication abilities. This discontinuity leads educators to lower expectations, which ultimately affects achievement (p. 246).

Malloy and Malloy (1998) suggest that teachers consider three areas in order to accommodate African American students: (1) possess knowledge of students and create a classroom culture that promotes learning; (2) understand the importance of multicultural education and integrate multicultural pedagogy into instruction; (3) be aware of African American students' learning preferences and have the ability to adjust instruction to capitalize on these learning preferences. On the other hand, Native American students: (1) process information using acute visual imagery; (2) perceive globally; (3) value independence; and (4) posses reflective thinking patterns (Guild, 1994). Thus, for Native American students, Guild explains that "schooling should establish a context for new information, provide quiet times for thinking, and emphasize visual stimuli" (p. 2). Conversely, Mexican American students value personal relationships and

are comfortable with cognitive patterns and generalizations (Cox & Ramirez 1981; Vasquez 1991). These students: (1) are motivated through peer orientations and interactions; (2) are field dependent, (3) value structure and (4) would rather learn through interaction (Cox & Ramirez 1981; Vasquez 1991). Although most cultures have specific learning preferences, there exist variations among individuals within groups. These distinctions suggest that educators must use diverse teaching strategies in order to engage all students.

Schussler (2009) suggests three components of the classroom environment that promote student engagement. These include: opportunities to succeed; flexibility within the learning process; and respect as learners. In order to facilitate this type of environment, teachers must challenge students academically, provide academic support, utilize purposeful teaching strategies that capitalize on students' interest, and select authentic tasks that are relevant to students' lived experiences. Maintaining high expectations and care for students assist them in achieving academically. However, this is accomplished through the use of a flexible, student-driven environment, where the teacher is aware of student understandings and responsive to their needs. This means that the curriculum must meet the students where they are and be of relevance to them. Schussler writes, "Teachers manage classrooms that facilitate student engagement when they demonstrate enthusiasm for authentic content and purposefully use instructional strategies to capture students' interest" (p. 118). Capitalizing on students' interests entails knowing the students, specifically, in ways that will inform teachers on how to challenge and support them.

Being knowledgeable of students and their learning preferences will assist teachers in selecting tasks and contexts that are appropriate for their students and providing the appropriate support for each of them in the learning process. As a result, students feel a sense of belonging

within the classroom, within the curriculum, and within the learning process. This sense of belonging supports student engagement.

Engagement through Cultural Perspectives

Hiebert, Carpenter, Fennema, Fuson, Wearne, Murray, Oliver, & Human (1997) identify the core features of the classroom as: a) the nature of classroom tasks; b) the role of the teacher; c) the social culture of the classroom; d) tools and learning supports; and e) equity and accessibility. Each of these features is essential to this study. The classroom tasks should connect with where students are. The teacher must select appropriate tasks and establish a classroom culture that allows learners to work individually and interactively. Through interaction and collaboration, students use tools and learning supports which assist in their mathematical understandings. This highlights the importance of the social culture of the classroom, in which all learners feel essential to the learning process thereby providing access for all students. These features are consistent with Fredricks, Blumenfeld, and Paris's (2004) ancestors of student engagement: classroom context and individual needs. When considering student engagement, these features have a major impact on the learning process (Fredricks, Blumenfeld, & Paris, 2004; Hiebert et al, 1997).

When analyzing the mathematics classroom, the culture of the classroom is defined based on the individuals within the classroom (Nickson, 1994). Teachers and students bring more than one culture to the classroom, i.e. school culture, home culture, neighborhood culture, etc. Therefore, it is imperative that teachers and students establish and negotiate the culture of the classroom to obtain an optimal learning zone, which is formed by formal and informal agreements between the teacher and students to establish a learning space. "The recognition of the mathematics classroom as a functioning community where the teacher and students' activity

in it is shaped by a set of norms and practices for learning mathematics highlights the importance of issues such as competence, ownership, and alignment in engaging in this community" (Diversity in Mathematics Education Center for Learning and Teaching (DMECLT), 2007, p. 408). Therefore, the interrelatedness of classroom practices and cultural identities have implications for student engagement in the classroom community.

Research related to theories of cultural activity emphasize the understanding of knowing and learning as a function of how an individual views him/herself in the learning process as well as the individual's interaction within the community of learners of mathematics (DMECLT, 2007). Major contributions to this research provide many accounts of the participation of students and teachers in the classroom community, the curricular and participation structures within these communities, and the relationship between these structures and the identities students develop as learners of mathematics (Cobb & Hodge, 2002; Gutierrez & Rogoff, 2003; Hand, 2003). In the next paragraph, descriptions of this research will be highlighted in relation to participation as a means of engagement.

Focusing on practice and participation, Cobb and Hodge (2002) analyzed diversity and equity in mathematics education. They offered a "relational perspective" which described the relationship between a student's mathematical practices within and outside the classroom (p. 251). This perspective emphasized the links and gaps between students' ways of thinking, communicating, and collaborating across different contexts. They concluded that students' participation in the classroom is closely related to how they participate in their out-of-school communities. In 2003, Gutierrez and Rognoff employed participation and practice to examine culturally-related strategies for learning. Their research focused on "variations in individuals and groups' histories of engagement in cultural practices" (p. 19). They found that by

understanding this difference educators are more informed of the consistencies in both the students' practices and the organization of their communities as well as how students operate and engage in those practices. This research provides insight into the importance of linking students' everyday practices with their classroom practices. Hand (2003) found that the misalignment between students' social and intellectual activity within the classroom may provoke tension and disengagement among diverse students. She argued that classrooms that practiced negotiated participation were more likely to encourage participation among diverse groups of students than classrooms that practiced non-negotiated participation. The aforementioned studies (Cobb & Hodge, 2002; Gutierrez & Rogoff, 2003; Hand, 2003) reveal the existence of the relationship between students' participation (engagement) in the classroom and their developing identities within the learning process.

Since research studies have identified the existence of a linkage between identity and social practice, identity has been a central focus in studies dealing with participation (Martin, 2007; Nasir, 2002). "The concept of identity must account for the perceptions that individuals have for themselves and for those held by others about them, and the relation of these multiple perceptions to an individual's social positioning in interaction" (DMECLT, 2007, p. 409). Identity encompasses the multiple personalities students negotiate within and across contexts. In Martin's (2007) research, he studied the struggles that African-American students confront when negotiating identities as mathematics learners both in and out of the classroom. He writes, "any analysis of identity construction and students' becoming doers of mathematics must, in my view, simultaneously consider African American identities as well" (p. 148). He argues that the nature of mathematics education research positions African American students' abilities beneath the abilities of their White counterparts. He calls this a "master narrative" (p. 149). Martin focused

his research on African American students' successes in mathematics to combat the negative identities in order to emphasize the positive identities of African American students as mathematics learners. Nasir (2002) also examined identity and learning along with students' personal goals. She explored this relationship among African American students outside of the classroom, in practices of basketball and dominoes. She found that the players learn the practice through their desire to accomplish the practice. However, this desire changes as they begin to see themselves in the practice. Nasir explains:

> School is a practice where groups of novices come together to perform academic activities, which is quite different in nature than other practices where one new-comer enters an already established group of old-timers and others of varying stages of becoming old timers. From this perspective, we can understand learning as novices moving through a set of increasingly complex activities within which they develop corresponding competencies. This reconceptualization may be particularly appropriate in the case of schooling, as a key question then becomes how to structure this successive set of activities in a way that maximizes learning and cognitive developmental outcomes (p. 242).

In her research, Nasir showed how identities involve aspects of both community and learning, which both affect and reflect identity. This research illustrates the complexity in understanding individual activity within various social contexts. It sheds light on the importance of examining the linkage between identity and social practice as this linkage informs educators about the participation patterns of diverse students.

"By focusing on participation and identity as key aspects of individual and joint social practice, this perspective acknowledges the role of both individual agency and socio-cultural

processes in shaping the learning experience" (DMECLT, p. 416). Thus, this standpoint highlights the processes of compromise and rejection with which students' cope with respect to their activities within multiple contexts. The aforementioned studies have unfolded the notion of how mathematics learning is situated within a cultural practice that can serve to either "enfranchise or marginalize" diverse groups of students (DMECLT, p. 416). It provides insights into the process within which the engagement gap between ethnically diverse students takes place in classrooms (Hand, 2003; Yazzie-Mintz, 2009). As a result, educators can take steps in closing this gap through cultural competence. The researcher drew upon this notion to constitute a framework for understanding how the use of the cultural referents of students can inform instructional practice and promote student engagement among diverse students thereby addressing achievement. A description of this framework is defined in the conceptual framework section of this chapter.

Culture and Mathematics Education

Cultural basis for mathematics teaching and learning

For a long time, mathematics was viewed as a culture-free subject in school curriculum. Although a few studies suggested the converse, it wasn't until after Bishop (1988) published his book called Mathematical Enculturators that this view began to change. His ideas, along with other authors (Ascher, 1991; D'Ambrosio, 1985; Gerdes, 1988a, 1988b) became influential in the acknowledgment that culture is pivotal in mathematics education. Terms like culture, ethnomathematics, and everyday mathematics are used frequently and interchangeably in mathematics education. Bishop defines culture as "a complex of shared understandings" which provides a means for how individuals interact with one another (p. 5). This definition draws

attention to the relevance of culture in mathematics education as it encompasses individuals' ways of doing and communicating.

While attempting to understand the relationship between culture and mathematics, several researchers have toiled with a specific definition of the term ethnomathematics. Barton (1996) explains that the seminal writers (D'Ambrosio, Gerdes, and Ascher) have provided contradicting views of the term and its relationship to mathematics education. As a result of his motivation for understanding the term, Barton created a framework which encompasses the three different views and their relation to one another. This framework is known as an "Intentional Map" (Barton, 1996). The map encompasses mathematics, mathematics education, and society (Barton). He writes, "For D'Ambrosio it is a window on knowledge itself; for Gerdes it is a cultural window on mathematics; and for Ascher it is the mathematical window on other cultures" (p. 213). Each view is described by the lens of the viewer; "they contribute to the broadened lens on the role of culture in teaching and learning mathematics" (Presmeg, 2007, p. 439). Each researcher's viewpoint of ethnomathematics offers approaches that support the presence of culture in mathematics education.

Similar to ethnomathematics, definitions of everyday mathematics are sought to gain a clear and deep understanding of its issues and significance to mathematics education. The overarching question: What is the relationship, or is there a relationship, between everyday mathematics and academic mathematics (Brenner & Moschkovich, 2002). Fitzsimmons (2002) pointed out that professionals like engineers and automobile workers use mathematics as a part of their daily work. In contrast, Smith (2002) acknowledges jobs that did not require the use of mathematics such as assembly-line workers and machine operators. Difficulties in the construction of a definition of everyday mathematics led Masingila (2002) to refer to everyday

mathematics as in-school and out-of-school mathematics. For linking in- and out-of-school, research studies include two categories: (1) studies that attempt to bridge the connection between in-school mathematics practices and those of out-of-school mathematics and (2) studies that link with in-school mathematics education by exploring the culture of mathematics in various places (Presmeg, 2007). These studies highlighted the point that teachers are an important component of the success of attempting to use out-of-school practices effectively in the mathematics classroom (Brenner, 2002; Moschkovich, 2002b). Teachers' beliefs about mathematics, what culture is and its role in the mathematics classroom are major factors in teachers' instructional decisions (Civil 2002; Presmeg 2002b). Thus, a teacher's cultural competence of students' cultures informs instructional decisions. The aforementioned highlights a need for research that utilizes theories that capitalize on learning through the use of cultural traits. Through this study, the researcher sought to describe this idea on the use of students' cultural traits and referents to support the engagement of diverse students in mathematics learning consistent with the current standards for teaching and learning mathematics.

Link to Mathematics Standards (NCTM and CCSSM Position)

The National Council of Teachers of Mathematics (NCTM, 1989) produced standards that took a stand on equity by ensuring that all students have the opportunity to learn mathematics. According to NCTM:

> Educational goals for students must reflect the importance of mathematical literacy. Toward this end, the K-12 standards articulate five general goals for *all* students: (1) that they learn to value mathematics, (2) that they become confident in their ability to do mathematics, (3) that they become mathematical problem solvers, (4) that they learn to communicate mathematically, and (5) that they learn to reason mathematically (p. 9).

In 2000, NCTM emphasized equity by selecting equity as one of its six principles in its *Principles and Standards* document. Success in mathematics is contingent upon high expectations and support for all students (NCTM, 2000). The equity principle states:

> All students, regardless of their personal characteristics, backgrounds, or physical challenges, must have opportunities to study-and support to learn-mathematics. Equity does not mean that every student should receive identical instruction; instead, it demands that reasonable and appropriate accommodations be made as needed to promote access and attainment for all students (p. 12).

This increased attention on equity in mathematics education highlights the importance of understanding the role of diversity in the mathematics classroom. In order for teachers to make accommodations, they must take the time to know their students and be deliberate about selecting tasks and contexts with which students have access. NCTM (2000) also emphasized 5 process standards that should be used in all mathematics classrooms: (a) problem solving; (b) reasoning; (c) communication; (d) connections; and (e) representations. Berry states, "The recommendations proposed by NCTM's process standards complement the learning preferences of African American students" (p. 247). Research states that classrooms focused on use of NCTM's process standards positively influence the academic achievement of African American students (ARC, 2003; Merlino & Wolf, 2001; Schoenfeld, 2002; Berry, 2003). However, results of the National Assessment of Educational Progress over the last decade have shown that an achievement gap still exists (see Table 1). In addition to this achievement gap, the 2007 Trends in International Mathematics and Science Study (TIMSS) showed that the academic performance of US students still lags behind Asian countries, like Japan and China. This evidence revealed that US school mathematics topics were "a mile wide and an inch deep" indicating that there was

no depth in teaching and learning mathematics in the US (Schmidt, McKnight, & Raizen, 1996, p. 62). To that end, "the mathematics curriculum in the United States must become substantially more focused and coherent in order to improve mathematics achievement in this country" (Council of Chief State School Officers and National Governors Association, 2010, p. 3). NCTM's response was the 2006 Curriculum Focal Points, which focuses on coherence with emphasis on a small number of topics at each grade level for grades K-8. In 2010, the US government responded with a new set of standards called the Common Core State Standards for Mathematics (CCSSM).

The CCSSM provides standards for content and for mathematical practice. The content standards define what students should understand and be able to do in mathematics at each grade level. These grade-specific standards are a balance between procedure and understanding. However, they do not define the processes by which understanding should take place. As a result, similar to NCTM's (2000) process standards, the Common Core State Standards, Standards for Mathematical Practice (SMP) provides a detailed list of "processes and proficiencies" (CCSSO & NGA, 2010, p. 10) that students should move through as they develop mathematical understanding. Understanding of mathematics is having the ability to explain, justify, and reason (Polya, 1985; Skemp, 1976). The teacher's goal is to facilitate this understanding as understanding cannot be taught. "Understanding takes place in the students' minds as they connect new information with previously developed ideas" (Lambdin, 2003, p. 11). Therefore, teachers must not only teach content, but must also ensure that the content is connected to practice. It is through these practices that students become mathematically proficient as defined by the National Research Council (NRC) (2001) and understanding takes place. The Standards for Mathematical Practice (SMPs) are:

1. Make sense of problems and persevere in solving them
2. Reason abstractly and quantitatively
3. Construct viable arguments and critique the reasoning of others
4. Model with mathematics
5. Use appropriate tools strategically
6. Attend to precision
7. Look for and make use of structure
8. Look for and express regularity in repeated reasoning (CCSSO & NGA, 2010, pp. 6-8)

Many teachers will grapple with making sense of the standards for mathematical practice as they are used to only focusing on the content (NCTM, 2011). As a result, educators must prepare professional development opportunities to model this type of instruction. Instruction that utilizes the SMPs requires teachers to have a profound understanding of mathematics content (Ball, 1990; Ma, 1999), select tasks with goals in mind (Hiebert, Carpenter, Fennema, Fuson, Wearne, Murray, Oliver, & Human, 1997), have a vision of the mathematical path (Simon, 1995), provide relevant information and pose problems related to the task at hand, and guide a classroom culture where all students are able to engage in mathematical talk (Cobb & Yackel, 1995). "The quality of the instruction depends on whether the teachers select cognitively demanding tasks, plan the lesson by elaborating the math through those tasks, and allocate sufficient time for students to engage in and spend time on tasks" (NRC, 2001, p. 9).

While in the process of designing and selecting tasks, teachers must be cognizant of the cultural traits and experiences within the classroom as these traits motivate student engagement. Due to the various cultures within the classroom environment, cultural traits provide insight into

how students will engage in mathematics thinking through the use of the standards for mathematical practice. According to the CCSSM, "No set of grade-specific standards can fully reflect the great variety in abilities, needs, learning rates, and achievement levels of students in any given classroom" (NGO & CCSSM, 2010, p. 4). As a result, teachers must be deliberate within the planning process to ensure that classroom tasks are connected to students' culture. It is through this connection that engagement takes place and mathematical proficiency develops. Consequently, the use of culturally responsive teaching capitalizes on this opportunity.

Culturally Responsive Teaching

Origin

The theory of culturally responsive teaching (CRT) grew out of a larger framework known as multicultural education (Applin, 2005). Banks and Banks (2010) define multicultural education as, "a reform movement designed to change the total educational environment so that students from diverse racial and ethnic groups, students of both genders, exceptional students, and students from each social class group will experience equal educational opportunities in schools, colleges, and universities" (p. 446). It is a broad concept that contains five dimensions: (1) content integration; (2) the knowledge construction process; (3) prejudice reduction; (4) equity pedagogy; and (5) an empowering school culture and social structure (Banks & Banks, 2010). Culturally responsive teaching is one aspect of this idea. Gay (2000) defines it as "using the cultural knowledge, prior experiences, frames of reference, and performance styles of ethnically diverse students to make learning encounters more relevant and effective for them. It teaches to and through the strengths of these students. CRT is culturally validating and affirming" (p. 29). It invites students to bring all of their experiences, ways of thinking, resources, and characteristics to the learning process (Gay). Teachers capitalize on the diversity

of their students as mediums for teaching them more effectively (Tutak, Bondy, & Adams, 2011). The incorporation of students' cultural perspectives becomes a necessity in the learning process. At times, multicultural education and culturally responsive teaching are used interchangeably. However, this study focused primarily on culturally responsive teaching as one aspect of multicultural education.

Characteristics of Culturally Responsive Teaching

Research on the connection between culture and learning has identified that the students' cultural perspectives and experiences make up the classroom environment (Gay, 2000; Ladson-Billings, 2001; Nickerson, 1994). The framework of culturally responsive teaching proposes a bridge for facilitating a classroom environment that integrates both the cultural heritages and prior experiences of culturally diverse students. In order to utilize cultural differences as strengths in the learning process, Gay provides descriptive characteristics of this framework. She describes culturally responsive teaching as validating, comprehensive, multidimensional, empowering, transformative, and emancipatory. Through validation, teachers exemplify the following characteristics: (1) acknowledging the importance of including students' cultural heritages in the curriculum; (2) bridging students' home and school experiences; (3) utilizing various teaching strategies to connect to diverse learning styles; (4) promoting a positive self-identity and an appreciation for human differences; and (5) incorporating students' cultural experiences and resources into learning (Gay, 2000; Leonard, 2008). By making learning relevant to students' lived experiences and cultural heritages, teachers validate diversity and promote positive self-concept (Gay, 2000). Students see themselves in the learning process, which in turn promotes student engagement.

The use of validation in a learning environment can be beneficial to all students, including culturally diverse students (Malloy & Malloy, 1998). Culturally responsive teaching endorses the backgrounds of all students and emphasizes cultural competence. Culturally competent students not only learn the content, but they also learn and gain a greater appreciation for difference. This appreciation is the beginning of establishing a classroom environment where all learners and their perspectives are respected and valued (Taylor & Whittaker, 2003).

To that end, culturally responsive teaching teaches to the whole child; it is comprehensive. Teachers develop social, emotional, intellectual, and physical skills by "using cultural referents to impart knowledge, skills, and attitudes" (Ladson-Billings, 1992, p. 382). In addition to promoting academic success, culturally responsive teaching helps students maintain their ethnic identity and develop a sense of community, solidarity, and shared responsibility. Learning is valued as communal, reciprocal, and interdependent (Gay, 2000). In her study with elementary teachers, Ladson-Billings (1994a) observed these values during instruction. She witnessed interpersonal relations as a collected effort designed to promote academic and cultural success. The students functioned like a family, in which they supported and encouraged each other; they were "held accountable for each other's learning as well as their own" (Gay, 2000, p. 30).

Culturally responsive teaching is multidimensional because it encompasses the curriculum, the learning environment, student-teacher relationships, classroom interactions, instructional strategies, and assessments (Gay, 2000). It promotes interdisciplinary lessons and activities, which encourage students to examine a particular concept from different perspectives with respect to a specific discipline. Teachers collectively decide on a concept that can be taught across the disciplines. Students become challenged to demonstrate critical understanding of this

concept from various disciplines. This type of teaching requires teachers to have a wide range of cultural knowledge, contributions, and perspectives. "Emotions, beliefs, values, ethnos, opinions, and feelings are scrutinized along with factual information to make curriculum and instruction more reflective of and responsive to ethnic groups" (Gay, 2000, pp. 31-32). This type of teaching focuses on the aspects of culture socialization that are directly related to learning.

Culturally responsive teaching empowers students to obtain academic success and to become productive citizens (Gay, 2000; Moses & Cobb, 2001). Gay (2000) writes, "Empowerment translates to academic competence, personal confidence, courage, and the will to act" (p. 32). Students not only see themselves in the learning process but they also maintain a positive self-efficacy about their ability to master concepts. And therefore teachers must maintain high expectations while at the same time be aware of student challenges. Culturally responsive teachers create infrastructures within their classrooms to support the efforts of students as they strive to achieve academic success (Gay, 2000). This is accomplished by providing resources and personal assistance, praising students' accomplishments both collectively and individually, and heightening their self-confidence (Gay, 2000). An example of this practice of empowerment can be found in the Advancement via Individual Determination (AVID) project (Mehan, Hubbard, Villanueva, & Lintz, 1996; Swanson, Mehan, & Hubbard, 1995). Through AVID, Hispanic and African American students are encouraged to take advanced placement courses while at the same time receive instructional interventions through "social scaffolding" (Mehan et al., 1996). Mehan and others (1996) describe social scaffolding as students' (a) explaining and justifying their thought processes to each other; (b) spending time together; (c) learning the components of academic success; and (d) receiving mentorship both

academically and socially. Shor (1992) characterizes this type of empowerment in his statement below:

> The goals of this pedagogy are to relate personal growth to public life, to develop strong skills, academic knowledge, habits of inquiry, and critical curiosity about society, power, inequality, and change…The learning process is negotiated, requiring leadership by the teacher, and mutual teacher-student authority. (pp. 15-16)

He describes both the role of the teacher and student as well as the instructional strategies that support a student-centered environment. Within this student-centered classroom environment, the students are customers and creators of knowledge (Shor, 1992). Instruction encompasses contexts that include problem posing, problem-solving, inquiry, interdisciplinary, multiculturalism, dialogism, and democracy (Gay 2000; Shor, 1992). This aspect of culturally responsive teaching elucidates the importance of self and social change. Learning is active, cooperative, and social and in order to accomplish this empowerment, teachers must provide students with these opportunities within the classroom and during instruction.

Consequently, the transformative characteristic of culturally responsive teaching involves assisting "students to develop the knowledge, skills, and values needed to become social critics who can make reflective decisions and implement their decisions in effective personal, social, political, and economic action" (Banks, 1991, p.131). This agenda is two-fold: it challenges traditional teaching methods and practices and it develops social consciousness and personal efficacy in students so that they may combat and triumph over various forms of oppression (Gay, 2000). Gay writes:

> Culturally responsive teaching makes academic success a non-negotiable mandate for all students and an accessible goal. It promotes the idea, and develops skills for practicing it, that students are obligated to be productive members of and render service to their respective ethnic communities as well as to the national society (p. 34).

Students are encouraged to transform school knowledge in ways that address societal issues. They become motivated to seek for solutions.

This leads into the last characteristic of culturally responsive teaching; it is emancipatory. This type of instruction liberates students from the constraints of mainstream ways of knowing (Gordon 1993; Lipman 1995; Pewewardy, 1994). Gay (2000) explains, "Central to this kind of teaching is making authentic knowledge about different groups accessible to students" (p. 34). This freedom empowers students to believe and recognize that they have the ability to obtain and transmit knowledge. Knowledge is no longer solely dependent on the teacher rather it is in the hands of the learner and is always available. As a result, students become more active participants in the learning process as they begin to find their own voices and shape their own learning. Crichlow and colleagues (1990) expound on emancipatory teaching and learning. According to them,

> By collectively representing diverse cultures and groups as producers of knowledge, it facilitates a liberative student/teacher relationship that "opens up" the written text and oral discourse to analysis and reconstruction (p. 103).

Emancipatory teaching enables students to become actively engaged in shaping their own learning. Research has shown many forms of improved achievements among these students (Gordon 1993; Lipman 1995; Pewewardy, 1994). These forms include: thinking more critically;

having better interpersonal skills; and obtaining the ability to contextualize issues in various cultural perspectives (Ladson-Billings & Henry, 1990; Crichlow, Goodwin, Shakes, & Swartz, 1990). These achievements make up the heart of intellectual and cultural liberation.

Overall, the theory of culturally responsive teaching provides a framework that can be utilized to incorporate students' cultural experiences within the learning process. All six characteristics of CRT provide a clear explanation for what students gain from instruction that exemplifies CRT. However, the instructional practices are not clearly defined. These practices are defined by Gloria Ladson-Billings (1994a) who describes CRT teaching practices as the use of culturally relevant pedagogy.

Culturally Responsive Teaching Practices

As stated above, culturally relevant pedagogy (CRP) was developed by Gloria Ladson-Billings (1994a) from her study of eight successful teachers of African-American students. In her research with these teachers, she documented the following set of behaviors as effective strategies to meet the intellectual and social needs of students of color:

a. Treat students as competent
b. Provide instructional "scaffolding" in order for students to move from what they know to what they need to know
c. Demonstrate instruction has high priority
d. Extend students' thinking and abilities; and
e. Posses in-depth knowledge of both students and subject matter (pp. 123-125)

Through the use of culturally relevant pedagogy, Ladson-Billings proposes three goals for students: (1) academic success (not limited to standardized assessments); (2) cultural competence; and (3) the ability to critique the existing social order. This requires that teachers

attend to students' academic needs and utilize students' culture as a vehicle for learning (Ladson-Billings, 1995). Moreover, teachers must provide students with instruction needed for success in society as well as instruction that will engage students in a critical analysis of their world in an effort to promote a democratic society in which all students have an opportunity to participate fully. Consequently, students possess cultural integrity as well as academic excellence (Ladson-Billings, 1994a; 1994b; Villegas & Lucas, 2008). They also develop the ability to challenge the status quo. Although this pedagogy is not specific to mathematics education, it speaks to issues of mathematics education as it relates to culture in the teaching and learning of mathematics.

Through the analysis of the literature related to CRT and culturally relevant pedagogy, the researcher compiled the following framework (Figure 1)based upon the work of Ladson-Billings (1994a; 1994b; 1995), Gay (2000; 2002), the National Center on Culturally Responsive Educational Systems (NCCREST) (2006), and Villegas and Lucas (2002) to provide a set of teacher characteristics and instructional practices that are consistent with CRT research. Figure 1 provides a framework for CRT that exemplifies the role of the teacher and the context of the classroom. The proceeding paragraphs provide an explanation of the derivation of each cell of the framework as each portion of it was derived from research on CRT.

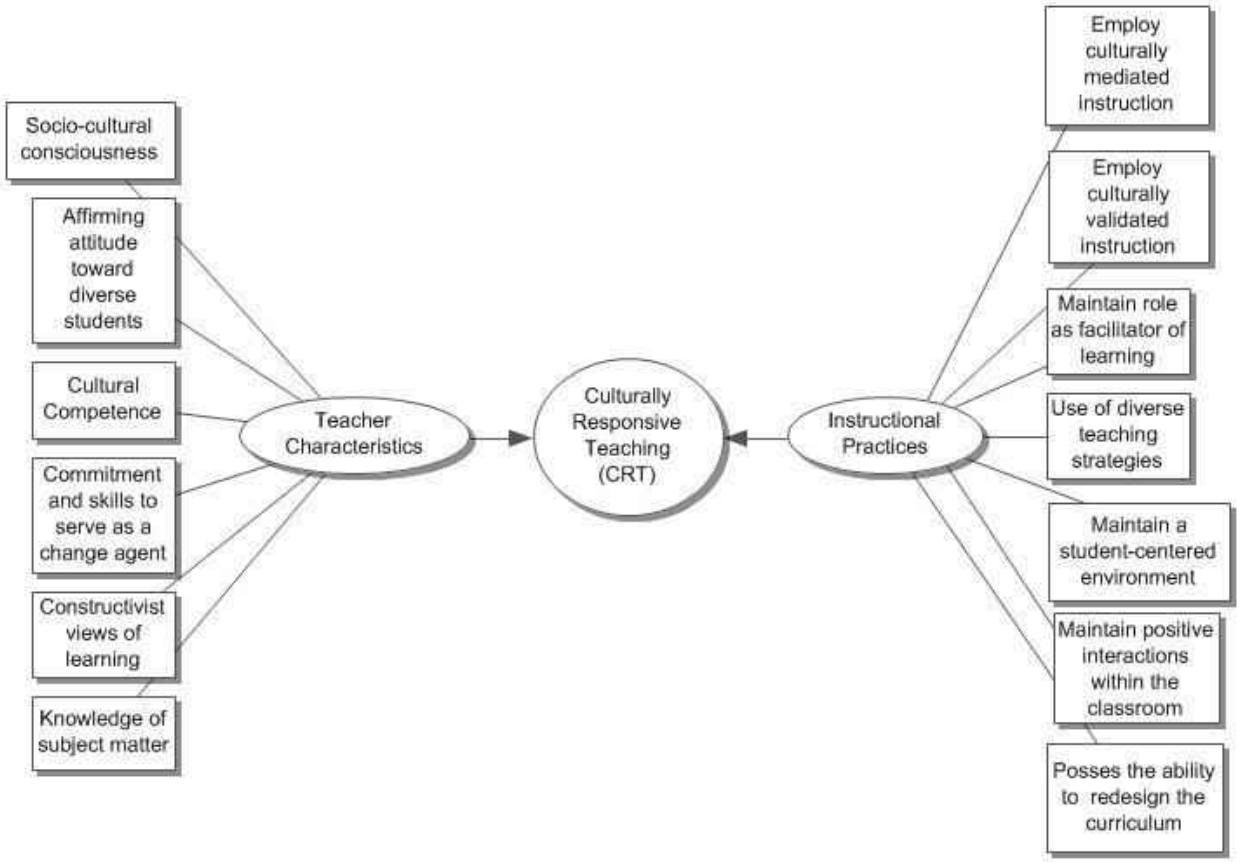


Figure 1 : Culturally Responsive Teaching Framework

Teacher Characteristics

Villegas and Lucas (2002) describe *socio-cultural consciousness* as being aware of one's identity and prejudices and then having the ability to examine and confront any biases that may have developed toward any cultural group. Teachers "must come to see that, as traditionally organized, schools help to reproduce existing social inequalities while giving the illusion that such inequalities are natural and fair" (Villegas & Lucas, pp. 22-23). By understanding the connection between schools and society, socio-cultural consciousness equips teachers with the ability to critique and challenge those social inequalities (Ladson-Billings, 1995). This characteristic assists teachers with maintaining an *affirming attitude toward diverse students*, which is having respect and an appreciation of cultural differences (Gay, 2000; 2002; Ladson-

Billings, 1994a; 1994b; NCCREST, 2006; Villegas & Lucas, 2002). Villegas and Lucas (2002) explain, "Teachers who see their students in an affirming light acknowledge the existence and validity of a plurality of ways of thinking, talking, behaving, and learning" (p. 23). Research supports the notion that a teacher's attitude toward students impacts a student's overall achievement (Irvine, 1990; Ladson-Billings, 1994a; NCCREST, 2006; Nieto, 1996). NCCREST (2006) echoed that this affirming attitude supports students in having a positive disposition about themselves and their ability.

Cultural competence is defined as "the ability to teach students from different cultures other than your own" (Diller & Moule, 2005, p. 2). It entails self-awareness, an appreciation for human differences, understanding the dynamics of difference, knowledge of students' cultures, and the ability to adapt teaching practices to accommodate those differences (Diller & Moule, 2005; Klump, 2005). Culturally competent teachers possess: 1) an intimate knowledge of students; 2) a positive perspective on students' parents, families, and communities; 3) the expertise to maintain and communicate high expectations; 4) the ability to understand student perceptions; and 5) the ability to use cultural differences as a catalyst for learning (Gay, 2000; 2002; Ladson-Billings, 1994a; 1994b; 1995; NCCREST, 2006; Villegas & Lucas, 2002).

NCCREST (2006) explains that the capability and responsibility to act as a *change agent* enables teachers to confront barriers and obstacles for change within the school or environment to promote equity. Villegas and Lucas (2002) write:

> Teachers need to believe that schools can be sites for social transformation even as they recognize that schools typically served to maintain social inequities. They need to have

> faith in the ongoing project to fashion a democracy, acknowledging that there will be failures and successes along the way (p. 24).

This commitment to social justice provides opportunities for all students to learn rigorously. Teachers must portray the view that all students have the ability to learn thereby maintaining a *constructivist view of learning*. The notion of constructivism is that knowledge is constructed (Piaget, 1953; Vygotsky, 1978); therefore, teachers scaffold knowledge through students' experiences and the content at hand. Cobb and Steffe (1983) write:

> In the constructivist view, teachers should continually make a conscious attempt to "see" both their own and the children's actions form the children's points of view. This emphasis stems from an analysis of teaching as primarily the activity of communicating with students (p. 85).

Ladson-Billings (2002) describes this as "cultural scaffolding", using students' cultural traits and referents to expand their academic horizons (p. 109). Constructivist teaching promotes problem posing, critical thinking, problem solving, cooperation and the acknowledgement of multiple ways of thinking (Cobb & Steffe, 1983; Simon, 1995; Villegas & Lucas, 2002). In order to accomplish these characteristics, teachers must have pedagogical content knowledge (Shulman, 1986), which is the intersection between a teacher's *knowledge of the subject matter* and their knowledge for teaching and learning. Ma (1999) describes this knowledge as having a "profound understanding" of the subject which embodies four components: connectedness; multiple perspectives; basic ideas; and longitudinal coherence (p. 120).

The paragraphs above provide descriptions of each CRT teacher characteristic; however, they do not provide observable indicators of how a teacher displays each characteristic during

instruction. Table 2 outlines observable indicators of each characteristic. What follows is an explanation of how these observable indicators were adapted from research.

Table 2: Indicators of Culturally Responsive Teaching Teacher Characteristics

Teacher Characteristic	Indicators
Socio-cultural consciousness	1. Displays awareness of one's own identify and prejudices 2. Displays the ability to examine and confront personal negative feelings toward any cultural group
Affirming Attitude Toward Diverse Students	1. Displays respect for cultural differences 2. Displays an appreciation of cultural differences 3. Displays and shares cultural artifacts from students primary or home culture (Applin, 2005; Sobel, Taylor, & Anderson, 2003) 4. Uses positive body language when students speak of family or culture (Applin, 2005; Sobel, Taylor, & Anderson, 2003) 5. Listens to students offer examples of their home life and family to illustrate points or answer questions while displaying positive body language (Applin, 2005; Sobel, Taylor, & Anderson, 2003)
Commitment and Skills to Serve as a Change Agent	1. Displays the ability to confront barriers and obstacles for change within the school or environment to promote equity 2. Identifies personal biases and guards against bias in teaching and planning (Applin, 2005; Sobel, Taylor, & Anderson, 2003)
Culturally Competent	1. Displays having an intimate knowledge of students 2. Displays a positive perspective on students' parents, families, and communities. 3. Demonstrates the ability to maintain high expectations 4. Demonstrates the ability to understand student perceptions 5. Demonstrates the ability to use students' cultural differences as a catalyst for learning.
Constructivist Views of Learning	1. Demonstrates the ability to see their own and their students' actions develop their students' overall perspectives. 2. Demonstrates the ability to scaffold knowledge through students' experiences and the content at hand.
Knowledge of the Subject Matter (Mathematics)	1. Displays the knowledge to connect mathematical concepts and procedures (Ma, 1999)

Teacher Characteristic	Indicators
	2. Displays the understanding of the interrelatedness of the concepts and sub-concepts of mathematics (Ma, 1999) 3. Demonstrates the ability to provide varying facets, ideas and approaches to mathematical content (Ma, 1999) 4. Demonstrates the ability to provide mathematical explanations for varying facets, ideas, and approaches (Ma, 1999) 5. Displays awareness of basic mathematical concepts and ideas in relation to the principles of mathematics (Ma, 1999) 6. Displays an understanding of the fundamental knowledge of the mathematical curriculum as a whole including its coherence (Ma, 1999)

The researcher compiled these indicators from the works of Applin (2005), Gay (2000; 2002), Ladson-Billings (1994a; 1994b; 1995), NCCREST (2006), Villegas and Lucas (2002), and Ma (1999). Specific indicators were adapted from the Diversity Responsive Teaching Protocol (Sobel, Taylor, & Anderson, 2003) which emerged from a study on preservice and inservice teachers' capabilities to manage diversity in the classroom. Indicators related to teacher knowledge of the subject matter were adapted from Ma (1999). Together these indicators provide a means for how these CRT teacher characteristics are displayed during instruction. The following paragraphs will describe the other component of CRT: instructional practices.

Instructional Practices

According to Gay (2000), CRT instruction is culturally affirming and validating. *Culturally mediated* instruction refers to involving issues related to family, community, or schools within the context of learning and having the ability to challenge students on those issues (Bonner, 2009; Gay, 2000; Ladson-Billings, 1994a; 1994b; 1995; Leonard, 2008; Peterek, 2009). It encompasses and amalgamates diverse ways of knowing, interpreting, and portraying information. Instruction that is *culturally validating* assists students in developing a positive self

efficacy and the ability to see themselves in the learning process (Bonner, 2009; Gay, 2000; Ladson-Billings, 1994a; 1995; Leonard, 2008; Peterek, 2009). It utilizes student characteristics and experiences as a conduit for learning. And as a result all cultures are equally exemplified and embraced. Table 3 outlines observable indicators of culturally mediated and culturally validated instruction. What follows is an explanation of how these indicators were adapted from research.

Table 3: Indicators of Culturally Responsive Teaching Instructional Practices

Instructional Practices	Indicators
Culturally mediated	1. Incorporates issues related to family, community, or schools 2. Challenges students on issues related to family, community, or schools 3. Mediates controversial intercultural issues among students to enhance any culture, group, or person while affirming individual heritages (Applin, 2005; Sobel, Taylor, & Anderson, 2003) 4. Prompts student-to-student interactions among students of different cultures (Applin, 2005; Sobel, Taylor, & Anderson, 2003)
Culturally validated	1. Assists students in developing a positive self-efficacy about their ability to do mathematics 2. Assists students in positioning themselves in the learning of mathematics 3. Uses students' characteristics and experiences as a focus for learning mathematics 4. Teaches mathematics concepts from multiple cultural perspectives to equally exemplify and embrace all cultures 5. Displays student work and other artifacts illustrating personal and cultural identity of students (Applin, 2005; Sobel, Taylor, & Anderson, 2003)

Like the indicators from teacher characteristics above, these indicators were compiled and adapted from the works of Applin (2005), Gay (2000; 2002), Ladson-Billings (1994a; 1994b; 1995), Sobel, Taylor, and Anderson (2003), NCCREST (2006), and Villegas and Lucas (2002).

They provide a vision for what culturally mediated and culturally validated instruction looks like in the classroom.

The role of the teacher as a *facilitator* means the teacher uses *diverse teaching strategies;* uses *student-centered instruction;* maintains *positive interactions within the classroom*; and has the ability to redesign the curriculum. *Redesigning the curriculum* refers to using resources in addition to textbooks, interdisciplinary lessons, and activities reflective of students' backgrounds. These instructional practices embody constructivist teaching, where the classroom environment contains worthwhile tasks, time for investigating in those tasks, and opportunities for students to justify and explain (Larson, 2011). Larson describes this classroom discourse below:

1. posing questions and tasks that elicit, engage, and challenge students' thinking;
2. listening carefully to students' ideas and deciding what to pursue in depth from among the ideas students generate during a discussion;
3. asking students to clarify and justify their ideas orally and in writing;
4. deciding when and how to attach mathematical notation and language to students' ideas;
5. encouraging and accepting the use of multiple representations;
6. deciding when to provide information, when to clarify an issue, when to model, when to lead, and when to let students productively struggle; and
7. monitoring students' participation in discussion and deciding when and how to encourage each student to participate (p. 24).

The use of the CRT framework provides a clear description of how culturally responsive teaching is reflected within the learning process. Both the teacher characteristics and the use of these instructional practices utilize students' culture as a catalyst for learning. It provides access and opportunity for all students to learn. In addition, through this type of learning diverse students obtain a positive perception of their ability to do mathematics. And, in turn, this supports mathematical proficiency. Mathematically proficient students possess a productive disposition (NRC, 2001), which supports autonomy in mathematics.

Culturally Responsive Teaching as Good Teaching

Some mathematics educators may argue that CRT is simply a combination of the elements of Realistic Mathematics Education (RME), social norms, and sociomathematical norms. More specifically, it can be argued that CRT is simply just "good teaching." Good teaching promotes autonomy in mathematics as well. This study, however, will draw a clear distinction between CRT and RME, as well as between CRT and social and sociomathematical norms. The researcher will argue that CRT extends beyond these frameworks.

Realistic Mathematics Education

The theory of RME originated at the Freudenthal Institute (Gravemeijer, 1994; Streefland, 1991) and is based on Freudenthal's idea of mathematics as a human activity (Freudenthal, 1973). Freudenthal writes, "What humans have to learn is not mathematics as a closed system, but rather as an activity, the process of mathematizing reality and if possible even that of mathematizing mathematics" (Freudenthal, 1968, p.7). Through mathematization, "one sees, or organizes and interprets the world through and with mathematical models (Fosnot & Dolk, 2005, p. 189). According to Freudenthal, in order for mathematics to be of human value, it must be connected to reality, tangible to children, and be relevant to society. RME helps

students construct mathematical ideas through their own mental activities. Students are active participants in the learning process. Using RME, Treffers (1987) describes five characteristics of mathematics activities for students: (1) the use of contexts; (2) the use of symbols; (3) the use of student's own discoveries and strategies; (4) facilitation by the teacher; and (5) the connection among various learning strands. Later Gravemeijer (2004), through design research, developed "a domain specific instruction theory" to support teachers' use of RME (p. 109). He defines it as the RME theory, which is comprised of three design heuristics: (1) guided reinvention; (2) didactical phenomenology; and (3) emergent modeling. For guided reinvention, teachers develop a learning path for students by taking into account their students' ways and sources of learning mathematics. The learning path is comprised of tasks and activities that make up the learning process. The didactical phenomenology heuristic ensures that those tasks and activities are sequential in supporting students' mathematical development. And lastly, the emergent modeling heuristic employs symbols and models so students have the opportunity to model their mathematical intuitions. Together these heuristics provide an instructional sequence which assist teachers in developing students to become autonomous in mathematics.

Use of Social and Sociomathematical Norms

In order to develop autonomy in mathematics, students must engage in mathematical talk within the learning process. Students need to be able to explain and justify mathematics concepts (Cobb, Yackel, & Wood, 1989; Yackel, Cobb, & Wood, 1991). Cobb and Yackel (1996) describe this as developing social and sociomathematical norms, which are negotiated by both the teacher and the students. "The understanding that students are expected to explain and justify their solutions and their ways of thinking is a social norm, where as the understanding of what counts as an acceptable mathematical explanation is a sociomathematical norm" (Cobb &

Yackel, 1996, p. 461). In any classroom, one of the most important components of sustaining a healthy environment is maintaining an atmosphere of respect and value for an individual's ideas, ways of reasoning, and justifying (Larson, 2011). As a result, teachers and students should negotiate their ways of acting, communicating, and interacting with one another and within the classroom (Stephan & Whitenack, 2003). The establishment of these social norms is important as all students' opinions and ways of thinking are valuable to the learning process. The negotiated sociomathematical norms give rise to new learning opportunities. Students begin to make sense of the reasoning of others in relation to their own reasoning. Consequently, teachers gain a better understanding of their students' mathematical reasoning and become facilitators of the mathematical discussions. The use of sociomathematical norms assists students in developing their own mathematical beliefs and values, which consequently results in their independence in mathematics (Cobb & Yackel, 1996). This is a major goal of educational reform in mathematics education (Cobb & Yackel, 1995; 1996; NCTM, 1989; 2000). However, it can only be achieved by the expertise of the teacher to facilitate rather than lecture. Cobb and Yackel (1996) write, "It is the analysis of sociomathematical norms implicit in the inquiry mathematics tradition that clarifies the process by which teachers foster the development of intellectual autonomy" (p.473). Dixon, Andreasen, and Stephan (2009) suggest three phases of the norm building process: planning for negotiation of norms, negotiating new norms, and sustaining norms. They write, "…a teacher must understand and value the norm building process so that she may recognize fruitful opportunities and capitalize on them at the moment" (p. 63). Through the establishment of social and sociomathematical norms, teachers and students create an environment that promotes problem solving where all explanations are valued and accessible to all students (Stephan & Whitenack, 2003).

The use of RME and social and sociomathematical norms support good teaching practices. As with CRT, RME teachers utilize context that is relevant to students' lives as well as ensures that the mathematics is tangible for students. In addition, RME teachers allow students to construct their own mathematical discoveries through facilitation of mathematics concepts. By establishing social and sociomathematical norms, students are provided the opportunity to talk about mathematics. Both of these theories promote mathematical autonomy; however, they do not take into consideration students' cultural practices and how to use them as a catalyst for learning. Furthermore, these theories leave out the importance of teachers having cultural competence and maintaining the commitment to serve as social change agents. Cultural competence "entails mastering certain personal and interpersonal awarenesses and sensitivities, learning specific bodies of cultural knowledge, and mastering a set of skills that, taken together, underlie effective cross-cultural teaching" (Diller & Moule, 2005, p. 5).

In order to select appropriate contexts or tasks for students, teachers must possess: 1) an intimate knowledge of students; 2) a positive perspective on their parents, families, and communities; 3) the ability to maintain high expectations; 4) the ability to understand student perceptions; and 5) the ability to use cultural differences as a catalyst for learning (Gay, 2000; Ladson-Billings, 1994a; 1994b; NCCREST, 2006; Villegas & Lucas, 2002). The commitment to serve as a change agent refers to the will to confront barriers and obstacles for change within the school, environment, or community to promote equity. Cultural competence and a commitment to serve as a social change agent are the components of culturally responsive teaching. Franke, Kazemi, and Battey (2007) echo this notion below:

> Although some may argue that these principles signify good mathematics teaching, what differs here is the focus on the relationships with students, and how students are respected for who they are and what they bring to the classroom (p. 247).

From this perspective, RME, social norms, and sociomathematical norms are subsumed in culturally responsive teaching. CRT extends beyond the relevance and the establishment of norms to include other key factors that promote learning for all students. The proceeding paragraphs provide insight on the use of culturally responsive teaching within the mathematics classroom. Each of these studies provides implications for improving the academic performance of diverse students and closing the achievement gap.

Culturally Responsive Mathematics Instruction

Culturally Responsive Teaching in Mathematics

Through interviews and observations, Tate (1995) documented the teaching practice of Mason, a middle school mathematics teacher with 5 years of teaching experience. Teaching at a predominately African American school, Mason's mathematics classes were comprised of children who varied academically. In teaching mathematics, Mason viewed herself as a social change agent, which is one of the teacher characteristics of culturally responsive teaching. Her teaching philosophy was to empower students to become active participants in their community through the learning of mathematics. Using a problem-solving approach, Mason related mathematics to her students' lived experiences. She utilized a three-step approach where she: (1) prompted students to pose problems related to the community; (2) required students to research the problem and generate a strategy to solve it; and (3) encouraged students to solve the community problem using their generated strategies. Tate writes:

> Central to her approach to teaching are the following: (a) communication between students, teacher, and outside entities; (b) cooperative group work; (c) investigative research throughout the learning process; (d) questioning content, people, and institutions; (e) open-ended problem solving connected to student realities; and (f) social action (p. 172).

Mason's students viewed mathematics as a part of their lives and their reality. Mathematics became tangible to them.

Correspondingly, Gustein and his colleagues (1997) conducted a longitudinal qualitative study of five mathematics teachers' pedagogy in a Mexican American context. The purpose of this three-phase study was:

> …to help teachers use what they know about their students' culture to improve students' learning of mathematics, and of other subjects as well, and to help students develop critical approaches to knowledge and the tools they will need to be agents of social change (Gustein, Lipman, Hernandez, & Reyes, 1997, p. 709).

During phase 1, the teachers participated in a school-change project, in which they were introduced to the Mathematics in Context (MiC) middle school curriculum developed by the National Center for Research in Mathematical Sciences Education & Freudenthal Institute (Gustein, Lipman, Hernandez, & Reyes, 1997). In Phase 2, they implemented the curriculum in their bilingual programs for grades 4 -8. Data were collected and analyzed using observations; participation in classroom activities; open-ended interviews; materials produced by the teachers, students, and school; and teacher reflections. Based on their findings, they proposed the following theoretical framework for mathematics instruction focused on the connection between the NCTM standards and culturally relevant pedagogy:

> (a) connections between becoming critical mathematical thinkers and viewing knowledge critically in a broad sense; (b) connections between building on students' informal mathematical knowledge and building on students' cultural and experiential knowledge; and (c) orientations to students' culture and experience (Gustein, Lipman, Hernandez, & Reyes, 1997, p. 718).

The authors suggest that, although there is a connection between the NCTM Standards and CRT, that connection is superficial without conscious action (Gutstein, Lipman, Hernandez, & Reyes, 1997). The first aspect of the framework deals with thinking critically, that is encouraging students to view different perspectives, inquire about the curriculum, discover their own voice, and construct their own knowledge. The second aspect of the framework involves "perspectives on and the use of children's knowledge" (p. 722). And lastly, the third aspect provides two positions on the orientations of students' culture and experience: "a deficit or empowerment orientation" (p. 722). Although the teachers varied on how they put their beliefs into practice, this research provides a model for the connection between culturally relevant teaching and the NCTM Standards.

Using the framework designed by Gustien et al and following their research design, Matthews (2003) documented similar results. In addition, he highlighted the complexities of incorporating culturally relevant pedagogy that emerged from his experience in the classrooms of four mathematics teachers who taught at four predominantly black schools in Bermuda. The first complexity dealt with building empowering relationships involving students, teachers, and community. The second complexity dealt with building on culture and fostering critical thinking formally. And lastly, the third complexity dealt with building on cultural knowledge and fostering critical thinking informally. After collaborating with the teachers as they reflected,

Matthews concluded that teachers striving to incorporate the culturally relevant teaching framework into the mathematics classroom will need to "let go" of the traditional mathematics teaching model, which is described as being lecture and textbook centered.

Using a grounded theory approach, Bonner (2009) and Peterek (2009) documented the teaching practices of Ms. Johnson in order to construct a framework for culturally responsive mathematics teaching (CRMT). Over a four-month period, Ms. Johnson's teaching practices were obtained from observations, interviews, and artifacts. Data analysis revealed a three-pronged framework, in which all prongs are connected and students are at the core. The three prongs include: knowledge, communication, and relationship/trust. The *knowledge* theme encompassed Ms. Johnson's pedagogical content knowledge and her profound knowledge base of her students' lives, culture, interests, neighborhood, and families. This theme lead into the *communication* theme as Ms. Johnson's cultural knowledge of her students allowed her to communicate effectively with them. "She uses a specific vernacular when speaking with students, and employs familiar patterns of interaction in her mathematics lessons" (Bonner, 2009, p. 4). Ms. Johnson also employed a caring attitude among her students in which students felt that she was sincerely concerned about their success. This attitude complemented the care discipline that she maintained in her classroom. Bonner explained, "These communication patterns mirror those that students experienced in their own homes" (p. 4). The communication theme emphasized the interconnection between culture and cognition. Research supports the notion that this connection leads to academic success and empowerment (Bonner, 2009; Allen & Boykin, 1992). For the third and final theme of *relationships/trust*, Bonner documented the relationships that Ms. Johnson built with her students, their student's families, and their community. These relationships resulted in trust. Bonner explained, "Successful practices in the

classroom, coupled with community involvement and familial relationships have resulted in an immensely trusting relationship between the neighborhood and Ms. Johnson" (p. 5). Ms. Johnson's pride and support for her students enabled her students to have a productive disposition about their learning of mathematics.

Each of the aforementioned studies contributes to and is consistent with the framework outlined in Table 2. The results of the studies show how the use of culturally responsive teaching is validating for culturally diverse students. Students begin to position themselves in the mathematics curriculum. However, one may ask, how does CRT impact student achievement as that is the ultimate goal? Thus, exploring research on its implications for student achievement would be beneficial as it may provide insight into closing the achievement gap. The next paragraphs will provide justification for studying CRT based on connections to student achievement.

Culturally Responsive Teaching in Mathematics and Student Achievement

Lipka and his colleagues (2005; 2007) conducted a quasi-experimental study of four Yupiaq elementary teachers who implemented a culturally-based curriculum called Mathematics in Cultural Context (MCC). The MCC curriculum was developed through demonstrations and explanations of Yupiaq teachers and elders in the community who identified key cultural aspects of their community that would support Yupiaq students in mathematics. Examples of these cultural aspects included: "how to build a kayak, how to design and sew a border pattern, and how to navigate using the stars" (Lipka, Webster, & Yanez, 2005, p. 3). Using expert-apprentice modeling, joint production activity, and cognitive apprenticeship, the teachers successfully connected their community, home culture, and language culture to the teaching and learning of mathematics. As defined by Lipka and Yanez (1998), expert-apprentice modeling is when

"observable skills are reinforced, respect for elders is practiced, and respect and individual autonomy" is the norm (p. 134). Joint productive activity is referred to as "cross-cultural" where the experts and novices work together towards a particular goal (Doherty, Hilberg, Epaloose, & Tharpe, 2002, p. 36). Cognitive apprenticeship enables students to work independently. Lee (1995) refers to it as cultivating motivation through actual, rather than fabricated problem situations thereby working towards autonomy. One kindergarten/first grade teacher in particular, named Nancy Sharp, utilized the border pattern to introduce geometry concepts, specifically shapes and their properties (Lipka, Sharp, Brenner, Yanez, & Sharp, 2005). As the lesson progressed, the students' engagement level increased. Mathematics achievement of her students was measured using a pre-assessment and a post-assessment. Ms. Sharp's students out-performed their counterparts having significant learning gains from the pre- to post on geometry.

Similarly, in geometry, Moses-Snipes (2005) conducted a quasi-experimental study with fifth-grade African American students. Eighteen students were randomly selected to participate in either the Mathematics with Culture (MWC) group or the Mathematics without Culture (MWOC) group. The researcher developed a pre- and post-assessment, which were validated using three different pilot studies. Although all students' scores from both classes improved from the pre- to the post-assessment, the highest score and greatest learning gains were made by a student in the MWC group. Overall, 100% of the students in the MWC group improved their score on the post-assessment.

In a comprehensive four-year longitudinal study of three high schools, Boaler (2006; 2008) documented teaching practices that enabled mathematics departments to obtain mathematics achievement for culturally diverse students. Of the high schools that participated in the study, one mathematics department, Railside, utilized a "mixed-ability, reform-oriented

approach" (p. 41), while the other two high school mathematics departments utilized "tracking and traditional teaching methods" (p. 41). This study was conducted with more than 700 students in California. Data were collected through classroom observations, yearly assessments given to the students, questionnaires, and interviews. Railside contained more urban students than the other two schools; its mathematics teachers adopted a teaching approach called "complex instruction" (p. 41), which was developed by Cohen and Lotan (1997). This approach can be used in all subject areas and includes many teaching practices. However, Railside employed the following 7 practices: multidimensional classrooms, student roles, assigning competence, student responsibility, high expectations, effort over ability, and learning practices (Boaler, 2006). The *multidimensional classes* were referred to as providing students with open-ended problems that contained several solution paths and allowed for multiple representations. When placed into groups, the students were assigned specific *roles* with specific responsibilities, which held every group member accountable. The practice of *assigning competence* was referred to as "raising the status of students who may be of a lower status in a group by praising" the academic ability of the student (Boaler, 2006, p. 43). As a result, students become responsible for each other's learning, indicating the *student responsibility* practice. By maintaining *high expectations*, the teachers also valued students' *efforts over their ability*. Teachers emphasized that success in mathematics stems from hard work. Therefore, teachers were very clear about the *learning practices* employed by the students that were considered engagement. Boaler (2008) found that students at this high school not only achieved at higher levels, they also gained a sense of appreciation and respect for students from different cultures and social classes. Through their teachers' approach to teaching as well as the use of curriculum materials designed to connect with students' cultures, the students learned effective problem-

solving behavior and closed the mathematics achievement gap between Whites, Blacks, and Hispanics within their school.

The aforementioned studies provide insight into how the use of CRT in mathematics supports the mathematics achievement of culturally diverse students. The focus on achievement provided a basis for this study. However, these studies highlight the academic success of diverse students through the use of CRT in mathematics; they contain many variables, in which CRT may not be the only contributor to students' success. Some of these variables include the use of problem-based learning in both the MCC and MWC studies and the use of mixed ability grouping and tracking in Boaler's study. Moreover, these studies fail to describe the types of engagement in which the students became involved. According to the CCSSO & NGA (2010), students must process mathematics using specific engagement practices to reach mathematical understanding. As a result, research geared specifically to the use of CRT and student engagement practices consistent with the Common Core State Standard's SMPs are needed. The purpose of this study was to explore the relationship between teachers' use of CRT and students engaging in SMP3.

Standard for Mathematical Practice 3

Of the eight Standards for Mathematical Practice from CCSSM, practice three requires a major shift in classroom environments and the development of mathematical independence. Standard for Mathematical Practice 3 (SMP3) requires students to construct viable arguments and critique the reasoning of others. According to CCSSO & NGA (2010), students who construct viable arguments do the following:

- Use stated assumptions, definitions, and/or previously established results

- Make conjectures and build logical progression of statements to explore the truth of their conjectures;
- Analyze situations by breaking them into cases;
- Can recognize and use counter examples;
- Justify their solutions and communicate them to others;
- Respond to the arguments of others; and
- Reason inductively, making plausible arguments that take into account the context from which data arose (pp. 6-7).

Each of the above observable student engagement practices were adapted from the description of SMP3 provided by CCSSO & NGA (2010). In order for students to fully engage in this practice, teachers must provide students with opportunities to reason with mathematics and opportunities to communicate their reasoning with others. Teachers must choose tasks that are problematic, start with where students are, and engage students in thinking about mathematics critically (Hiebert et al, 1997). According to CCSSO & NGA (2010), students who critique the reasoning of others do the following:

- Actively listen to the arguments of others and decide whether they make sense.
- Read arguments of others and decide whether they make sense;
- Ask careful questions to clarify arguments of others; and
- Ask useful questions to improve arguments of others (pp. 6-7)

As with the previous list of practices, each of the above observable student engagement practices were adapted from the description of SMP3 provided by CCSSO & NGA (2010). In order for students to engage in this practice, teachers must create a classroom culture where students are

comfortable communicating about mathematics. This classroom culture must also support cognitive conflict. Hiebert and his colleagues write:

> …cognitive conflict is created as students present their ideas and solution methods, defend them in the face of questions, and question others' ideas. These experiences encourage students to deal with incongruities, to reevaluate their methods, to elaborate, clarify, and reorganize their thinking (p. 46).

Both the nature of the classroom tasks and the social culture of the classroom will have a major impact on how students engage in CCSS's SMP3. Students should be able to freely interact with and about mathematics. Heibert et al (1997) provide four features of the social culture that encourage students to interact with mathematics: "(1) ideas and methods are valued; (2) students choose and share their methods; (3) mistakes are learning sites for everyone; and (4) correctness resides in mathematical argument" (p. 12). Utilizing these features is key in supporting students to construct viable arguments and critique the reasoning of others.

In order to determine if a student has constructed a logical argument, teachers require students to explain and justify their ways of reasoning about a problem or situation. Whether written or verbal, justification requires students to reflect or unpack their own thinking. This refers to metacognition, reflecting on one's own thinking. Through oral explanations and justifications, students can critique the reasoning of others while at the same time reflecting on their own thinking. This requires the use of social and sociomathematical norms, in which students engage in mathematical talk (Cobb & Yackel, 1995; 1996). During mathematical talk, students make sense of the reasoning of other students while at the same time they explain and justify their own thought processes. The use of RME provides a basis for this type of learning (Gravemeijer, 2004; Treffers, 1987). In order to engage in mathematical talk, students must be

provided with specific mathematical tasks and situations that are related to their lived experiences. However, when selecting tasks, teachers must be culturally competent as this will influence the tasks they select based on the cultures and experiences of the students within the class (Gravemeijer, 2004). Furthermore, teachers must be cognizant of students' cultural traits as they influence student engagement (DMECLT, 2007; Martin, 2007; Nasir, 2002). Being knowledgeable of students and their learning preferences will assist teachers in selecting tasks and contexts that are appropriate for their students and provide the appropriate support for each of them in the learning process.

As described in the preceding paragraphs, SMP3 will require an instructional shift which will change the role of the teacher and students. Teachers will need to facilitate a "math-talk learning community" as describe by Hufferd-Ackels, Fuson, and Sherin (2004, p. 82). They suggest four aspects of this community: (a) questioning; (b) explaining of mathematical thinking; (c) source of mathematical ideas; and (d) responsibility for learning. Rather than teachers doing all the questioning, both teachers and students become co-questioners in clarifying thinking (Hufferd-Ackels, Fuson, & Sherin, 2004). Rather than focusing on answers, teachers focus on mathematical thinking. Instead of teachers being the sole proprietor of learning, teachers become flexible by allowing students to generate ideas and methods. Both the students and the teacher are seen as important sources of mathematical ideas (Hufferd-Ackels, Fuson, & Sherin, 2004). Students are increasingly afforded the opportunity to articulate their ideas to the class as well as with each other. And, as a result, students began to gain mathematical independence. When students are mathematically independent, they take ownership of the learning and of the evaluation of others and self (Hufferd-Ackels, Fuson, & Sherin, 2004). This instructional shift in the classroom environment supports a "math-talk" learning community, which is needed to

support students' engagement in constructing viable arguments and critiquing the reasoning of others.

Student engagement in a "math talk" learning community is best situated within the cultural perspectives of the students (DMECLT, 2007; Nasir, 2002; Hand 2003; NCTM, 2000; Berry, 2003). When students engage in rationalizing mathematical ideas, they draw upon their own experiences and frames of references to make mathematical decisions (Berry, 2003). Furthermore, culture serves as the lens through which students consider the mathematical viewpoints of their peers. It follows that students' cultural perspectives are valuable tools that can be used to enhance the quality of a "math-talk" community, especially when working with students from diverse backgrounds (Hufferd-Ackles, Fuson, & Sherin, 2004; Berry, 2003). Therefore, the student engagement practices of constructing viable arguments and critiquing the reasoning of others is best carried out when the mathematical content is relevant to students' cultures and when the context of the classroom is representative of students' lives (Berry, 2003; NCTM, 2000). It follows that teachers who are proficient in the use of culturally responsive teaching practices can best support students' engagement in practices consistent with SMP3. Culturally responsive teachers allow students' cultural referents to inform instructional decisions.

Although the use of social and sociomathematical norms and the theory of RME support SMP3, they do not take into consideration the process of how to engage all students, specifically culturally diverse students. A student's engagement is connected to his/her cultural experiences (DMECLT, 2007; Martin, 2007; Nasir, 2002). Therefore, the framework of CRT provides another dimension in that students' cultural experiences are used as a catalyst for learning. In that regard, the theory of RME and the use of norms are subsets of the framework of culturally responsive teaching (See Figure 1). Combining this framework with the construct of student

engagement embodied the conceptual framework of this study which is described in the proceeding paragraph.

Conceptual Framework

Research on the teaching of mathematics indicates that US teachers' instructional methods overemphasize providing students with sets of procedures to follow (Silver, 2010; Stigler & Hiebert, 1999). This shifts the focus of the lesson from "thinking" to following a procedure. As a result, students do not get to reason and interact with mathematics. However, with the implementation of the CCSS, teachers will be required to have their students engage in SMP3, which supports reasoning, sense making, and interaction with mathematics. The SMP3 provides another dimension to mathematical learning as it forces the teachers to select mathematical tasks critically and establish a healthy classroom culture. A healthy classroom culture includes facilitating an environment where all students engage in interactive mathematics. Therefore, understanding how culturally responsive teaching strategies influence student engagement in the classroom is imperative to establishing a healthy classroom environment where students can engage in practices consistent with SMP3. To facilitate this major shift in the classroom environment, teachers will need professional development in modeling strategies that support the use of culturally responsive teaching to engage students in constructing viable arguments and critiquing the reasoning of others (CCCSSO & NGA, 2010; Hufferd-Ackles et al, 2004; Guskey, 2002). Research on professional development (PD) for inservice teachers indicates a positive impact on reform-based teaching practice (Heck, Banilower, Weiss, & Rosenberg, 2008; Huffman, Thomas, & Lawrenz, 2003), which is needed for the instructional shift warranted by CCSSO & NGA (2010). Through a comprehensive review of research related to teacher change, Guskey (2002) found that one major goal of

professional development is to create change in teacher practice. The current study used professional development to support teacher change in the use of CRT to support student engagement in SMP3. Hufferd-Ackles, Fuson, & Sherin (2004) identified four levels (0-3) of teacher change in creating a classroom environment where students engage in mathematical talk. Level 0 is teacher-centered with brief answer responses from students with a focus on answers to problems. At level one, teachers begin to solicit mathematical thinking; however, the teacher remains the questioner and the central role in the classroom. At level two, student-to-student interactions increase; however, only when prompted by the teacher. The teacher models and assists students in building new roles; students become more involved in discussions. Questions are still prompted by the teacher including more open-ended questions. As students answer questions, the teacher probes deeply to unpack student thinking and begins to use student errors as opportunities for learning. And lastly at level three, the role of the teacher becomes co-learner and co-teacher. Student-to-student interactions are initiated by the students; they ask questions of one another. This interaction becomes the expectation of the teacher. The teacher continues to ask probing questions to extract student thinking and help to make students' explanations complete. The teacher also allows students to suggest and offer new strategies with explanations and justifications. The role of the teacher becomes that of a facilitator of learning, while the students become dominators of mathematical discussions and gain mathematical independence. Within these levels, Hufferd-Ackles et al (2004) emphasize four key components of instruction: (a) questioning; (b) explanations and justifications of mathematical thinking; (c) student discovery of mathematical ideas; (d) student ownership of learning. Each of these levels and components informed the professional development used in this study.

To embody the teachers' use of CRT to support student engagement in SMP3, the professional development was based on the following components: (a) culturally responsive teaching; (b) questioning; (c) soliciting students' explanations and justifications of mathematical thinking; and (d) student collaboration. These components were used to create the instructional shift needed for teachers to facilitate SMP3. Figure 2 provides a graphic model of the conceptual framework for this study.

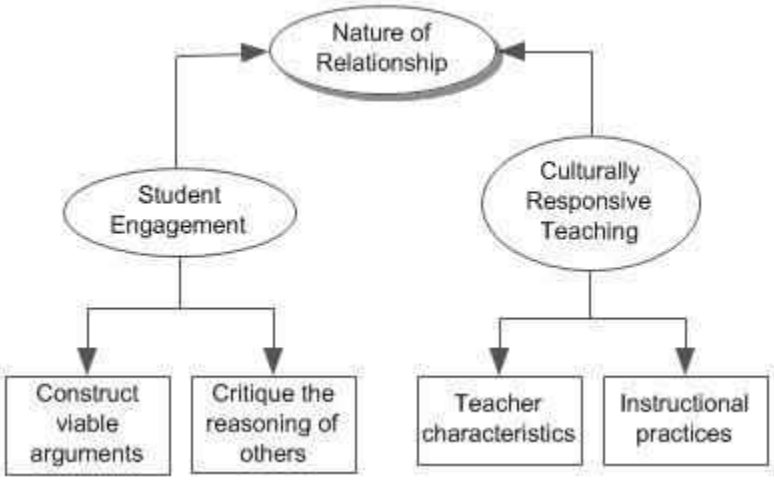


Figure 2: Conceptual Framework

This model framed the focus of this study: there exist some relationship between student engagement and the use of CRT. The goal of this study was to describe the nature of this relationship. In the following chapter, the methodology for describing this relationship is provided.

CHAPTER 3: METHODOLOGY

Research Design

The methodology used for this research was qualitative with a collective case study design (Creswell 2007). Patton (2002) explains, "Qualitative methods facilitate study of issues in depth and detail and enable researchers to approach fieldwork or problems without being constrained by predetermined categories of analysis" (p.14). This study sought to determine how the use of CRT supports student engagement in practices consistent with the Common Core State Standard's SMP3. A case study design was selected because it is appropriate for studying a complex phenomenon using multiple bounded systems seeking an in depth understanding of the phenomena (Yin, 2003; Creswell, 2007). Research has documented the complexity of the relationship between teacher practice and classroom interaction (Walshaw & Anthony, 2008). Walshaw and Anthony explain, "Given the scope of this system, the features of quality practice necessarily constitute a large matrix of practice, consisting of multiple dimensions and complex relationships between its parts" (p. 522). As described figure 1, culturally responsive teaching contains six teacher characteristics and seven instructional practices. When examining classroom interaction that is consistent with SMP3, there are nine engagement tasks related to constructing viable arguments and four engagement tasks related to critiquing the reasoning of others. The aforementioned, culturally responsive teaching practices and characteristics as well as the specific engagement tasks are the bounded systems in this study. In a collective case study, two or more cases are analyzed using the same procedures for each case (Yin, 2003). Using more than one case increases the variability across the cases and results in a more compelling interpretation of the phenomenon (Merriam, 1998). Specific to this research, the

phenomenon was the relationship between teachers' use of CRT and their students' ability to construct viable arguments and critique the reasoning of others.

Overview

In order to describe the relationship between a teacher's use of CRT and their students' engagement in SMP3, a collective case study design using qualitative methods was employed. Data were collected on two participants over a six-week period. Interpretative cases were developed with each teacher and treated as a unit of analysis, a bounded case. At the same time, a cross-case analysis was conducted to highlight similarities and differences across cases and to increase the potential for generalizing beyond each case (Merriam, 1998; Yin 2003). Intentionally, this research aimed to study teachers' transitioning to use CRT to support minority students' engaging in practices consistent with SMP3. The research design focused on teachers who were likely to have limited prior knowledge of CRT and SMP3 but could rely on support from professional development to influence their instructional practices to enhance student engagement. The teachers selected were involved in a 7-day professional development on CRT and SMP3.

Establishing Researcher Position and Transparency

As written in the literature, the researcher's background and positionality influences his/her lens as the instrument of data collection and analysis (Glesne, 2006). Therefore, self-reflection is an important part of qualitative research. As an African-American female and former high school mathematics teacher, the researcher's lens may affect the interpretation of data collection and analysis. Throughout the study, the researcher intentionally reflected on the subjectivity that may arise within the study. Through this awareness, the researcher made use of data verification strategies (discussed in the last section of this chapter) to alleviate their

influence on study results (Glesne, 2006). In this study, the role of the researcher included facilitator of professional development, observer during classroom observations, and interviewer during interviews.

This research was conducted in collaboration with another researcher, Mercedes Sotillo, a doctoral candidate who was conducting research on teachers' abilities to support classroom discourse to facilitate SMP3. Mercedes served as a facilitator during professional development, an observer during classroom observations, an interviewer during formal and informal interviews, and a peer reviewer in data collection and analysis.

Setting, Population, and Sampling

Setting

The site selected for this study was Park Ridge Middle (pseudonym), a school located in the southeastern region of the United States, which has a 76% minority student population. Park Ridge is one of the most diverse schools in the ABC (pseudonym) school district. In the ABC district, only the Asian, and White students obtained mathematics proficiency according to the 2010-2011 District's adequately yearly progress (AYP) report. These data are consistent with the Nation's Report Card in that African American and Hispanic students perform below their counterparts in mathematics (NCES, 2011b). Eight hundred eighty-seven students were enrolled at Park Ridge Middle with the following student demographics: 14% of the students were African-American; 57% of the students were Hispanic; 23% of the students were White; and 5% of the students were Asian/Pacific Islander. Based on the 2011 state standardized assessment, 65% of the students within Park Ridge scored at or above proficiency in mathematics. Park Ridge was selected because it provided the researcher access to teachers of students from

minority backgrounds. Research on the engagement gap emphasizes the importance of increasing the engagement of minority students in classrooms. Likewise, the achievement gap highlights the importance of increasing the performance of minority students in mathematics. Because engagement is linked to achievement, the focus of this study was primarily on the practices of teachers of minority students.

Population & Sampling

Through the use of purposeful sampling, the researcher worked with the school district and leaders of Park Ridge Middle to identify two teachers for participation in this study. According to Patton (2002), purposeful sampling is utilized when cases are selected based on some characteristic. These characteristics included: (1) a sixth grade mathematics teacher; (2) a teacher of minority students; (3) willingness to participate; and (4) likelihood of implementing CRT. The ethnicity of the teacher was not considered, as it was not a focus of this study. In deliberations with the school leaders, the research questions and conceptual framework related to this study were discussed. The researcher then worked with these leaders to select teachers based on grade level, topics of instruction, and the school curriculum pacing guide. Because this study was conducted towards the end of the school year around standardized testing and spring break, emphasis was given on the teachers' willingness to participate and their likelihood of implementing CRT. For the purposes of this study, two teachers were selected.

The teachers selected were Ms. Jane (pseudonym) and Mr. John (pseudonym). Ms. Jane is a white female with a Bachelor's degree in Elementary Education and a Master's degree in Exceptional Education. Teaching is her first career; she has three years of teaching experience. She has taught Pre-Kindergarten for two years, which means, this is her first year teaching middle school as well as her first year teaching mathematics. Therefore, this year can be

considered as Ms. Jane's first year teaching. There were 21 students in Ms. Jane's classroom, in which data were collected: 13 boys and 8 girls. The demographics of the students included 4-ESOL, 3-ESE, 1-multiracial, 2-Caucasians, 1-African-American, and 17-Hispanics.

Mr. John is a white male whose grandfather was born in Spain and his grandmother was born in the Bahamas. Therefore he described himself as being Caribbean, White. He has a Bachelor's degree in Mathematics Education with six years of teaching experience. Prior to pursuing a degree in education, Mr. John worked with the local Boys and Girls Club for five years. This experience inspired him to teach. He has completed all six years of teaching at Park Ridge MS. There were 21 Advancement via Individual Determination (AVID) students in Mr. John's classroom, in which data were collected: 16 females and 5 males. The demographics included 5-Caucasians, 3-African-Americans, 11-Hispanics, 2 Middle-Eastern, and 4 ESE students. Approximately 75% of these students were on free or reduced lunch.

After the teachers were selected to participate in this study, an initial interview was conducted with each teacher to obtain his or her perception of the relationship between culture and mathematics. Following initial interviews, the framework for CRT and the practices consistent with SMP3 were used as lenses for initial classroom observations. Data gathered from these interviews and observations were used to prepare seven-one hour sessions of professional development on Culturally Responsive Teaching and Common Core State Standard's SMP3. The sessions were conducted over a three week period with two/three sessions per week. The purpose of the professional development will be described in the data collection section of this chapter.

Data Collection Procedures

For case studies, Yin (2003) recommends 6 types of tools for data collection: documents, archival records, interviews, direct observations, participant-observations, and physical artifacts. Classroom observations, interviews, journal writing prompts, video recordings, and artifacts of student work were used as data tools in this study. "The use of multiple data collection methods contributes to the trustworthiness of the data" (Glesne, 2006, p.36). Use of these tools assisted the researcher in triangulating the data for the study. Data collection occurred in three phases of this study: (1) before the professional development; (2) during the professional development; and (3) after the professional development

Phase One: Pre-Professional Development

Initial Interviews

Formal interviews were conducted with each teacher before the professional development. Prior to the professional development, it was important to capture the teachers' perceived teaching practices, their perception of the nature of learning mathematics, and their perception of diversity in learning. Initial interviews were conducted using the protocol located in Appendix B. This interview protocol (Appendix B) was piloted in an earlier study. The purpose of the pilot study was to explore the characteristics of culturally responsive teaching in a mathematics classroom in order to gain insight into teaching practices that may increase the mathematics performance of African American students. The interview protocol served as an instrument to gather insight on a teacher's perceived teaching practices, knowledge of his/her students, and interactions with his/her students prior to classroom observations. The findings from the study were used to modify the protocol.

The initial interviews assisted the researcher in understanding each teacher's perception as it related to the relationship between culture and mathematics learning. This information also assisted the researcher in preparing a professional development that capitalized on the teachers' intuitions and enhanced their understanding of the relationship between culture and mathematics learning. In order to fully capture the teacher's responses to every question, the interviews were audio recorded. In the proceeding paragraphs, Ms. Jane and Mr. John's perceived instructional styles, knowledge of their students, and understanding of diversity in learning will be revealed.

Ms. Jane's Initial Interview

Instructional Style & Planning

Ms. Jane viewed herself as a facilitator of learning. Rather than teaching skills to pass a standardized test, she taught skills useful to her students' lives. In order to prepare for a mathematics lesson, Ms. Jane relied heavily on teacher guides and the scope and sequence calendar. Below, her transcribed response from the interview provided insight on her confidence in teaching mathematics:

> I look at the teacher guides because I am a first year teacher, so it's really hard for me. I also have that scope and sequence, like a calendar, I have to look at it to see what bench marks I should be covering; so I look at the bench-mark as well. I don't do it as well as I should bench mark wise. I wish I could get like a bench-mark and maybe come up with like essential problems and do like a problem based teaching. I haven't gotten there yet so I really do use the teacher guide.

She provided a description of her mathematics lesson implementation from beginning to end:

> Ok usually I start off with a warm up to just kind of settle them down. Usually about five minutes I get them to work on it by themselves or with a partner and then I usually go over that with them. Sometimes I go over homework if it was a hard concept or those kinds of things and then I usually go into the lesson. If it's a new lesson, we usually do notes or I do a presentation… I'll find a video or something that connects with it and we'll go through that or we'll go through notes and then I usually do some practice problems, either in their notes or sometimes I have them start their homework so I can

answer questions.

This description is consistent with the scenario presented above.

When focusing on expectations for learning, Ms. Jane expressed that she wanted her students to fully understand the concept. Most of the time her students were concerned with getting the right answer instead of focusing on the process for obtaining the right answer. This is difficult for her because she wanted them to apply the concepts to real life. Most of her students struggled with mathematics. To address struggling learners, she retaught, provided one-on-one assistance, related concepts to real world, and encouraged them to attend tutoring. For tests and quizzes, she allowed struggling learners to use their notes or submit test corrections. Although most of her students struggled with mathematics, she consistently encouraged them by making positive statements, like "You can do it!"

When referring to student engagement, Ms. Jane regarded students' asking questions as the most important component, while her students preferred playing games and group work. The statement below provided insight on Ms. Jane and her students' preference for engagement:

> Yeah I prefer more asking questions and getting to the part so, I stray away so much from I don't get it. Well what part don't you get? So I can actually understand where their misconceptions are I guess…..Hmm, games. Games, they prefer, obviously not notes. They're not note taking. That's a big thing. They don't like to note take. Um but yeah they like the games and they like group work.

During both whole and small group interactions, she tried to maintain an environment where students are comfortable in communicating. However, she explained that it is a struggle at times. Her response below explains this struggle:

> You know it is tough because I do have middle schoolers and they are making that change now and they are disrespectful to each other and it is frustrating, but I try if I see it to be like ok, what's a better way that we can be doing this?

Ms. Jane tried to control this negative communication by sometimes allowing her students to select their partners when working in groups. As a whole class, she redirected the students and spoke with them individually about their negative behavior/comments. Ms. Jane expressed that her students are not always negative. She consistently encouraged participation. Signs of participation included students answering questions, actively listening, nodding their heads, and writing down notes. When asked about maintaining intellectual rigor, she explained that trying to reach all the levels in her class was a difficult task. The response below provided insight on her expectations for her students and her confidence in teaching mathematics:

> …..I do find trouble sometimes reaching everybody because I do have a few high ones and it is hard to try and reach them too because I feel like sometimes they know it and I don't really know how to scaffold as well because this is a new kind of curriculum; so I'm kind of still getting my feet wet……because I have had some of the higher team transfer to my team and so now they're at that point where they are really here but they're not…

This response led into Ms. Jane's discussion of her use open-ended questions. She did not use them often as, according to her, she is not good at it. At times she included them in warm-ups; she provided the following as an example of an open-ended question in warm-up:

> Would you like 25 pennies or 2 dimes, and they had to kinda figure out what they wanted. If they wanted to hold all of that change, or they wanted more money?

This example indicated Ms. Jane's expectations of her students as it relate to higher-order thinking. In order to motivate her students, she gave them tickets for participating and maintaining good behavior. She also offered extra credit, which helped whenever they were struggling to receive a passing grade in her class.

The instructional style presented here provides insight into Ms. Jane's classroom and how she viewed her role as a new mathematics teacher. In the next section, Ms. Jane's knowledge of

her students will be revealed.

Knowledge of Students

Ms. Jane explained that she has the lowest students in the 6th grade as her school practices ability grouping. Students are grouped based on their academic performance on the state standardized test. Although her students are low, their ability levels still vary. She had a difficult time reaching all the levels, so she tried to teach to the middle. Because her students were very low, she graded them based on effort, participation, and performance. When comparing her students' academic performance to other students in the 6th grade at her school, she stated:

> …I'm not sure grade wise how they do it, because obviously I grade differently than their other teachers would because I'm grading on my kids' performance...participation and those kinds of things. And I do grade on effort. I don't know if it's politically correct (giggle), but I do….

This response pointed to Ms. Jane's expectations of her students. Parental involvement for her students varied from being so involved to the point where "some parents do their children's homework to not being involved at all." Although the parental involvement varied, Ms. Jane did not initiate it. As a result, she did not know anything about her students' parents. The fact that she did not know her students' parents highlighted a concern for her knowledge of her students. When describing how she learned about her students and their backgrounds, she replied:

> ….some of them are just forthright in telling me about it. I think, I don't really know, I mean I ask questions and stuff but I don't know if I've actually formally ever asked about background information or anything. I've never had a questionnaire or anything.

From this response, it was evident that Ms. Jane did not have an intimate knowledge of her students. On the other hand, she described them as being visual and kinesthetic learners who are unmotivated to learn mathematics. She explained that in order for her students to demonstrate

understanding, she had to model procedures/practices for them. Ms. Jane stated that her students' greatest impediment to learning was their lack of fundamental skills. The students' lack of motivation and fundamental skills presented challenges for the learning environment. She tried to offset these impediments by presenting mathematics in ways that captivated their interest. Ms. Jane stated that her way of communicating high expectations to her students was emphasized by the "tone of her voice."

When characterizing her success or effectiveness as a teacher related to her students' outcomes, Ms. Jane replied:

> I don't know how effective I am yet, because it's my first year. I'm just not really sure how my teaching is or I don't know so. (Giggle). Yeah, I don't know.

She expounded that nothing sets her apart from other mathematics teacher because this was her first year. The lack of confidence in her ability to teach mathematics may have an effect on her instructional style, planning, and knowledge of her students. This section highlighted multiple deficits within Ms. Jane's classroom. Both the teacher and the students lack confidence in their ability to do mathematics. In addition, Ms. Jane did not maintain high expectations for her students because of how she emphasized her students' impediments to learning. The next section will provide another level into Ms. Jane understanding related to diversity.

Diversity in Learning

Ms. Jane described culture as more than one's ethnicity; it also encompasses one' beliefs, practices, and community. In her words, "Those things that are kind of ingrained or what you do every day." She believed that culture is linked to learning, so in order to draw upon this connection, Ms. Jane tried to always emphasize positives in any situation that occurred within

her classroom. When asked to describe how culture/diversity is reflected in her classroom, Ms. Jane provided the following response:

> I think we have a diverse culture in my classroom. I think that there are a lot of kids from different homes, different backgrounds, those kinds of things, and I do welcome that. I have a lot of ESOL kids as well, which is a struggle for me, because I don't speak Spanish but I think it's really cool……often times they get afraid of saying something and getting emotional and I'm like well say it in Spanish. I might not know it but then they feel comfortable enough to at least speak in my classroom so I think it's about being comfortable….

This reflection of culture/diversity in the classroom is related to having a respect for students' native languages and embracing difference as it relates to communication. However, when asked about how culture was reflected in the curriculum and in instruction, Ms. Jane drew a blank in her thought process. The following response warranted the need for support in this area. Ms. Jane stated:

> Hmm. That's where I struggle too because I feel like some of it is not connected. I feel like a lot of examples and stuff I could connect but I'm not really sure how to yet because I'm still learning like exactly what they need to know and so I do not have the creative mind yet to set it up to something that I could involve them in I guess.

This response provided insight on Ms. Jane's knowledge of culturally responsive teaching (CRT). The framework of CRT may assist her with this struggle. When asked about her knowledge of CRT, she expressed having heard of it vaguely. Therefore, her response to the final question provided closure on her case for the study. When rating herself on cultural competence on a scale from one to ten with one being the least competent and ten being the most competent, she rated herself at three. Below she explained her reasoning for rating herself so low:

> I would say about like a three. Not that I don't, that I want to be there but I wouldn't say that I'm that great at connecting the dots. I want to know more but I know I'm not very

good at connecting.

Ms. Jane's response here aligned with the previous sections related to knowledge of students and instructional style. Cultural competence is an aspect of CRT, which may provide insight for Ms. Jane on her ability to maintain high expectations for her students and to use their cultures as a catalyst for learning. As a result, Ms. Jane may be able to redesign the curriculum so that it connects with her students. Throughout the establishment of her case, Ms. Jane has expressed the need for support within her diverse classroom.

Mr. John's Initial Interview

Instructional Style & Planning

Mr. John viewed himself as a facilitator of learning; someone who sparks students' interest and inspires them to do mathematics. When he planned to teach lessons, he tried to consider his students' interests, like make references to things happening in society and popular age appropriate movies, music, and games. From year to year, he updated his lessons to make them more current. Mr. John integrated cooperative learning and manipulatives in his lesson at least 4 times a week. Often times he brought in objects from the community.

Mr. John exuded high expectations for learning. In the following excerpt from the interview, he explained that students would rise to their teacher's expectations:

> You wanna have your expectations as high as you can….I mean they're gonna go to the expectation level. They always do. And if you set your expectations low, like, a lot of people see these kids as numbers (referring to standardized numbers). Well I've got numbers, but they are so much more than that. Like if you see a 3 or a 2 or a 1, and you only see them as a 1 or a 2, they're never gonna change but my 3s or my middle of the road kids or whatever you call them, like I see them as 5s. They really are. And when they feel that way and when they have that kind of confidence then if they get a 4 then that's so much better than what they thought they could probably do on their own so always aim high.

Here, Mr. John expressed his passion for believing in his students and requiring only their best effort. He explained that maintaining high expectations helped his students gain confidence in their ability to do mathematics. Confidence was the biggest issue for his struggling students. Students' lack of skills did not explain their struggle. He explained that his students' negative experiences with mathematics have caused them to shut down. In the following excerpt he expounded more:

> I've had a couple of students in my career that, that it was just a confidence thing and right when that light bulb comes on and right when they start to believe in themselves, that's when everything changes. Not so much that it was a skill that they just didn't know…. you just taught it to them. Oh, ok now I get it. It's not really like that. It's really a confidence thing. So I like to teach more toward that confidence level and boost that first and then things start to change.

Here, Mr. John provided another level of maintaining high expectations; high expectations helped to boost students' confidence. This was how he assisted students with seeing themselves in mathematics or seeing themselves as good in mathematics. When working with difficult concepts, he preferred to start easy and build up to the difficult, in others words this was how Mr. John scaffolded mathematics concepts.

For the most part, Mr. John described student engagement as everybody participating in similar tasks. He preferred a positive classroom environment where everybody was comfortable with sharing answers and asking questions. In this type of environment, he explained that we all learn from each other, in his words, "like a family". At the beginning of the school year, Mr. John established his expectations for communicating in his classroom. Those expectations were like rules, which helped to create a positive environment. He encouraged questioning and diverse ways of reasoning.

Insight on Mr. John's instructional style highlighted the notion of his students being at the core of his lessons. In order for this to happen, teachers must be knowledgeable of their students and their backgrounds. In the next section, Mr. John's knowledge specific to his students is unpacked.

Knowledge of Students

Mr. John explained that he was on the AVID team, so his students were considered average as it relates to the state standardized testing. Although these students were average, they have not had opportunities to advance due to specific circumstances. Therefore, being in AVID, it afforded them those opportunities by receiving more advanced instruction. This supported their entrance into advance level courses. Mr. John spoke negatively about parental involvement; the parents did not get involved. He expressed that this factor contributed to his students' lack of confidence in their academic ability. Mr. John stated that he has a mixed population of students in his classroom; they were mostly Hispanic. Although standardized testing placed his students on the same academic level, Mr. John explained that his students' "academic abilities ranged from low to high".

When asked about getting to know his students, Mr. John got really excited. He explained that at the beginning of the school year, he devoted time for getting to know them. He stated:

> In the very beginning, I love to learn about my students so I am always doing activities in the beginning like getting to know you, which is an activity. I pass out index cards to everyone and ask them general questions like their favorite hobby, their race, their background, things they love to do, things they don't like to do. And then just being with them, like I'm always trying to spend as much time as I can with my students so, before school, after school… I coach some sports here just to get to know them at a different level. So just spending more time with my kids; that's how I really get to know them the best.

This statement aligned well with his instructional style in the previous section as his lessons are planned with his students' interests in mind. He described his students as mostly visual learners and some kinesthetic. When asked about his students' impediments to learning, Mr. John replied that his students' lack of confidence and parental support. It bothers him that his students do not seem to dream about the future. He compensated for this by telling them that, "they can do it" and giving them scenarios about his life. The excerpt below provided insight on how he does this.

> I try to boost it as much as possible, so I'm always trying to tell my kids they can do it. I'm always stopping class to try to relate to them and give them stories of my life where, when I didn't believe in myself and how you need to have the confidence. I'm always trying to talk to them as far as having a dream and trying to start something that can motivate them to do something.

In this response, Mr. John spoke about confidence and motivation, which easily lead into the next question. He motivated his students using "martial arts math." At the beginning of the year, all the students begin with the same color belt and just like in Karate, as they advance, they move to another belt color. Advancement was connected to academic standing in his classroom. The highest level was black belt, so the students strived to get a black belt. Below Mr. John explained how this system motivates his students:

> That's one of the big things I tried to incorporate in my class was something that they can work for because let's face it, a lot of kids don't have the support at home, so working for a grade just isn't for them. Like so if you say oh if you get it, you can get an A. They don't care about letters anymore. Like the high level kids do because they get that support and that push at home….So As and Bs for them are good. All they need to hear is the letter. But for a lot of my kids they don't care about that. So I wanted to give them something to work for. So if they see it as a martial arts class where they're earning a belt and they're earning tickets on top of that, that gets them prizes and things. But mostly it's not even the prices, they could care less about the tickets, it's really the belts. It just gives them something tangible, like look I got this! Not a grade but I got this belt. They don't know what grade it is. They're parents don't know. They just know they got this

color belt so, having that belt in their hands is more important than having a grade so… In this response, Mr. John exuded his understanding of the importance of knowing your students and motivating them to learn even if they do not have support from home. However, he struggled with turning that motivation into really great standardized test scores. He felt that his kids did well with him, but their test scores were not as good as he expected them to be. Reflecting on this success motivated him to improve from year to year. When asked about what distinguished him from other math teachers, Mr. John stated:

> I love my kids. I love to get to know them and I don't know if it's me because I have more time in my schedule maybe than some people. But I love to get to know my kids and I love to make lessons that relate to them so I don't see a lot of people doing that. Not to say that their lessons aren't good but when you can really make a lesson that relates to your kids or your audience, I think that really makes a big difference in whether they learn or not.

Mr. John's statement was so powerful in that he valued the relationship that he had with his students. This relationship impacted his lesson planning and instructional style. The fact that his students struggled with mathematics was not an issue for him. Rather, it made him work harder at making the mathematics come alive for his students by relating it to their lives. In the next section, Mr. John understanding of diversity is unpacked, which has also been exemplified in the previous sections.

Diversity in Learning

Mr. John believed that culture is defined by life; it is "what makes life interesting and unique". He further explained that cultures were what make up the classroom. He believed culture is linked to learning as individuals learn from each other. In order to draw upon the connection between culture and learning, Mr. John tried to incorporate his students' cultures and experiences in his lessons. However, he could not speak to communication and interaction with

parents, his focus was purely on the students. As a result, he did not initiate parental involvement.

The case of Mr. John is unique as he exuded some aspects of CRT, however he has never heard of it. Yet, he rated himself as a seven or eight as it relates to cultural competence because he did not do well with communicating or interacting with parents. He demonstrated confidence in teaching mathematics and ensured that he established relationships with his students. However, when reviewing the teacher characteristics and instructional practices of CRT, Mr. John did not meet all of them.

After conducting initial interviews with each teacher, initial classroom observations were conducted. In the next section, details of the classroom observations will be provided.

Initial Classroom Observations

Glesne (2006) writes, "Although participant observation ideally continues throughout the period of data collection, it is particularly important in the beginning stages because of its role in informing you about appropriate areas of investigation and developing a sound researcher-researched relationship" (p. 49). Observations prior to the professional development assisted the researcher in establishing a baseline for understanding each teacher's instructional style, classroom discourse, and patterns of student engagement in mathematical tasks and instruction. In order to fully capture the aforementioned components of the classroom environment, initial classroom observations were video recorded. Observation field notes were collected during each classroom observation. In the paragraphs that follow, typical classroom scenarios for Ms. Jane and Mr. John will be provided.

Ms. Jane's Typical Classroom Scenario

Students entered the classroom (desks arranged in rows) and began working on warm-up, which was related to previous lessons. Students struggled with getting settled. Ms. Jane walked around to assist students with questions and tried to ensure all students were working. The warm-up was comprised of closed-ended review questions. An example of the warm-up is below:

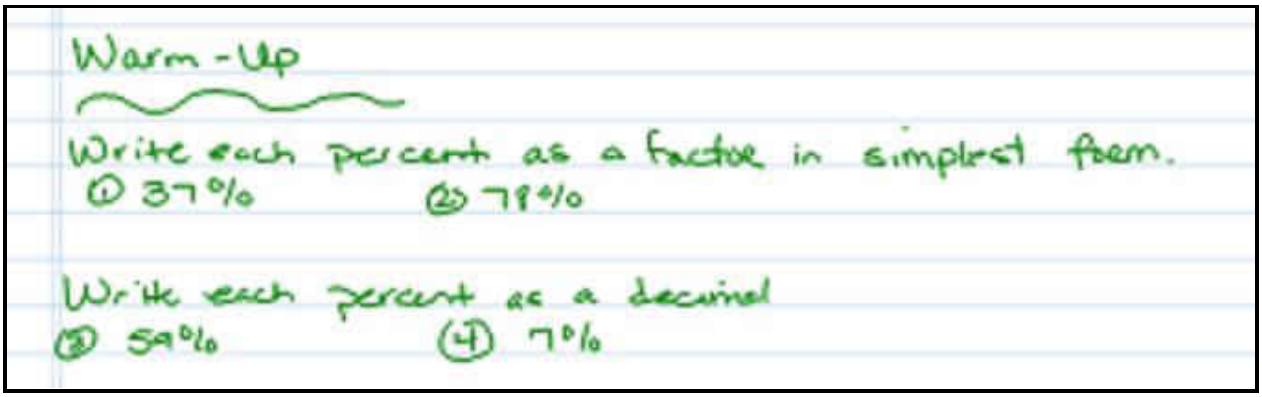


Figure 3: Warm-up Example – Ms. Jane

After allowing about five minutes for students to complete the warm-up, Ms. Jane reviewed each problem from the warm-up with the class. Students volunteered to share their answers from their seats. After reviewing the warm-up, Ms. Jane reviewed homework questions. During the review of the warm-up and homework, dialogue was mainly between the teacher and student. The following excerpt is taken from the review of the warm-up and is representative of this dialogue:

Ms. Jane:	Let's go to 3. Number 3, 59%. What are the directions, the directions? Carlos?
Carlos:	Write each percent as a decimal?
Ms. Jane:	Write each percent as a decimal, ok? So the first one is 59%. How do we write that as a decimal? Carlos.
Carlos:	0.59.
Ms. Jane:	0.59. Carlos, how did you know that?
Carlos:	Because um the percent goes by, it's in the hundredths place….
Ms. Jane:	It's in the hundredths place. Right. So we have to take our decimal place and.
Carlos:	And we move it back to the.

Ms. Jane: And we move it back one, you divided it by 100. Ok?
Carlos: Wait why do you put a 0? Couldn't you just…
Ms. Jane: It would be .59, I just added the 0 because of the point there.
Carlos: Ok.

This excerpt shows that although Ms. Jane asked students to explain their reasoning, she only communicated with the student who asked the question. The communication remained between the student and teacher. Next, students were directed to place homework in designated baskets and then take out their notebooks. Ms. Jane provided lecture notes for the next lesson using Cornell-style note taking. The notes provided students with step-by-step directions as to how to carry out a specific mathematics task. An example of the notes is provided below in figure 4:

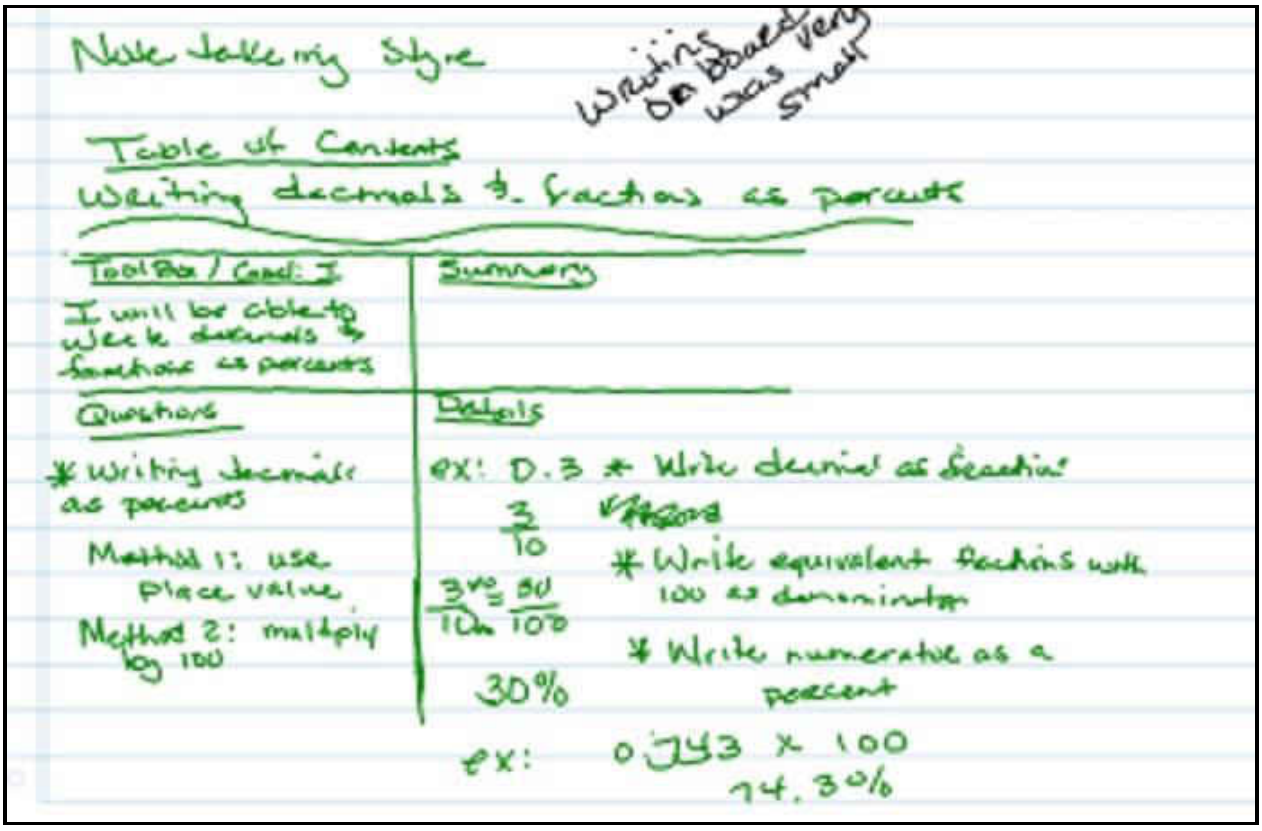


Figure 4: Cornell Style Notes – Ms. Jane

Throughout the lecture, unrelated student activity and disruptive behavior occurred. Ms. Jane constantly redirected students to control the class.

Mr. John's Typical Classroom Scenario

Students entered the classroom (desks arranged in rows) and began working on bell work, which was a review of previous lessons. All students were attentive and on task. While students were working on bell work, Mr. John did housekeeping, like pass out papers, take attendance, etc. He also walked around to assist students who had questions. The questions in bell work tended to be closed-ended review questions. An example of a warm-up is below:

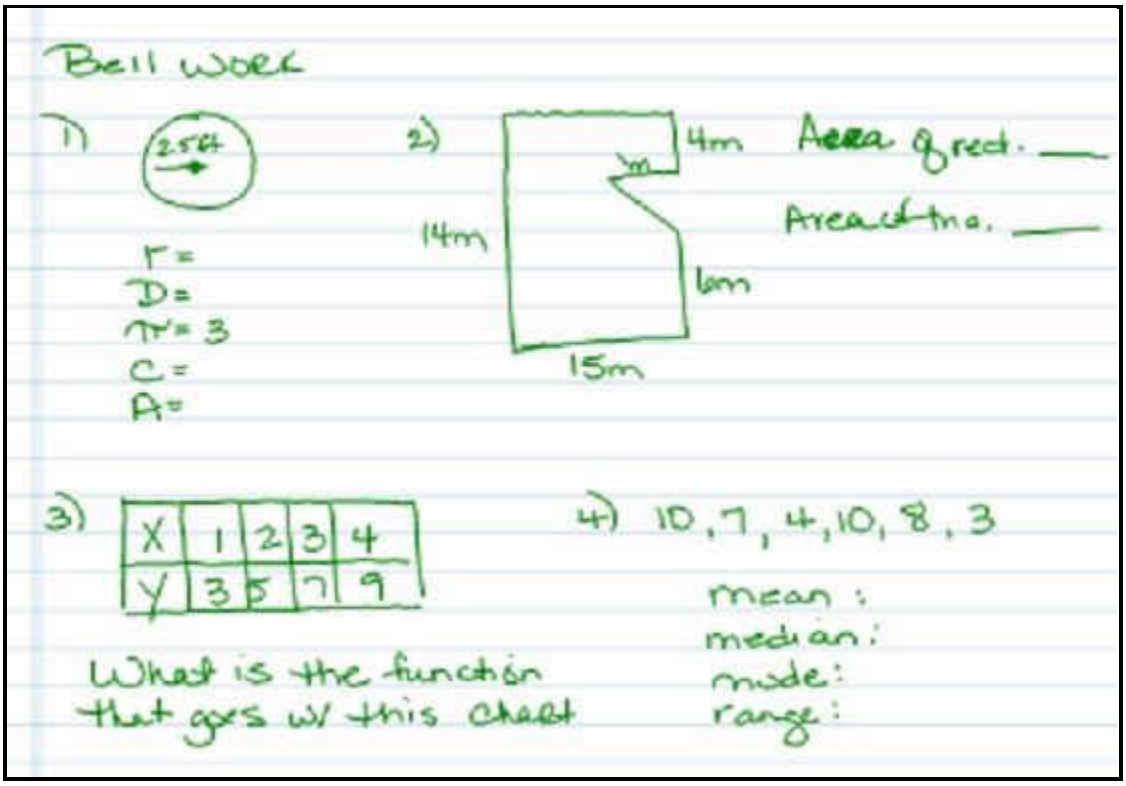


Figure 5: Bell Work Example – Mr. John

After allowing about 10 minutes for students to complete the warm-up, Mr. John reviewed the bell work by selecting students to write their answers on the board. Although students provided answers, they were not asked to explain their reasoning. When students returned to their seats, Mr. John unpacked the steps for each problem by recalling prior knowledge using questions. The excerpt below provided insight on how this was done:

Mr. John: Alright let's see how we did with numbers 1, 3, and 4, and then number 2 we are going to do together. Ok, so I can walk you guys through the process and really see um how to do this. Okay, let's start with this one, number 1. What is a line that starts in the center and touches the edge of a circle called? Um, Michelle.

Michelle: A radius

Mr. John: That's a radius. Right. The line from the center to the edge is a radius. So I give you r already, right? It's 2.5. So your radius is 2.5. How do I take a radius and find the diameter? Michelle?

Michelle: Multiply the radius by 2

Mr. John: Multiply the radius x 2. Right? So when I do that, 2.5 x 2 gives me 5.0 or just 5, either one. That's a terrific job. The pi that I have given you is 3. That's what we are going to use for pi for number 1. What two things do I multiply to find circumference?

Keyshawn: You multiply the 2 numbers and then you divide.

Mr. John: Yeah but what 2 numbers? Uh, Keyshawn.

Keyshawn: You multiply diameter times pi

Mr. John: Diameter times pi, ok. Good job!

Dialogue presented in this excerpt was specifically between the teacher and students. The discussion was teacher lead. During transition to the new lesson, students moved into quick groups (pairs) and took out their geometry notebooks to copy pre-written teacher notes. The notes provided students with definitions and pictures. Below are the notes that were provided in:

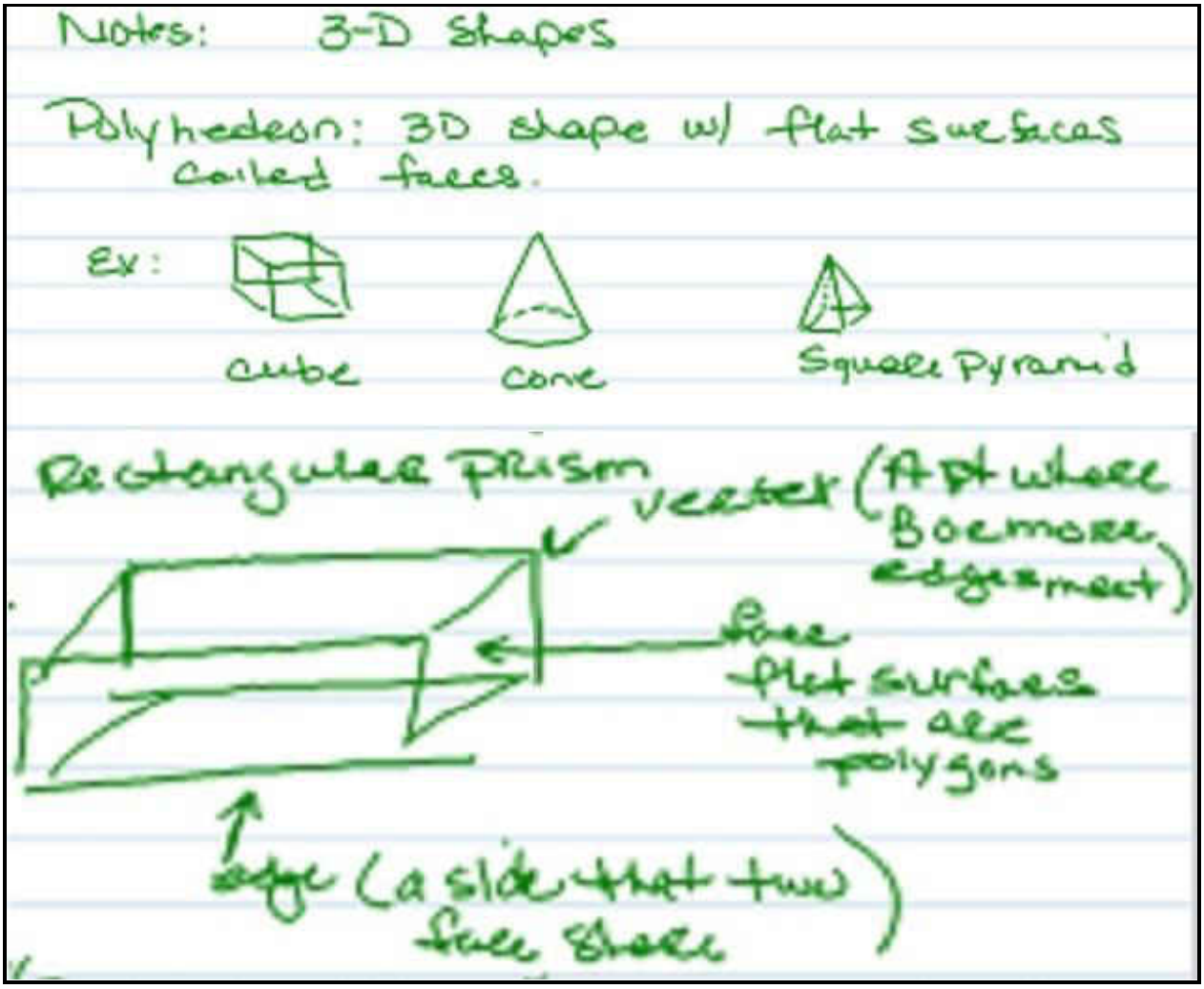


Figure 6: Geometry Notes – Mr. John

The teacher provided practical examples about each shape while the students took notes. Throughout the lecture, all students were on task.

Data collected from the initial interview and classroom observations enabled the researcher to gauge each teacher's understanding of CRT; identify areas of greatest need as it related to CRT and SMP3; and develop and align activities and trainings into the components of greatest need. Moreover, the initial interview and classroom observations enabled the

researcher to establish a baseline for professional development and design a professional development specific to the teachers in this study.

Baseline for Professional Development

Analysis of the initial interviews and initial classroom observations informed the development of the professional development focusing on CRT and SMP3. As defined in chapter two, CRT consists of teacher characteristics and instructional practices. Also defined in chapter two, the student engagement practices consistent with SMP3 include students' constructing viable arguments and critiquing the reasoning of others. In the proceeding subsections, each case was rated using indicators that were informed by research related to CRT and SMP3.

Use of Culturally Responsive Teaching

Culturally responsive teaching encompasses five teacher characteristics and seven instructional practices (Applin, 2005, Gay, 2000; 2002; Ladson-Billings, 1994a; 1994b; 1995; NCCREST, 2006; Villegas and Lucas, 2002; and Ma, 1999). Each characteristic and instructional practice contains observable indicators that provided a lens for initial classroom observations. In the following sections, data related to CRT from classroom observations and the initial interviews are provided.

Analysis of Teacher Characteristics

The teacher characteristics of CRT included: (a) sociocultural consciousness; (b) affirming attitude towards diverse students; (c) cultural competence; (d) commitment and skills to serve as a change agent; (e) constructivist views of learning; and (f) knowledge of the subject matter. Each characteristic contains indicators, which were defined in chapter 2 and informed from research. The indicators were used in identifying the characteristics that each participant

demonstrated during the interview and classroom observations. The following tables denote whether the indicators were observed. What follows each table is an explanation for how and why these indicators were rated. In each table, the researcher rated each participant using three levels: (a) not evident indicated by a "-"; (b) somewhat evident indicated by a "~"; and (c) evident indicated by a "+". The socio-cultural consciousness of each teacher is rated in table 4.

Table 4: Teacher Characteristic One

Socio-cultural Consciousness		
Indicator	**Ms. Jane**	**Mr. John**
Displays awareness of one's own identity and prejudices.	~	~
Displays the ability to examine and confront personal negative feelings toward any cultural group.	~	~

Both participants displayed some socio-cultural consciousness. They displayed awareness of their own identities, as they were both able to talk about their own ethnicities. For instance, Mr. John stated that his grandfather is from Spain and his grandmother is from the Bahamas, so he can be considered Caribbean. However, he defined himself as White. When referring to displaying awareness of their own prejudices, neither participant displayed that characteristic. This leads into table 5, where each participant's attitude toward diverse students was rated.

Table 5: Teacher Characteristic Two

Affirming Attitude towards Diverse Students		
Indicator	**Ms. Jane**	**Mr. John**
Displays respect for cultural differences.	+	+
Displays an appreciation of cultural differences.	+	+
Displays and shares cultural artifacts from students' primary or home culture.	-	-
Uses positive body language when students speak of family or culture.	+	+
Listens to students offer examples of their home life and family to illustrate points or answer questions while displaying positive body language.	+	+

Both Ms. Jane and Mr. John employed somewhat of an affirming attitude towards diverse students. This was evident in both interviews as they spoke about the desire to connect mathematics topics to their students' real life experiences. For instance, Ms. Jane spoke about allowing her students to use their native language at times to communicate with her. Mr. John frequently referred to his students' favorite music or movies to make a mathematics point. However, neither of them displayed or shared cultural artifacts from students' primary or home culture. In table 6, the teachers' commitments to serve as a change were rated.

Table 6: Teacher Characteristic Three

Commitment and Skills to Serve as a Change Agent		
Indicator	**Ms. Jane**	**Mr. John**
Displays the ability to confront barriers and obstacles for change within the school or environment to promote equity.	-	-
Identifies personal biases and guards against bias in teaching and planning.	-	~

This characteristic includes having the ability to confront inequitable situations related to your students and the community. Having this commitment also includes using mathematics to

empower students to change negative situations within their communities or schools. Mr. John's "somewhat" rating was informed by his commitment to update his lessons from year to year and class to class to reflect his students cultures. This was indicated as "somewhat" based on his interview, but not demonstrated in the classroom during initial observations. On the other hand, Ms. Jane did not employ either of these characteristics. Table 7 refers to cultural competence.

Table 7: Teacher Characteristic Four

Culturally Competent		
Indicator	**Ms. Jane**	**Mr. John**
Displays having an intimate knowledge of students.	-	+
Displays a positive perspective on students' parents, families, and communities.	-	-
Demonstrates the ability to maintain high expectations.	-	+
Demonstrates the ability to understand student perceptions.	-	+
Demonstrates the ability to use students' cultural differences as a catalyst for learning.	-	-

Based on Ms. Jane's interview alone, it was evident that she did not know her students, which is a major part of being culturally competent. From both the interview and the classroom observation, Ms. Jane appeared to struggle with the cultural differences of her students. She respected them; however, she struggled with connecting with them. On the other hand, Mr. John employed some cultural competence, but he is not fully culturally competent. Throughout the interview Mr. John, displayed having an intimate knowledge of his students to the point where he connects with them in and outside the classroom. He also takes the time to survey them on their likes, dislikes, and hobbies. Neither of the participants spoke much about their students' parents nor have they been deliberate about meeting their students' parents. Although both stated that they try to incorporate students' cultures into mathematics lessons, they did not

demonstrate the ability to use their students' cultural differences as a catalyst for learning. In table 8, the participants' ratings on their constructivist views were rated.

Table 8: Teacher Characteristic Five

Constructivist Views of Learning		
Indicator	**Ms. Jane**	**Mr. John**
Demonstrates the ability to see their own and their students' actions develop their overall perspectives.	-	-
Demonstrates the ability to scaffold knowledge through students' experiences and the content at hand.	-	+

During the initial observations, both participants provided students with processes and procedures rather than allowing them to develop those processes and procedures from their own perspectives. They both provide pre-written notes that students followed step-by-step; they never deviated from the flow of their notes. On the other hand, Mr. John demonstrated the ability to scaffold. For instance, in the interview, Mr. John spoke specifically about scaffolding from prior knowledge to new knowledge. However, Ms. Jane stated specifically that she did not know how to scaffold, as the mathematics material was new for her. Table 9 presents each participant's rating on their knowledge of mathematics.

Table 9: Teacher Characteristic Six

Knowledge of the Subject Matter (Mathematics)		
Indicator	**Ms. Jane**	**Mr. John**
Displays the knowledge to connect mathematical concepts and procedures.	~	~
Displays the understanding to connect the interrelatedness of the concepts and subconcepts of mathematics.	-	-
Demonstrates the ability to provide varying facets, ideas, and approaches to mathematical content.	-	~
Demonstrates the ability to provide mathematical explanations for varying facets, ideas, and approaches.	-	-
Displays awareness of basic mathematical concepts and ideas in relation to the principles of mathematics.	~	+
Display an understanding of the fundamental knowledge of the mathematical curriculum as a whole including its coherence.	-	-

Research on mathematics teachers' content knowledge contains multiple sources for measuring teachers' knowledge for teaching mathematics (Fennema & Franke, 1992; Hill, Sleep, Lewis, & Ball, 2007; Schoenfeld, 1998; Ma, 1999). Because the focus of this study was not on measuring teacher content knowledge, the researcher derived observable indicators of teacher knowledge from Ma (1999), which are included in the list above and described in chapter 2. Based on the classroom observations and an initial interview, Ms. Jane and Mr. John displayed knowledge of basic mathematics procedures and concepts. During the interview, Ms. Jane expressed her limited understanding of the coherence of mathematics concepts and procedures. And, therefore, her mathematics lessons are solely dependent on the mathematics text and scope and sequence calendar, which is provided by the ABC school district. The lessons observed during initial classroom observations were on converting fractions, decimals, and percents. Through those lessons, she displayed awareness of basic mathematics concepts and procedures as well as some knowledge of connecting them. Like Ms. Jane, Mr. John also displayed basic awareness of mathematics concepts and procedures and the knowledge to connect them. However, during initial classroom observations he displayed it more than Ms. Jane. This was evident through his bell-work. Rather than using bell-work to review mathematics from the previous day, Mr. John used that time to review a plethora of mathematical concepts including the concept from the previous day. During the interview, Mr. John discussed how he plans mathematics lessons by drawing connections between mathematics and current events in society. This indicated his ability to demonstrate the ability to provide varying facets, ideas, and approaches to mathematical content. It is important to note here that the fact that some indicators were not evident does not indicate that Ms. Jane or Mr. John lacked in their

mathematics teacher content knowledge, as that was not the focus of this study. In the next section, Ms. Jane and Mr. John's CRT instructional practices are presented.

Analysis of Instructional Practices

The instructional practices of CRT included: (a) culturally validated instruction; (b) culturally mediated instruction; and (c) facilitation of learning. Each instructional practice contains indicators, which were defined in chapter 2 and informed from research. The indicators were used in identifying the characteristics that each participant demonstrated during the interview and classroom observations. The following tables denote whether the indicators were observed. What follows each table is an explanation for how and why these indicators were rated. In each table, the researcher rated each of the participants using three levels: (a) not evident indicated by a "-"; (b) somewhat evident indicated by a "~"; and (c) evident indicated by a "+". In table 10, the ratings for culturally validated instruction are presented.

Table 10: Instructional Practice One

Culturally Validated		
Indicator	**Ms. Jane**	**Mr. John**
Assists students in developing a positive self-efficacy about their ability to do mathematics.	~	+
Assists students in positioning themselves in the learning of mathematics.	-	~
Uses students' characteristics and experiences as a focus for learning mathematics.	-	~
Teaches mathematics concepts from multiple cultural perspectives to equally exemplify and embrace all cultures.	-	-
Displays student work & other artifacts illustrating personal and cultural identities of students.	~	~

Neither of the participants employed all components of culturally validated instruction. Ms. Jane only somewhat employed development of positive self-efficacy and displaying of

student work. In the interview, she spoke about telling students that 'they can do it'. However, she does not provide anything to motivate them. Although she displayed students work, it was only work that was completed within her classroom or during lessons. There were no artifacts or symbols displaying her students' cultural identity. On the other hand, Mr. John's instruction was a little more culturally validating. Within the interview and during classroom observations, he constantly demonstrated the ability to assist students with feeling that they can succeed in mathematics. He also motivated them with his Math Martial Arts, which caused his students to work towards a goal. Throughout his lectures, Mr. John also used song/rap lyrics and students' ideas to make connections to mathematics concepts. He also displayed lots of student work; however, like Ms. Jane, there were no artifacts or symbols displaying his students' cultural identity within his classroom. Table 11 provides ratings on culturally mediated instruction.

Table 11: Instructional Practice Two

Culturally Mediated		
Indicators	**Ms. Jane**	**Mr. John**
Incorporates issues related to family, community, or schools	-	-
Challenges students on issues related to family, community, or schools	-	-
Mediates controversial intercultural issues among students to enhance any culture, group, or person while affirming individual heritages.	-	~
Prompts student-to-student interactions among students of different cultures	~	+

Although both participants stated in their interviews that they tutor at the local Boys and Girls Club, they did not speak much about their students' parents or community. As a result, neither of their classrooms was culturally mediated. Mr. John, however, displayed the ability to prompt student-to-student interactions among students from different cultures. In the interview, he specifically stated that learning from each other is how individuals become informed. This

leads to table 12, where facilitation of learning was rated. As described in chapter two, facilitation of learning encompasses use of diverse teaching strategies, a student-centered environment, positive interactions within classroom, redesigning the curriculum, and actively listening to students' questions or comments. The bolded terms in table 15 represent distinct CRT instructional practices that are subsumed in the facilitation of learning (described in chapter 2).

Table 12: Instructional Practice Three

Facilitation of Learning		
Indicators	**Ms. Jane**	**Mr. John**
Uses **diverse teaching strategies** including cooperative learning, active learning, inquiry based learning, etc…	~	~
Conducts a **student-centered** environment.	-	~
Maintains **positive interactions** within classroom.	-	+
Redesigns the curriculum by using multiple resources, interdisciplinary lessons, and activities reflective of students.	-	-
Actively listens to students' questions and or comments.	~	~

Both participants employed "somewhat" diverse teaching strategies. Mr. John used quick groups where his students work in pairs; however, when observed, the students worked alone while in pairs. Similarly, Ms. Jane employed groups as well, but the students worked by themselves within the groups. In regards to classroom interactions, Mr. John maintained a comfortable environment where students respected one another and were comfortable with sharing their thinking. On the other hand, Ms. Jane struggled with this. Neither of them displayed or demonstrated the ability to redesign the curriculum. Ms. Jane specifically stated that she used the teacher's guide and the calendar as her guide for instruction. Although both

appeared to actively listen to their students, they both struggled with providing responses that would assist in moving learning forward.

Based on the ratings above, all CRT instructional practices warrant support for Ms. Jane and Mr. John. Because instruction is the central factor in student engagement (NCR, 2004), it becomes evident that student engagement practices consistent with SMP3 will warrant support as well. In the next section, Ms. Jane and Mr. John's students' engagement practices will be rated.

Common Core State Standards SMP3

Student engagement practices consistent with standard for mathematical practice three include: constructing viable arguments and critiquing the reasoning of others. CCSSO and NGA (2010) defined indicators for each practice. The indicators provided a lens for initial classroom observations. There are seven indicators for students' engaging in constructing viable arguments; and, four indicators for students' engaging in critiquing the reasoning of others. The following tables denote whether the indicators were observed. What follows each table is an explanation for how and why these indicators were rated. In each table, the researcher rated each participant using three levels: (a) not evident indicated by a "-"; (b) somewhat evident indicated by a "~"; and (c) evident indicated by a "+". In the following table, Ms. Jane and Mr. John's students' engagement in constructing viable arguments were rated.

Table 13: SMP3 – Construct Viable Arguments

Construct Viable Arguments		
Practices	**Ms. Jane's Students**	**Mr. John's Students**
Use stated assumptions, definitions, previously established results.	~	~
Make conjectures and build logical progression of statements to explore the truth of their conjectures.	-	-
Analyze situations by breaking them into cases.	-	~
Recognize and use counter examples.	-	-
Justify their solutions and communicate them to others.	-	-
Respond to the arguments of others.	-	-
Reason inductively, making plausible arguments that take into account the context from which data arose.	-	-

As indicated in Table 13, both participants demonstrated the ability to facilitate students using stated assumptions, definitions, and/or previously established results. This was evidenced by the students' abilities to answer the closed-ended questions during the warm-ups within Ms. Jane's classroom and the bell work within Mr. John's classroom. However, the other practices were not observed with the exception of students' analyzing situations by breaking them into cases. This was evidenced at the somewhat level in Mr. John's classroom when reviewing the bell work. In the bell work, the students were given an irregular figure, for which they needed to find the area. Although they solved the problem as a whole class, the students demonstrated somewhat of an ability to use the definition of area. Table 14 provides the ratings for their students' engagement in critiquing the reasoning of others.

Table 14: SMP3 - Critique the Reasoning of Others

Critique the Reasoning of Others		
Indicator	**Ms. Jane's Students**	**Mr. John's Students**
Actively listen to the arguments of others and decide whether they make sense	-	-
Read arguments of others and decide whether they make sense	-	-
Ask careful questions to clarify arguments of others	-	-
Ask useful questions to improve arguments of others	-	-

As indicated in Table 14, neither of the participants demonstrated the ability to facilitate students' engaging in productive mathematical arguments. As a result, these student engagement practices were not observed.

Summary: Areas of Greatest Need Identified

The analysis above aided in identifying the areas of greatest need as they relate to CRT and SMP3. As a result, the design of the professional development emerged, which will be discussed in the next section of this chapter. The lack of evidence of some indicators of the following CRT teacher characteristics emphasized a need for support: (1) commitment and skills to serve as a change agent; (2) cultural competence; and (3) constructivist views of learning. The lack of evidence of some indicators of CRT instructional practices emphasized a need for support in all three: (1) culturally validated instruction; (2) culturally mediated instruction; and (3) facilitation of learning. Because all the instructional practices warranted support, it was evident that students engaging in SMP3 would warrant support as well. Student engagement depends on the instruction provided (NCR, 2001). According to the results, both components of SMP3

emphasized need. In the next section, a description of the development of PD around the aforementioned greatest needs will be provided.

Designing Professional Development

The purpose of professional development (PD) was to inform teacher practice of CRT to support student engagement in SMP3. Guskey (2002) explained that there are three major goals of PD: (a) change in teachers' instructional practices; (b) change in students' progress; and (c) change in teachers' beliefs and attitudes. This study focused on the change in teachers' instructional practices. Research on professional development (PD) for inservice teachers indicates a positive effect on teacher practice (Heck, Banilower, Weiss, & Rosenberg, 2008). Heck et al. (2008) conducted a 7-year study of 48 projects to examine the relationship between professional development and standards-based instruction in mathematics. They found that professional development strongly affected the teachers' attitudes and preparedness, which had a positive impact on the teachers' teaching practice. Although the integration of theoretical research into day-to-day instruction can be challenging (Heid, Middleton, Larson, Gutstein, Fey, King, Strutchens, & Tunis, 2006; Robins et al., 2002), this study sought to examine this process through classroom interactions among teachers and students. Hufferd-Ackles, Fuson, and Sherin (2004) described four components that should be included in mathematical talk learning communities: (a) questioning; (b) explaining mathematical thinking; (c) a shift in the source of mathematical ideas; and (d) students taking responsibility for their own learning. The professional development provided emphasis on these components. For specificity of this study, the professional development included not only the components from Hufferd-Ackles et al (2004), but also the components of culturally responsive teaching as the focus of this study was on teachers' use of CRT to support SMP3.

Based on the participants' ratings in the previous section, prior to professional development, it was determined that most of the PD would focus on instruction and planning. Focusing on instruction and planning, the PD encompassed the following components:

1. Culturally Responsive Teaching
2. Formative Assessment
3. Mathematical Tasks
4. Student collaboration

As stated in the previous section, specific CRT teacher characteristics and instructional practices warranted support. These included: (a) cultural competence; (b) serving as a change agent; (c) constructivist views of learning; (d) culturally mediated and validated instruction; and (e) facilitating learning. In order to extend CRT to SMP3, the components of formative assessment, mathematical tasks, and student collaboration were selected. Teachers must be strategic and deliberate in their planning process in order to select mathematical tasks that solicit students communicating in mathematics. The mathematical tasks must be "problematic" and "begin with where the students are" (Hiebert et al, 1999, p. 9). Mathematical tasks must also ensure students are explaining and justifying their ways of reasoning and then communicating them to one another. Uses of problem solving and concept development tasks lend themselves well to students' communicating in mathematics (Shell Center for Mathematics Education (SCME), 2013). Teachers facilitate this way of communicating through the use of formative assessments and student collaboration. Formative assessments assist teachers with making adjustments to teaching and learning while in the process of teaching (SCME, 2013). Through strategic questioning and observations of student learning, the teacher can make decisions about future instruction. The teacher can also move learning forward. Student collaboration allows students to actively listen to one another and critique one another's way of thinking.

The professional development was two-fold: teachers were introduced to (1) the framework of culturally responsive teaching and its practices to support student engagement in mathematics and (2) the Common Core State Standards, standard for mathematical practice 3, which provides specific student practices related to student engagement in mathematics. The researcher conducted a series of professional development sessions which provided an overview of CRT and SMP3, instruction on how to facilitate and implement these constructs, and a deeper understanding of the factors that influence student practices that are consistent with SMP3.

To aide in the design of the professional development around CRT and SMP3, resources were strategically selected in order to support critical areas emphasized prior to professional development. Table 15 contains a list of the resources used and their contribution to the professional development. What follows is a detailed explanation for how each was used.

Table 15: Resources Used for Professional Development

Resource	Contribution
Houghton Mifflin Harcourt Videos	SMP3
YouTube Videos	CRT
LearnerCenter.org Videos	SMP3
Mathematics Assessment Project (MAP) Videos	SMP3 & CRT
Modules/Lessons from the Mathematics Assessment Project (MAP)	SMP3 & CRT
Lessons from Chartock (2010)	CRT
TEACH MATH (2012)	CRT & SMP3

The videos allowed the participants to observe the mechanisms of the instructional components of CRT & SMP3 in action. Houghton Mifflin Harcourt (2013) provided videos of Juli K. Dixon facilitating SMP3. In each video, participants were able to observe how a teacher supports students communicating in mathematics. More importantly, they observed students making

arguments around a specific concept, and then explaining, justifying, and critiquing each other. The YouTube videos offered support on understanding CRT as well as observing aspects of its manifestation in the classroom. Videos from the learnercenter.org provided support on teachers facilitating students' reasoning and sense making, which support SMP3.

The Mathematics Assessment Project (MAP) provided videos and lessons. MAP is collaboration between the University of Nottingham and the University of California, Berkley. This project was supported by the Bill and Melinda Gates Foundation to design lessons that focus on the use of assessments in implementing the Common Core State Standards for Mathematics along with facilitating the Standards for Mathematical Practice. The MAP professional development series offered support to the PD for CRT instructional practices and SMP3.

The book *Strategies and Lessons for Culturally Responsive Teaching* by Chartock (2010) provided CRT lessons from all disciplines. TEACH MATH (2012) provided an analysis tool that has been adapted from the following sources: (a) National Center for Research in Mathematics Education (1992); (b) Wisconsin Center for Educational Research, Madison; (c) Aguirre & Zavala (2013); (d) CEMELA (2007); (e) Kitchen (2005); (f) Turner, Drake, Roth McDuffie, Aguirre, Bartell, & Foote (2012); and (g) Aguirre, Turner, Bartell, Drake, Foote & McDuffie (2012). This tool is called the Culturally Responsive Mathematics Teaching Analysis Tool (CRMT-TM); it was designed to "promote intentional teaching discussions and critical reflections on mathematics lessons with a combined focus on children's mathematical thinking and equity" (TEACH MATH, 2012, p.1). It consists of six categories: (a) cognitive demand; (b) depth of knowledge & student understanding; (c) mathematical discourse; (d) power and participation; (e) academic language support; and (f) cultural/community-based funds of

knowledge. This tool was used when analyzing videos and lesson plans in relation to CRT and SMP3 as well as in designing lessons that encompass both CRT and SMP3.

Description of Professional Development

The professional development consisted of 7-one hour sessions containing two participants and two researchers. The sessions occurred over a three-week period, approximately two to three days per week. Table 16 provides an overview of each session.

Table 16: Overview of Professional Development Sessions

SESSION	CONTENT
Session 1	• Participant and facilitator introductions • Overview of the study • Communities of learning • Introduction to the CCSSM • Introduction to the SMP and Culturally Responsive Teaching (CRT) • Overview of SMP 3 and CRT • Video relating to SMP 3 and CRT
Session 2	• Participants share and discuss • Overview of assessment (Formative & Summative) (MAP Module 1) • Participants share and discuss • Watch MAP video on assessment using mini whiteboards • Houghton-Mifflin Harcourt video on assessment • Whole group (two teachers and two researchers) discussion on assessments observed in videos • Review of a MAP lesson
Session 3	• In-depth look at CRT (what and why) • YouTube video on becoming a CRT teacher • Review of CRMT-TM Analysis Tool • Whole group discussion on Initial Observation Lessons • Homework: Review videos from YouTube and learnercenter.org and analyze it using CRMT-TM • Homework: Review MAP lesson plan and Chartock (2010) lesson plan
Session 4	• Review MAP Concept Development (MAP Module 2) and Problem Solving (MAP Module 3) Lessons • In-depth discussion of mathematical reasoning • In-depth discussion of choosing worthwhile mathematics tasks • Houghton-Mifflin Harcourt videos on facilitating SMP3 • Whole group discussion on lesson planning employing culturally validated and mediated instruction
Session 5	• Improving Learning Through Questioning (MAP Module 4) • Houghton-Mifflin Harcourt videos on questioning • Whole group discussion on questioning • Identify practical classroom application of topics presented
Session 6	• Whole group discussion of CRT Homework tying in questioning, reasoning, and choosing mathematical tasks that connect with your students. • Students Working Collaboratively (MAP module 5) • Houghton-Mifflin Harcourt videos on facilitating group work • Whole group discussion on facilitating groups • Identify practical classroom application of topics presented
Session 7	• Summary of topics discussed: SMP3 and CRT • Review study plans for implementation within learning community • Group discussion and reflection of experience • Thank you to the teachers for their participation

During session one, the researchers provided the overview of the study and a brief personal background of themselves as a means to cultivate rapport with the participants. Glesne

(2006) writes, “Rapport describes the character of effective field relationships” (p. 109). The participants also received an overview of the study as well as an overview of CRT and SMP3. Videos were provided within the presentation to complement the explanation of SMP3 and CRT. Session two focused on formative assessment emphasizing its benefits of questioning, peer discussion and feedback, and self and peer assessment. These benefits promote students’ engaging in SMP3 and teachers’ use of CRT instructional practices (facilitation of learning). Participants discussed how they assessed their students and gained insight on how they should plan assessment with their students’ in mind. Session three focused on the components of CRT including teacher characteristics and instructional practices. This tied to the previous day in that one cannot plan without considering his/her students. Students must be at the forefront of planning and this is why it is important for teachers to know their students. During this session, the group (participants and researchers) examined a video and lesson plan in order to analyzed it using the CRMT-TM lesson plan analysis tool. Homework was provided at the conclusion of session three.

The focus of session four was on concept development and problem solving lessons. It included the benefits of both and how types of lessons promote students in engaging in SMP3 and teachers’ use of CRT. These lessons were student centered and promoted context in concept development. The use of context provides opportunities for teachers to start with where their students’ are and use context related to students’ experiences. Concept development lessons promote explanations and justifications and invite students’ own ways of reasoning about a mathematical situation. Here, teachers have the ability to redesign the curriculum in order to connect with their students. Problem solving lessons are open-ended and allow students to work collaboratively to reach a solution. They promote students’ comparing and critiquing each

other's ways of reasoning. The participants engaged in a concept development activity and a problem solving activity where they revised structured problems to make them more open-ended. Open-endedness allows students to make their own decisions. Participants also reviewed videos of teachers implementing these tasks. The use of concept development and problem solving lessons afford teachers the opportunity to be deliberate with their selection of mathematical tasks, which will in turn afford them opportunity to promote culturally validated and mediated instruction.

In session five, the participants and researchers engaged in discussion on questioning and the use of questioning during mathematical tasks. Participants reviewed different types of questioning, the reasons for questioning and common mistakes in questioning. They reflected on their own practice of questioning and discussed how they can improve upon it. Videos were reviewed and analyzed to emphasize the benefits of good questioning and how it promotes reasoning. This session led into session six smoothly as the focus was on students' working collaboratively. The CRT homework from session three was reviewed as it tied in as the lesson and video reviewed employed group work. During this session, the role of the teacher and student was discussed as well as the establishment of ground rules for group work. Participants reflected on their own practice of group work and discussed ways that they can improve upon their practice.

And lastly, during session seven, the group reviewed the topics discussed throughout the PD related to CRT and SMP3. These topics included: (a) choosing worthwhile tasks related to students; (b) questioning; (c) collaborative group work; and (d) promoting mathematical reasoning. These topics are informed by a teacher's knowledge of his/her students and their ways of communicating and reasoning. Study plans for implementing PD within their

classrooms were reviewed and discussed. Participants were instructed to utilize the CRMT-TM analysis tool to assist them in developing lessons that incorporated both CRT and SMP3. And, finally participants reflected on the PD experience and on their ability to implement it within their classrooms.

The goal of the professional development was for the participants to develop a deeper understanding of CRT and SMP3. The expectation of this study was that the PD would provide the participants with a foundation to be able to integrate strategies addressed during PD into their classroom instruction by facilitating CRT lessons.

Phase Two: During Professional Development

Classroom Observations during Professional Development

Two classroom observations took place between session four and six of professional development. These observations assisted the researcher in documenting each teacher's change and reaction to the professional development. In order to capture change in each teacher's instructional style related to CRT and SMP3, observation field notes were collected. Additionally, classroom observation were video and audio recorded.

Phase Three: Post-Professional Development

Classroom Observations after Professional Development

Classroom observations took place when the teacher participants felt that they were ready to implement the strategies that they had learned in PD. To conduct an in-depth case study of each teacher's implementation of CRT and SMP3, the researcher collected observation field notes of each teacher's classroom instruction. Each observation was audio and video recorded. The observations allowed the researcher to document the classroom discourse, which included

the actions of the teacher and students, the words of the teacher and students, the conversations between the teacher and students, the conversations between the students, and the student engagement. These field notes allowed the researcher to extract information on the relationship between a teachers' use of CRT and students' constructing viable arguments and critiquing the reasoning of others. Each participant was observed over a one-week (5 day) period.

Informal Interviews

Following classroom observations, informal interviews were conducted. The goal was for the teachers to integrate CRT within their mathematics instruction as an effort to support student engagement in practices consistent with SMP3. Follow-up interviews were conducted with the teachers to extract their perception of their ability to use CRT to support student engagement and their perception of their students' ability to construct viable arguments and critique the reasoning of others. Glesne (2006) highlights, "Interview questions that develop through participant observation are connected to known behavior, and their answers can be therefore better interpreted" (p. 49). Every interview was audio recorded. The follow-up interviews took place within 48 hours of each observation during the teacher's planning period or at a time convenient for the teacher. Two informal interviews were conducted for each teacher participant. Information obtained from these interviews contributed to the description of this study and guided future observations.

Journals Writing Prompts

Self-reflection on instructional practices through written expression can prove purposeful (Wink, 2005). It assists teachers in expanding their professional toolkits and making instructional adjustments as necessary (Jaworski, 1994; Sowder, 2007). The journal writing prompts (See Appendix C) were developed as a means to assist teachers in their reflective

process during the implementation of the knowledge gained from the professional development. Prompts were completed daily by each teacher prior to informal interviews.

Video Recordings

Video recordings enhance observations and are permanent (Glesne, 2006). They are permanent in that the researcher can return to the observation multiple times during the data analysis stage of the research. For that reason, classroom observations during phase two and three were video recorded. In order to capture all classroom interaction, two cameras were used. One camera (stationary) captured the teacher's actions and instructional strategies. The other camera (mobile) captured the teacher-student and student-student interactions. A videographer managed the mobile camera as the researcher was collecting observation field notes. The recordings allowed the researcher to triangulate the observed phenomenon.

Student Artifacts

"Documents and other unobtrusive measures provide both historical and contextual dimensions to your observations and interviews" (Glesne, 2006, p. 68). They have the potential to enhance or deepen the researcher's understanding of the phenomenon by supporting his/her perceptions of what is observed and seen in the video. The student artifacts in this study added another dimension of triangulation as the researcher extracted the students' ability to construct viable arguments. When students constructed viable arguments, not all voices were heard and not all arguments were stated. As a result, the artifacts were examined for data that was not observed nor video recorded.

Data Analysis Procedures

"When multiple analysis cases are chosen, a typical format is to first provide a detailed description of each and themes within the case, called a within-case analysis, followed by a thematic analysis across these cases called a cross-case analysis, as well as assertions or interpretation of the meaning of the case" (Creswell, 2007, p.75). Table 17 provides the purpose and the research question(s) related to each data source. What follows is a brief description of how each data source contributed to the study.

Table 17: Data Sources and Research Questions

Phase One		
Data Source	**Purpose**	
Initial Interview	To establish a baseline for professional development	
Initial Observations	To establish a baseline for professional development	
Phase Two		
Classroom Observations during PD	Document changes in each teacher's instructional style	1. What is the nature of the relationship between teachers' use of CRT practices and students' engagement in constructing viable arguments? 2. What is the nature of the relationship between teachers' use of CRT practices and students' engagement in critiquing the reasoning of others?
Phase Three		
Data Source	**Purpose**	**Research Question(s)**
Interviews	Understand the teacher/student reality through the eyes of the teacher Accommodate need for "member checking"	1. What is the nature of the relationship between teachers' use of CRT practices and students' engagement in constructing viable arguments? 2. What is the nature of the relationship between teachers' use of CRT practices and students' engagement in critiquing the reasoning of others?
Classroom Observations after PD	Collect first-hand field notes of CRT and student engagement	1. What is the nature of the relationship between teachers' use of CRT practices and students' engagement in constructing viable arguments? 2. What is the nature of the relationship between teachers' use of CRT practices and students' engagement in critiquing the reasoning of others?

Data Source	Purpose	Research Question(s)
Journal Writing Prompts	Reflective practices in using CRT and perception of student engagement in SMP3.	1. What is the nature of the relationship between teachers' use of CRT practices and students' engagement in constructing viable arguments? 2. What is the nature of the relationship between teachers' use of CRT practices and students' engagement in critiquing the reasoning of others?
Video Recordings	Record of teacher and students actions throughout the lesson implementation Provides "Triangulation"	1. What is the nature of the relationship between teachers' use of CRT practices and students' engagement in constructing viable arguments? 2. What is the nature of the relationship between teachers' use of CRT practices and students' engagement in critiquing the reasoning of others?
Student Artifacts	Written documentation of student's construction of viable arguments	1. What is the nature of the relationship between teachers' use of CRT practices and students' engagement in constructing viable arguments? 2. What is the nature of the relationship between teachers' use of CRT practices and students' engagement in critiquing the reasoning of others?

As defined in table 17, every data source contributed to the research questions of this study. However, they each served a different purpose. The informal interviews assisted the researcher in understanding classroom interaction realities from the teacher's perspective. The field notes taken during classroom observations after PD provided first-hand notes on the classroom discourse specifically related to CRT and student engagement. The video recordings provided triangulation of the data collected. Using the videos, the researcher was able to revisit observations repeatedly making notes using the CRT framework and the practices consistent

with SMP3. Teachers reflected on their instructional ability to use CRT and their students' ability to engage in SMP3 using daily journal writing prompts. Because viable arguments can be constructed on paper, student artifacts provided written documentation. Only written documentation related to classroom instruction was collected.

The interviews, field notes, journal writing prompts, and student artifacts were transcribed. All data were coded using a holistic analysis of each case (Yin, 2003). To understand the complexity of each case, a thematic analysis was employed to identify patterns within each case seeking universal themes that are consistent across cases (Yin, 2003). For specific insight on teachers' use of CRT, the researcher used the Part A of the CRT & SMP3 Analysis Instrument (Appendix D) to analyze the observation field notes and video recordings in order to identify elements of the CRT framework as they were manifested in the teachers' characteristics and practices. Likewise, for specific insight on student engagement, the researcher used Part B of the CRT & SMP3 Analysis Instrument to analyze observation field notes and video recordings in order to identify student practices that were consistent with SMP3 as they were manifested during instruction.

Validity

Creswell and Miller (2000) described eight validation strategies that are frequently used in qualitative research. Of the eight strategies, two of them were selected to validate the findings of this study (Creswell, 2007). Creswell (2007) recommended that, "qualitative researchers engage in at least two of them in any given study" (p. 209). Through the use of multiple data sources, triangulation was used. Thurmond (2001) explains that the advantages of triangulation includes "increasing confidence in research data, creating innovative ways of understanding a phenomena, revealing unique findings, challenging and integrating theories, and providing a

clearer understanding a problem" (p. 254). Field notes were collected during classroom observations and interviews. Additionally, teachers completed journal writing prompts and student artifacts were collected. The filed notes assisted the researcher in recording constructions formed from observations and conversations during interviews. The journal writing prompts allowed the teachers to immediately self-reflect on their instruction the day it took place. These reflections, along with informal interviews about the classroom observations provided a venue testing and refining initial interpretations. Additionally, student artifacts were collected and provided another means to support interpretations from classroom observations. The use of triangulation provided corroborating evidence (Creswell, 2007) and confidence in the findings of this study.

Throughout the research process, the researcher engaged in peer reviewing and debriefing to cross-examine the basis of developing conjectures and theoretical claims. Peer review or debriefing provides another set of eyes to review the data in process. It is an external check of the data and data analysis (Creswell, 2007). Following each professional development session, classroom observation, and interview, the researcher debriefed with Mercedes Sotillo (described in the transparency section of this chapter) regarding developing conjectures and claims. Additionally, the researcher conversed with other mathematics education doctoral students who were present during the week-long classroom observations. Peer reviewing consistently occurred throughout the analysis of the data, which assisted the researcher in staying true to the findings that were revealed in this study. In reporting the findings, the researcher provided thick, rich descriptions such that others could judge the transferability of the findings. The strategies of triangulation and peer review helped to establish the validity of the results and findings revealed in the next two chapters.

CHAPTER 4: RESULTS

Introduction

Research supports the connection between culture and the teaching and learning of mathematics (Gay 2000; Ladson-Billings, 1995a, 1995b; Tate, 1995; DMECLT, 2007; Bishop, 1988; Presmeg, 2002b, 2007; Brown-Jeffy & Cooper, 2011; Tyler, 2008). This collective case study provided a context in which in-service teachers attempted to implement culturally responsive teaching while facilitating student engagement consistent with SMP3. The study was divided into three phases: (a) Pre-Professional Development; (b) During Professional Development; and (c) Post-Professional Development. Data from the Pre-Professional Development phase was provided in chapter 3. Data from both the During- and Post-Professional Development phases will be presented in this chapter. The latter phases of the study was undertaken to address the following research questions:

1. What is the nature of the relationship between teachers' use of CRT practices and students' engagement in constructing viable arguments?
2. What is the nature of the relationship between teachers' use of CRT practices and students' engagement in critiquing the reasoning of others?

Presentation of Data during Professional Development

Teacher Change during Professional Development

Guskey (2002) writes, "The three major goals of professional development programs are change in the classroom practices of teachers, change in their attitudes and beliefs, and change in the learning outcomes of students." Because the focus of this study was on describing the relationship between CRT and student engagement, change in classroom teaching practices was

relevant to this study. Professional development was provided to create teacher change, which is essential for teachers to facilitate student engagement that is consistent with the Common Core State Standards, Standards for Mathematical Practices. During the professional development provided in this study, classroom observations were conducted to document change in each teacher's instructional style and their reception to PD. In addition to instructional practices, student engagement practices were documented as well. Observations took place between session four and six of PD. Data from these observations will be presented in the following paragraphs.

Observed Change in Ms. Jane

There was an observable shift in Ms. Jane's instructional practices. The changes shifted from no evidence at all to being somewhat evident. She demonstrated an increased level of expectation for her students. During a PD session, Ms. Jane stated that her students would not be able to respond to the phrase "what did she say"; however, when using that phrase in her warm-up review, her student responded agreeing with the student that originally answered the question. Below is the dialogue that took place:

Ms. Jane:	Why is he going to divide?
Keisha:	Because that is how many numbers there are…
Ms. Jane:	Asking another student, she asked "What did she say?"
Keona:	Because that is how many numbers there are (indicating agreement with the other student)

Ms. Jane demonstrated an increased ability to prompt student-to-student interactions among students of different cultures. From observation to observation, Ms. Jane switched pairs of students working together. The class is mostly Hispanic, however, students from different cultures were paired together. Ms. Jane walked around from pair to pair and prompted communication among the students. One group in particular contained an African American

male and a Hispanic female. Before Ms. Jane could assist them, the female student was explaining to the male student about how to find the measures of central tendency and the range for their data matching activity. Ms. Jane wanted to ensure that he understood, so she asked him to explain what his partner (the female student) had said. This was powerful in that he was able to explain correctly to Ms. Jane while the female student began to feel good about herself and her ability to do the assignment. Ms. Jane praised both students.

Ms. Jane also demonstrated an increased ability to redesign the curriculum. For a lesson on the measures of central tendency and range, she used her students to collect data on a popular game that most of them enjoy playing. As a class they collected, organized, and displayed data. In another lesson over the same topics, students worked in pairs to match data to graphs. When asked about how this lesson came about, she stated that she searched online for a different way to teach the skill that would connect with her students' cultures.

Ms. Jane demonstrated an increased ability to maintain positive interactions within the classroom. During another lesson, she asked her students to describe the meaning of division. She paused the lesson for everyone to be quiet while a male student was sharing his way of reasoning about division. Below is an excerpt from the teacher-student dialogue referring to the problem below:

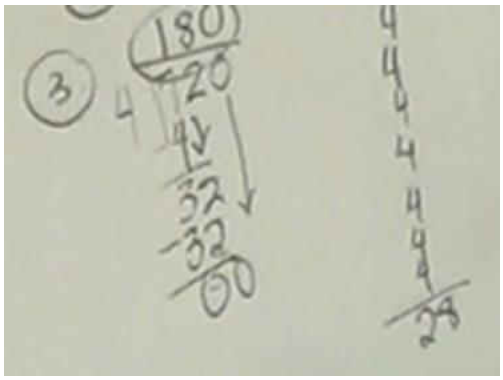


Figure 7: Division Problem – Ms. Jane

Ms. Jane: The answer is 180, so what does 180 mean?
Melanie: It means 180 x 4 = 720.
Ms. Jane: Okay, but what does it mean when you divide? What are you trying to do when you divide?
.....interaction, many students talking at one time.....
Marcus: It's like…
Ms. Jane: Marcus, you are doing fantastic, I just can't hear because other people are talking.
(She pauses for students to stop talking)
Marcus: Like if you have 4 people and there are 720, you can divide and give 180 and 180 and 180 and 180 to everyone.
Ms. Jane: Great, so you are dividing them into?
Everyone: Groups.
Ms. Jane: What kind of groups?
Shane: Mathematical groups
Ms. Jane: If Marcus said 180 to each one, are all those what, "4" are they different numbers? Do they have the same amount? So what kind of groups are they?
Marcus: Equal
Jane: Good, equal groups. (She went on to explain what dividing is and used Marcus's context to expound more).

This slight change in her instructional style resulted in a shift in her students' engagement. Although classroom management appeared to be a problem as evidenced by the unrelated student activity, the students were highly engaged when Ms. Jane asked them about their favorite computer game. As a class, they collected, organized, and displayed data. In the second lesson on matching data with appropriate graphs, classroom management was much better and the students seemed to all be on task. For this activity, not only did they engage in learning mathematics but they were excited about being able to cut and paste to match graphs together. In regards to SMP3, no change was observed.

Observed Change in Mr. John

A shift in Mr. John's instructional practices was also observed. Indicators that were rated as not evident prior to PD shifted to being "somewhat" evident during PD. There were also indicators that became a little more evident. Mr. John demonstrated an increased ability to use

students' cultural differences as a catalyst for learning. After reviewing the four questions from bell work, Mr. John asked his students to write down a fifth problem. He stated:

> We have been talking about cylinders and we have been talking about pyramids yesterday right? I want you to picture a holiday that you guys in your family celebrate…..I want you to tell me, if you were to… to sit down at the table to eat during this holiday, what are some things that you would find in the kitchen maybe, on the dinner table as you sat down to eat for that holiday that were the shapes of cylinders or pyramids? Don't tell me just write them down. So write down some 3-D shapes of cylinders or pyramids that you might find on your holiday dinner table when you sat down to eat or when you were at that party. This is problem number 5.

This task allowed his students to reflect on their own cultures and traditions. However, the students did not get to share the shapes with the class. When speaking about this task during the PD session later that day, Mr. John stated that he wanted his students to talk about their holiday and culture. They just did not have the time that day. He demonstrated this in another instance that day when he transitioned to a new lesson on cones. He asked the students to identify objects in the real world that would resemble cones. Some of the student responses included an ice cream cone, party hats, and the orange cones that builders use. This question allowed his students to identify cones from their own worlds while at the same time hear about cones from their classmates' perspectives. All of the students did not get to respond; however, if there were more time, they probably would have. Both instances provide evidence of Mr. John's increased ability to use students' cultural differences as a catalyst for learning.

Prior to PD, Mr. John conducted somewhat of a student-centered environment. However, during PD, this began to change a little. His lessons became more student-centered in that he allowed student responses to direct instruction. Because of this, he was able to use student mistakes as springboards for learning and move learning forward. Therefore, in addition to

student-centered, he demonstrated an increased ability to actively listen to students' questions and/or comments. This was evidenced in the following excerpt:

Diamond: Is a pyramid a cone?
Mr. John: Alright, let's think about that, Is a pyramid a cone? That's a good question. Someone raise your and give me your opinion on that
Krystal: No
Mr. John: Krystal says no, why? ..
Krystal: Because it's a pyramid.
Mr. John: So let's talk about that for a second, if she is saying no because it's a pyramid and not a cone, well let's take some of these characteristics. What makes a cone a cone? What makes a pyramid a pyramid? What is the difference cause if she is saying one is different than the other, what are the differences?
Ruby: The cone bottom is round and the pyramid bottom is a square
Mr. John: Okay...so Ruby says the bottom of a cone is round or a circle, right, a pyramid she says is a square
(John drew these figures on the board while he was restating what Ruby said).

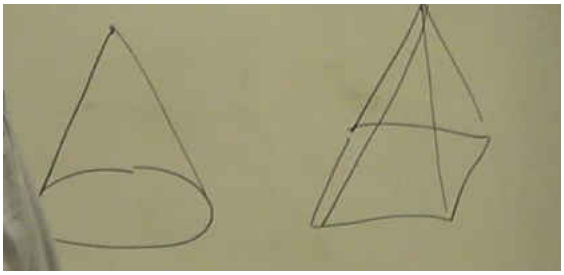


Figure 8: 3-Dimensional Solids – Mr. John

Mr. John: How many people agree?
(Most of the students raise their hands including the student that asked the original question)

Mr. John also demonstrated these practices during another observation when a student asked if the following two equations meant the same thing: $y = 3x + 2$ and $y = \frac{x}{3} + 2$. A picture of the problem and the dialogue is below:

Cassie: But can you also write it also, y=3 and x +2.
Mr. John: Why would you write and in there?
Cassie: Like 3 over x.
Mr. John: Like 3 over x? What is, well that's a good question does 3 over x mean the

same as 3x? Okay, so lets talk about that, I don't know
...(then writes the two numbers on the board).

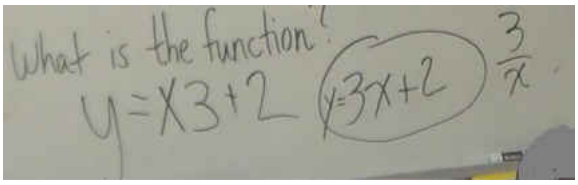


Figure 9: Comparing 3x and 3/x – Mr. John

Mr. John: So are you saying 3 over x like this?
Cassie: Sort of except the x is on the top.
Mr. John: Okay...so if I have..x over 3... Is x over 3 the same as 3x. Let's take a vote.

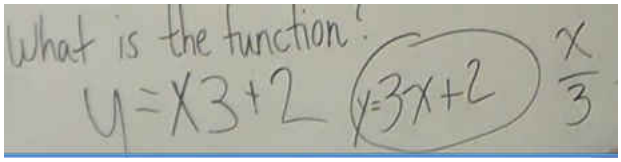


Figure 10: Comparing 3x and x/3 – Mr. John

Mr. John: So how many agree
Cassie: Raises her hand (the only student to raise their hand)
John: So, let's help her out. What does x over 3 mean?
Carmen: x over 3 is x divided by 3 not x times 3.

In both excerpts, Mr. John capitalized on students' misconceptions by prompting a whole class discussion. The female students that voiced those misconceptions reached a new depth in their understandings. In the excerpts above, the students shared their misunderstandings with the class and that is what is necessary for SMP3.

The following SMP3 practices were evidenced during both of Mr. John's observations: (a) students' justifying their solutions and communicating them to others; (b) students' asking questions to clarify arguments of others; and (c) students' reading arguments of others and deciding whether their arguments make sense. During the PD, these practices were observed in Mr. John's teaching. Mr. John's increased ability in his instructional practices assisted him in

facilitating students' engaging in practices consistent with SMP3. These practices were evident in the excerpts above as well as in the excerpt below:

Mr. John: In number 4, x does equal 21.

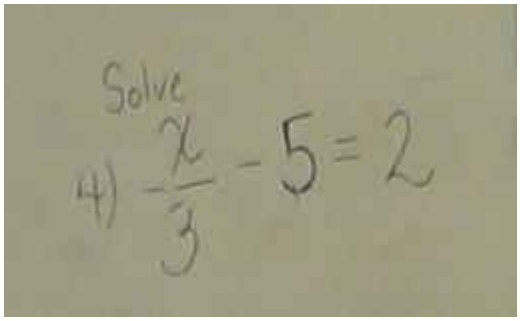


Figure 11: Problem from bell-work – Mr. John

Mr. John: Can anybody tell me, how I can check my work? Let's say I was doing this problem for the first time and I want to make sure I was right, like I was taking a test and there was only one question? I want to make sure I have a 100% before I turned it in, what could I do? Tamara....what do you think?

Tamara: Put 21 as x and then do the problem.

Mr. John: Okay, so who can tell me what she just said. Tia.

Tia: Put 21 as x

Mr. John: Is that what Tamara said? Who can tell me what Tamara just said? Tia is not wrong, she was on the right track, but what did Tamara just say? Brandy

Brandy: If you plug in 21 for x and you do the problem, you should get the same answer.

Mr. John: Okay, but what do you mean by same answer

Brandy: That you should get 21 when you do it

Mr. John: Well not 21, close, but what should I get?

Brandy: 2

Mr. John: Exactly...that's what Tamara just said. In fact, Let's do that to see if Tamara and Brandy are correct. So is Tamara way of checking her work, is it correct? Monica, what do you think?

Monica: Yes

Mr. John: Yes. Monica says it's a good way to check, why?

Monica: Cause you get the same answer and that

Mr. John: What do you mean by getting the same answer? I like detail, so if I put 21 in here, what do I get for this part.

Monica: You get 7

Mr. John: Good, you get seven, and what do I do with that seven?

Monica: You subtract it from 5

Mr. John: Good and what do I get?
Monica: 2
Mr. John: Sounds good to me, excellent job! Very, very good!

Although Mr. John is facilitating students to read other students' arguments and make sense of them, it is only evidenced at the somewhat level. This is mainly because the interaction is between the teacher and student. In order for these practices to be fully evident, there must be interactions between the students as well. During both observations, Mr. John directed his students to work with a partner. However, uses of these practices during student-to-student interactions were not captured.

Teacher Reaction

At the conclusion of the PD, both participants were prompted to verbally provide a reflection of the PD in relation to CRT and SMP3. Based on their responses, their overall reaction was positive. Ms. Jane thought that it was "a lot of great information", however, she felt more support was needed on how to specifically implement what she has learned in the classroom. Being that Ms. Jane is considered a 1st year teacher of mathematics, she inherits the pressure of learning the material. Therefore, implementing the PD in her classroom becomes a major task. Throughout the PD, she was intrigued about culturally responsive teaching, however, she would always ask, "How do I get to know my students?" Below is an excerpt of her response to what was shared in the PD:

> …..I think it's great like a lot of information that I learned ya know. I find it kind of hard because it's very general, kind of and I want specific things. You know what I'm saying? As a teacher, especially if you know it's hard for me to, it's kind of one of those things that you learn a lot of, you learn a lot of great information but I don't know how to specifically implement it in my classroom. As in, maybe not concepts but techniques that you like, you said it's about culture responsive getting to know your students, well what specifically could I do to get to know my students better? Because I have never really, I haven't gotten the opportunity to.

This response prompted a whole group discussion on how to gain an intimate knowledge of your students. One way that was discussed was to converse with your students. Another suggestion was to use a questionnaire or make an assignment for them to write about themselves. Ms. Jane elaborated a little more in regards to the support of implementation of PD. She expressed that having the opportunity to observe someone use the information learned in PD within her classroom would be beneficial. This prompted another discussion on the value of observing other teachers. Overall, Ms. Jane felt the PD was beneficial to her development as a new mathematics teacher.

Mr. John reflected on his attempts to incorporate what he had learned in PD within his classroom. Learning about culturally responsive teaching sparked his interest and he immediately saw the value of it. In regards to the facilitation of students' engaging in SMP3, Mr. John initially thought it would be difficult to facilitate this type of instruction. However, he found that it was not difficult at all; it became a natural part of his instructional style. Mr. John's response to the PD is below:

> I'm just, I'm very similar. I mean it opened my mind up to a lot of things. I can already tell like my teaching style changing just from the 7 PD's that we've had. Ya know from the first one like when I started like hearing certain things about incorporating culture into my classroom, like I started doing it at first constantly. I was like ok I'm going to try to find a way I can incorporate cultures and things like that. And then all of a sudden the questioning part, we started to learn more about the questioning and how to answer, how to ask questions and what questions to really get their conversations going and then talking about math. Like I started to do it right, more naturally, and I thought it would take me a long time to really like consciously ask these questions but then it's basically, it kind of fit into my teaching style anyway. Because I always asked a lot of questions, but I didn't, I don't think I was asking the right ones.
>
> So that's why like I really see a big impact on my class. Like when you guys said to; you're questioning and like you'll see your class change. And now they're trying to talk more about math. Even my group, when I do put them in groups, they don't have to hear me so much directly, when they already start talking about math and asking questions…..

Mr. John's response was indicative of his commitment to improve his practice. He observed that

an improvement in his practice would enhance his students' thought processes and their ability to engage in productive mathematical conversations, which is consistent with SMP3. Both participants' responses provided foresight on their reception to implement what they had learned from PD into their classrooms. In the next section of this chapter, data from their implementation of SMP3 and CRT will be presented.

Presentation of Data after Professional Development

As described in Chapter 3, participants were tasked with implementing what they had learned from PD within their classrooms. They were instructed to plan a week-long lesson using the Culturally Responsive Mathematics Teaching Analysis Tool (CRMT-TM) as a guide and including the following indicators of SMP3 and CRT:

1. Use of formative assessment
2. Questioning (facilitating critical thinking)
3. Culture embedded in the lesson (mediated and validated)
    a. Displaying CRT Teacher Characteristics
    b. Using CRT Instructional Practices
4. Students engaged in SMP3
    a. Representations, explanations, and justifications
    b. Assessing each other's reasoning

Because of the differences (students, environment, and topics of instruction) in each participant's classroom and the time of the school year, the task was open-ended in that they planned lessons around their students' needs for the school year. The participants were given two weeks to develop their lessons.

Instruction Realities focusing on CRT & SMP3 (Field Notes & Videos)

Ms. Jane's Week-long Lesson

Ms. Jane decided to conduct a lesson on statistics and probability where her students designed their own sneakers. On the first day, Ms. Jane sparked her students' interest by displaying magazine cut outs of sneakers. A picture is provided below.

Figure 12: Magazine Cut-outs of Sneakers – Ms. Jane

When her students walked into the classroom, they were taken by the display of the sneakers on the side wall of the classroom and walked over to observe them. After the late bell rang, Ms. Jane instructed the students to go to their seats and said, "I know some of you guys saw the shoes on my wall, which we will get a more chance to look at. Raise your hands if you are wearing sneakers." As the students raise their hands, Ms. Jane asked them to describe their sneakers. The students provided different characteristics of their sneakers including the color, type, and brand. From those characteristics, the class came up with categories within which they could place the shoes. Working in pairs, Ms. Jane tasked her students with collecting and displaying data from observing their classmates sneakers. She was deliberate about not giving specifics on how to collect and display data. Along with their partners, they had to make a decision about what type of data they wanted to collect, i.e. types of brands, colors, high tops vs. low tops, etc. In addition, they had to determine how they wanted to display the data on a mini-white board to share with the class. After Ms. Jane provided the directions, some students struggled with

getting started, which lead to a classroom management problem. There was lots of unrelated student activity including high-volume noise, the use of profanity, and students making fun of their classmates' shoes. Some negative comments included:

> You are wearing fake Jordans.
>
> Those are no-name brand sneakers. Where did you buy them?

Instead of addressing the misbehavior, Ms. Jane ignored it by assisting the pairs that struggled with where to begin. The excerpt below shows how Ms. Jane prompted the students in getting started.

Maria:	What are we supposed to do?
Ms. Jane:	Carlos, what do you think we are supposed to do?
Carlos:	Choose a category
Ms. Jane:	Okay so what category do you guys want to use?
Maria:	Color
Ms. Jane:	So is that okay with you? (Asking Carlos student)
Carlos:	Colors
Ms. Jane:	Okay, so now how are going to collect all the colors in the class. What are you going to do?
Maria:	Walk around
Ms. Jane:	You get to pick

She was very careful not to give direction on how to complete the task as she wanted this to be an open-ended task, which indicates her increased ability to have high expectations for her students. After the students completed this open-ended task, Ms. Jane instructed her students to share their data displays with the class. Instead of having the students present at the front, she walked around the room and held up their white boards to the class. A couple of the displays are provided below.

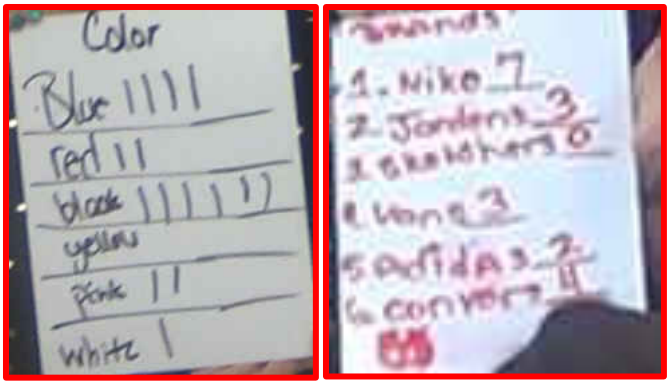


Figure 13: Student-generated Displays of Sneaker Data

While holding up the white boards, she asked the partners to explain how they decided to collect and display their data. The displays included lists, frequencies, and tables. Some groups displayed the data the same but collected data on different categories. This was an indication of Ms. Jane's attempt to have students' explain their reasoning behind data collection. The students also engaged in one practice consistent with constructing viable arguments, which is to use definitions and previously established results. This was done in writing.

After the mini board presentations, Ms. Jane conducted a whole class discussion on how mathematics can be used in manufacturing and designing sneakers. Ms. Jane asked, "How do you think mathematics can be used in designing and manufacturing sneakers?' The students raised their hands to share their ideas and suggestions while Ms. Jane documented them on the board. The list that was developed is provided in table 18.

Table 18: Student-generated list of how math is used!

How math can be used when designing and manufacturing sneakers? -price/cost of shipment/design (add cost) -how much material they use -time/to make -how many pairs they make -weight/height/length -profit

To further spark her students' interest and enhance the discussion, Ms. Jane showed her students two videos on sneaker design. She was selective in the process of choosing the right videos for her students. This was evidenced in Ms. Jane's statement during an informal interview when asked to explain how she selected the videos:

> …I had in mind the kid's interest level. I saw, I googled, I you-tubed those kinds of things, I looked up different ones that I knew that the kids were really into like the Jordans and the different types of sneakers. I don't even know their names. So I knew that they would like that. Also, I chose two because I saw one on making them and it was a really lengthy process and so I picked a little bit shorter one …I knew that was interesting too with the different pressure and those kinds of things so I kind of looked into see what they would like.

The videos were very detailed in that the machines used to make shoes were shown. The students were truly engaged and were able to provide more suggestions on the mathematics involved in designing shoes at the end of the videos. As students were providing their ideas, Ms. Jane demonstrated the ability to understand students' perceptions and an increased appreciation for their ways of thinking. This is evidenced in the excerpt below.

Ms. Jane:	What's another way math can be used?
Miguel:	Like when they put it in the machine (referring to video)
Ms. Jane:	Okay so you are going to need…for math…machine? Okay, well what does that machine do?
Miguel:	Pressure down 45
Ms. Jane:	Yeah..that pressure is so hard that it could press a car.
Lilliana:	Building the shoe.
Ms. Jane:	What about building the shoe, what math will be required?
Lilliana:	How long it will take to make the cell?
Ms. Jane:	Okay, how much time it will take?
Juan:	How tall it is and how much it weighs?
Ms. Jane:	Okay, weight. What's another word for tall?
Jose:	Height

Although she understood their perceptions, Ms. Jane did not extend her students' knowledge of the mathematics involved in the designing and manufacturing of shoes. Most of the ideas

mentioned remained superficial. This might be due to Ms. Jane's limited understanding of mathematics, which became evident in her initial interview. At the end of this discussion, Ms. Jane presented the students with two articles. One article was on the anatomy of a sneaker and the other was on sneaker material. She provided each student with one article to read for homework and told them that they will share what they read in class the next day. For the remainder of the class period, she instructed the students to begin reading. Some of her students struggle with speaking and reading in English, so she accommodated those students by reading to them. This demonstration indicated her ability of being knowledgeable of her students and their needs.

On the second day, Ms. Jane instructed the students to discuss two major points from the article they read with their partner and visa-a-versa. The students were tasked with writing the points on a mini white board and sharing those points to the class. Before the students presented, Ms. Jane established audience expectations for the class. She stated, "Okay, for those that are watching, if you were up here, you would want everyone else to be quiet, so let's give them your full attention and be a good audience." Throughout the partner presentations, Ms. Jane conducted a whole class discussion on the points that were presented. The excerpts below provide insight on those discussions.

Ms. Jane:	So what did you guys learn?
Students:	There are three shoe cuts; Foam pellets are sometimes used in the middle sole.
Ms. Jane:	Why do you think they use foam pellets? John?
John:	To make them smooth.
Ms. Jane:	Keona, what did John just say?
Keona:	I don't know.
Ms. Jane:	Joseph, what did John just say? Do you know?
Male 2:	To make them comfortable and cushion
Ms. Jane:	Close....John, what did you say?
Male:	Umm

Ms. Jane: Do you remember what you said?
Maribel: To smooth out the bottom.
Ms. Jane: Good...to smooth out the bottom; I want to make sure you guys are paying attention.

….After the group finished, Ms. Jane furthered the discussion on their last statement regarding how much Nike spends on shoes…

Ms. Jane: And I want to take a look at that...$20 per pair. On your sheet you will find that it has a breakdown of how many it spends on its shoes. It says a total cost of $20, but that includes the production labor, so what would production labor be? Melvin...
Melvin: Them um, making it, like, the people that they like, they pay them stuff to make it.
Ms. Jane: Right, so for that it was $2.75 cents. For every shoe that someone makes, they are using about $2.75 for that purpose. The next one is for materials, what are materials? John
John: The things to make the shoe
Ms. Jane: Yep, the different things to make the shoe, Okay they said rent equipment. What do you think that is? Rent and equipment, John is the only one that knows? Rent and equipment, Faith
Faith: Like if you don't have the money, you can just use it, but you got to pay it slowly, like layaway.
Ms. Jane: For rent, on yeah renting, but what the equipment, what does it take to make the shoe? Brian?
Brian: Like the machine they use to smooth the shoe, the staff need to seal the shoe and the machine press it (referring to video from yesterday.)
Ms. Jane: Very good job, he was talking about those machines that we saw yesterday, like the pressure machine, those things that help those things down okay. And it says that that costs about 3 dollars for every shoe. What is the suppliers operating profit? What do you think that is?
Faith: Like the workers that make the shoe, like what they earn.
Ms. Jane: Okay, where do you think the worker's work to make the shoe?
Class: Like at a factory...
Ms. Jane: So overall, Nike spends about $20 per all the shoes they make…
John: What?
Ms. Jane: So why do you pay, $80, $90, $100, Brian?

When Ms. Jane made this last statement, her students became absolutely amazed by the amount it cost Nike to make sneakers but they cost a lot more in stores. Although the discussions were lengthy, Ms. Jane demonstrated her ability to actively listen to students' comments and answers. She also assisted her students in developing their overall perspective on the topic. This is one of

the constructivist views of learning. The discussion extended her students' knowledge of shoe design and enhanced their interest in the project. After the presentations, Ms. Jane provided the details of the sneaker design project (Appendix D). For the project, the students were instructed to design the side and bottom view of their shoe including the name, price, and type of sneaker. Below is an excerpt of Ms. Jane giving the details of the project:

> The design packet is very important: you will fill out the name of your sneaker, the price of the sneaker, remember when you are deciding the price, we talked about how much it takes to make a sneaker; how much profit you might want to make; what your customers might want; so you are going to think about that. You are also going to explain why you picked the price……in your design, find the length, the width, and the height of your shoe. I am going to put out a ruler and things for you to measure them...

The students were so excited about the project that they asked if they could go home and research different kinds of sneakers.

For this extensive project Ms. Jane allowed the students to work on the design for three days. During this time, the students were using the computers to come up with authentic sneaker designs, like special types of Jordans, LeBrons, and Nike's. For students who did not feel that they could draw, Ms. Jane provided sneaker design templates (Appendix D). While students were working, Ms. Jane was walking around questioning students on their decisions related to the price, type of material, and name of their shoe. The following excerpt provides insight on this dialogue with one student:

Ms. Jane:	How is it going here? What are you working on?
Brian:	Converse; I am going to make them rainbow. They are not supposed to look good, I know they don't.
Ms. Jane:	(giggle) What does that mean? Do you want them to look good?
Brian:	Yes.
Ms. Jane:	Do you think more people would buy them that way?
Brian:	Yeah.
Ms. Jane:	What are you going to call them?
Brian:	Converse rainbow.

Ms. Jane: Okay, converse rainbow.
Brian: And I am going to add more color.
Ms. Jane: Do you think that's what's going to make people want to buy them.
Brain: (nodding yes)
Ms. Jane: How much are you going to sell them for?
Brian: Like $15.
Ms. Jane: How much do you think it is going to cost to make them?
Brian: Um.
Ms. Jane: Remember what we read in that article.
Brian: Yes.
Ms. Jane: What did we read?
Brian: We read about all the stuff like the people that you have buy and you have to pay them for all that money.
Ms. Jane: Right, so how much did it cost per shoe? Do you remember?
Brian: $20.
Ms. Jane: $20, so if you sell yours for $15 are you going to make a profit?
Brian: $15...No.
Ms. Jane: Are you going to be able to make them, if they cost $20? Or you going to have to use your own money?
Brian: I will make them cheaper, by using cheaper stuff.
Ms. Jane: Oh, okay. How would you make them cheaper?
Brian: I can use colored pencils.
Ms. Jane: On a shoe, that would take a long time do though wouldn't it?
Brian: Yes, but I will have multiple people working on different sections.
Ms. Jane: Oh, okay, you are going to explain this to me in your design packet right?

This excerpt indicated Ms. Jane's ability to prompt students in reflecting on their own thinking. Through this dialogue, the Brian was able to think critically about his choice for the price of his sneaker. Ms. Jane's questions were informed by the whole class article discussion. In this dialogue, Ms. Jane demonstrated the ability to actively listen to students' comments or answers in a way to move learning forward.

The students presented their projects to the class on the sixth and seventh day. Before the presentation, Ms. Jane allowed the students to establish ground rules for being respectful while their classmates were presenting. Some of the rules included: (a) do not raise your hands when someone is presenting; (b) no talking while someone is presenting; (c) be attentive; and (d) instead of clapping at the end of the presentation, snap. Throughout the presentation, she

revisited these rules to ensure students were respectful. During each presentation, the students were responsible for actively listening to their classmates by filling out a sneaker presentation form (Appendix E) on every presenter. Below is an excerpt from one of the presentations:

Figure 14: Student Example of Sneaker Project

> My sneaker is a converse, and its $35. I chose this price because I wanted it to be cheap and because of the material I used. The width is 3.5 cm, the height is 5.0 cm, and the length is....I used rubber for the sole; I used memory foam for the sneaker's middle, and synthetic leather for the top. I used all those because I wanted the shoe to be comfortable. The three reasons you should buy the shoe is because they are comfortable, they are a good price, and they are a good style.

In addition to taking notes on the presentation, the students were responsible for coming up with questions related to the sneaker presented. For the presentation above, the following questions were asked:

> What did you put on the bottom of your sneaker?
> What is the price of your sneaker?
> Do they come in different colors? What type of colors?

The presentation above was from a female student. The purpose behind the questions at the end of the presentation was for voting preferences. At the conclusion of all presentations, the class voted on their favorite sneaker design. Therefore, the answers to their classmate's questions informed their choice. For one particular male presentation, a student asked, "Can you play

basketball in them?" And the male student responded, "Yeah, but they won't last long because the material is not for basketball. They are more of a style." This response indicated the amount of thought that went into some of the designs. Ms. Jane required the student presenters to explain and justify their choices. In addition, she required students to critique their classmate's reasoning. The major rule in voting was for no one to vote for his or her own shoe. After the class voted, the students were required to reflect on the project thus far. The reflection questions included:

a. How do you think you did on your sneaker design?
b. What did you learn?
c. How can mathematics be used in designing and manufacturing sneakers?
d. What did you like best about this project?
e. What did you like least about this project?
f. Any suggestions for Ms. Jane if you did this project again?

This concluded Ms. Jane's sneaker design lesson.

Mr. John's Week-long Lesson

The focus of Mr. John's lessons was on adding and subtracting integers. On the first day, Mr. John informed his students that over the next few weeks, they would be involved in lots of group activity. And, therefore, for bell work, he prompted them to come up with a class list of rules for working in groups. Each student was responsible for formulating two rules. Mr. John asked a few students to share their rules. Some rules included: (a) everybody working together; (b) working at the same pace; (c) get into group without complaining; (d) no talking off topic; and (d) concentrate on what you are doing. While students shared their ideas, Mr. John expounded on them by providing practical examples and asking questions. This is shown in the dialogue below:

Gabriella: Work at the same pace, without some people working ahead.

....

Mr. John: Good. I like that! A lot of times we have all seen it, we have all been a part of a group where you might feel left out, where you are doing your job in the group, or you are doing what you are supposed to, and the other group members are flying through it. Or some people are not doing what they are supposed to be doing and some people end up off topic, so you guys got to work at the same pace so everybody know what they are doing. What are some benefits of working at the same pace?

Maribel: Get the same answer.

Hannah: Look over each other's work.

Mr. John was demonstrating the ability to value his students' opinions. Before proceeding with his lesson on integers, he decided to give his students a pop quiz. While taking the quiz, Mr. John walked around the classroom to answer student questions.

On the second day, as students entered the classroom, they immediately began working on bell work. The bell work consisted of one problem, in which the students were tasked with describing a negative integer situation that could happen to them while in the mall with $100. His students provided some scenarios, which gave Mr. John insight into his students' backgrounds and experiences. In the following excerpts, student scenarios are revealed:

Mr. John: Okay, let's see what your classmates had to say about this situation.

Kevin: I am at the mall with a $100 and I get robbed.

Mr. John: Okay, so explain to me what would the negative integer be?

Kevin: Negative 100.

Mr. John: Negative 100 cause you got robbed? (gives high five) Okay, you gotta protect your money, you gotta put it in your pocket, leave it in your pocket. It's safe to put it in your pocket, cause to grab your money they gotta grab you or your pants, which is scary.

The class giggles...

Mr. John: Hernando, what do you think?

Hernando: You buy 2 games that costs $50 each, you buy both then you have -100.

Mr. John: Well can you give another negative situation that you could come up with that. You said you bought how many two?

Hernando: Yes.

Mr. John: So what would a negative situation be with 1 of those games?
Hernando: You could be -50.
Mr. John: Very good, I like that, Imari?
Imari: You buy some clothes that cost 110, but you only have $100 on a card so you will end up with -10 in the account.
Mr. John: That's a very good example. Let's do one more.

From these examples, Mr. John demonstrated the ability to understand student perceptions and perspectives. Students' perspectives shape their students' funds of knowledge. He showed having a sense of humor, which is indicative of the rapport that he had with his students. After allowing a few students to share, Mr. John transitioned to the lesson on adding integers. He directed the students to get into "quick groups" (pairs) and then into groups of four. The students were used to this transition and it happened quickly without disruption, which indicated good classroom management. Before going into the lesson, he explained that the order of note taking would be a little different from previous lessons. Mr. John's explanation is provided below:

> You guys are going to be adding integers today. But this is going to be a little bit different. Usually we put up notes, right, I show you how to do it; you guys copy them down, we do some problems... Today, I am not going to put up anything. What we are going to do, I am going to leave it up to your group to come up with today, how to do today's lesson. You guys are going to come up with the steps, you guys are going to come up with exactly how to do today's problems just by using these objects I'm going to give you a second. So it's going to be a little different. You are going to struggle a little bit, but you have yourself and your group members to help you along. Okay!

Mr. John expressed a little anxiety regarding this change in his lesson delivery; however, it didn't stop him from proceeding with the lesson as planned. His expectations of his students were indicative of his confidence in his students' ability to derive the rules for adding integers by reasoning with counter chips. Within groups and using manipulatives, the students were tasked with making sense of the following problems:

1) -4 + 3 2) -3 + 6

Before they began, Mr. John reminded them of the group rules that they created the other day. In addition, he provided them with some specific instructions related to using the counter chips. The instructions are provided in the excerpt below:

> These are called counter chips. One side of the chips are red, and the other side is white. That's because these chip represent integers. So listen very carefully, here is your instruction ...how to solve these problems is completely up to you, but you have to use the chips to solve the problem. When you decide in a group and agree how you are going to solve the problem with the chips, I want you to draw or come up with some kind of graphic steps to show how you solved the problem using the chips…..The only other instruction I am going to give you is to solve these problems the red side of a chip represents one negative number. The white side represents one positive number. ...The only other thing I am going to tell you about these chips is if you have one red chip and one white chip, you can stack those together and they cancel each other out. They are gone (makes a relation to checkers).

Instead of Mr. John allowing the students to explore the chips and come up with their own way of reasoning about the chips, he did that for them. This is an example of providing too much information. By giving these rules, Mr. John gave the students specific parameters for using the chips. While the students were working in their groups, he walked around checking on the progress of some groups. Below is an excerpt of Mr. John working with one group that immediately figured out how to solve the problems using the chips:

$$-4 + 3$$

Mr. John:	So what are guys doing here? Why do you have 3 white chips?
Leader:	Because that's how many positive numbers there are.
Mr. John:	What about the red ones?
Leader:	Negative numbers.
Mr. John:	So how many red ones?
Leader:	4
Mr. John:	Do you all agree with that?
Group:	...says yes.
Mr. John:	So what do you do next?
Leader:	You cancel them out (Student is literally grouping red and white chips to cancel out one by one while group members are watching) And you have

one positive left.

Mr. John: What do you guys think? (Group members nod their heads indicating agreement.)

Mr. John: So Luis, what do you think? What did he just say?

Mr. John prompted the leader of the group to explain his group's reasoning. He also checked with the group members to see if they agreed, by asking, "do you all agree?" and "what did he just say?" This demonstrated his ability to facilitate students' actively listening to and critiquing one another. In the next excerpt, Mr. John struggled with a students' desire to use context for the same problem (-4 + 3):

Mr. John: Why are we cancelling chips out here?

Mikayla: If I am in debt 4 dollars, and I add 3 dollars to my bank account. That will cancel out three of the 4 dollars because I added 3 dollars.

Mr. John: Why are you canceling out?

Mikayla: Because I paid the dues.

Mr. John: Not with money.

Mikayla: Because I added the positive numbers to the negative numbers.

Mr. John: I still don't understand how that's cancelling out?

Mikayla: By putting an x through it.

Mr. John: No, why does one positive cancel out one negative.

Mikayla: Because a positive is adding and a negative is subtracting.

Mr. John: You are still being too vague.

Mikayla: Can anyone help me *(asking her group members to help her out).*

……

Mikayla: Because they are the same number of places from zero; if you have one positive number and one negative number.

Mr. John: How many is this *(hold up one red and hold up one white*)?

Mikayla: 1 and -1; because a positive one beats a negative one.

Mr. John: What do you mean beats, are they racing? They don't have legs.

Mikayla: This one erases this one.

Mr. John: Why?

Mikayla: Because 1 and -1 equal one whole.

Mikayla: Because positive one is a whole and negative one is deprived of that whole, so when you add the whole to it, you get 1.

Mr. John: Are you saying 1 plus negative 1 = 1

Mikayla: No, negative 1 plus 1 = 0

Mr. John: That's what I was looking for.

From this excerpt, it was clearly evident that Mr. John was looking for one answer. However, the student was confused regarding what he was asking. Based on her responses, she had

answered his question a few times using context, but he did not want context. He wanted her to say that cancelling out chips indicate zero. This suggested Mr. John's closed-mindedness in relation to this activity. He had a predetermined way of describing combining one and negative one and wanted the students to follow suit. This will be further highlighted in the next few excerpts.

Using "hip-hop slang," Mr. John stated, "all eyes on me," to focus his students' attention to the front of the classroom. Hip hop is a genre of music that includes a mixture of R&B and Rap; so, using "hip-hop slang" Mr. John refers to lyrics from a hip-hop song or rap. In this observation, Mr. John demonstrated the ability to validate his students. As a whole group, they reviewed the answers to the first two problems. Mr. John called on different groups to share their answers. For problem one (-4 +3), there were two different answers given, a positive one and a negative one. Mr. John polled to see which groups agreed with positive one and which groups agreed with negative one. Two groups got positive one and three groups got negative one. Mr. John asked one of the groups that agreed with positive one to reveal how they got it using chips. When the group began to demonstrate, they immediately realized that they were wrong because they had mixed up the color of the chips. Mr. John demonstrated the ability to see his students' actions develop their overall perspective; this is related to the constructivist view of learning. He also demonstrated the ability to facilitate students' reflecting on their own thinking. For the remainder of this lesson the group explored two more problems.

3) 5 + (-2) 4) 1 + (-3)

Again, the students worked together in groups and shared out their answers to the whole class. For problem three, Mr. John called on a group that could not agree on an answer. This group consisted of one male and two females. The females argued that the answer was negative seven

while the male argued that the answer was positive three. Mr. John polled the class to see what the other groups agreed with. All of the other groups agreed with positive three, so Mr. John asked the male student to demonstrate using the chips. He demonstrated the answer correctly and explained his reasoning. Mr. John agreed and said, "Excellent job". He missed the opportunity to clarify the female students' misconception. For homework, the students worked on more adding integer problems using chips. A sample of one student's homework is below:

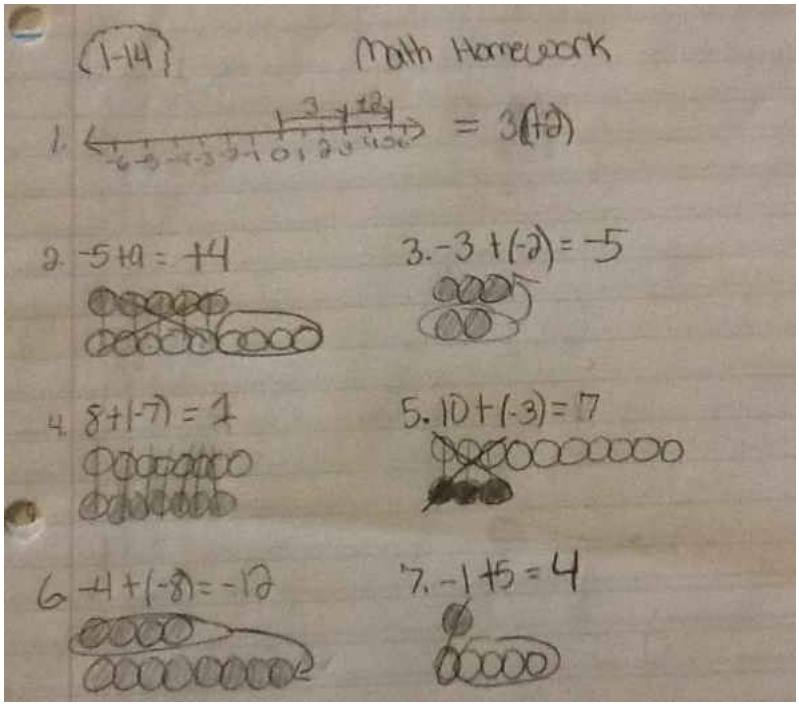


Figure 15: Sample of Student Homework

On the next day, the students were directed to discover steps for adding integers. A description of the bell work is below:

a. Take out your notes from yesterday and answer the questions on the overhead into your notes.

b. What happened when I added integers that had different signs? How did I get the number part of the answer? How did I know if my answer was positive or negative? (Problem 1-4).
c. What happened when I added integers that had the same time? (Problem 5-6)

Mr. John made following the statements:

> These two questions are going to help us come up with the steps that we can use to solve integer problems without the chips. Think about: What can I do or how can I solve the problems we worked on yesterday without using chips or the number line without using any kind of pictures or objects. What are some similarities between the answers you got yesterday?

After allowing about 10 minutes for students to ponder over the steps, Mr. John conducted a lecture on adding integers. He prompted his student to discover patterns from their notes on the previous day. Using the first problem from the day before (-4 + 3 = -1), he posed the following questions:

> How can I get the number part of this answer without using chips?

One student attempted to answer the question; however, her response confused Mr. John and the whole class. This dialogue is provided below:

> Isabel: By adding...from 3 to get 4.
> Mr. John: Did you say by adding?
> Isabel: What number would get 4.
> Mr. John: Who can add to what she just said? Let's piggy back off what she said. Can anybody add to that?
> *....No one answers or raises their hand...*
> Mr. John: Okay, let's try a different idea. What did someone else come up with?

After getting a few unsuccessful responses, he decided to switch to a different question:

> How do I get the negative part of my answer?

The class was struggling with making sense of what Mr. John was asking because he was separating the sign and the number to formulate the rules for adding integers. This could be a result of not connecting the concrete (the counters) and representation (the drawings of the

counters) to the abstract (rules for adding integers). This progression is important when building foundational concepts. After probing for a while, one student finally stated what he was looking for:

> Since 4 is bigger than 3, you keep the sign of the bigger number.

Instead of allowing the students to elaborate or restate what was said, Mr. John stated, "That's exactly what I am looking for." This was a missed opportunity especially with the fact that the class was struggling. From there, Mr. John was able to finish the notes for adding integers. The notes are provided below:

Table 19: Mr. John's Rules for Adding Integers

Adding integers with different signs:	Adding integers with the same signs:
1st: Keep the sign of bigger number 2nd: Ignore the signs and subtract the #'s	1st: Keep the sign of both numbers 2nd: Ignore the sign and add the #'s

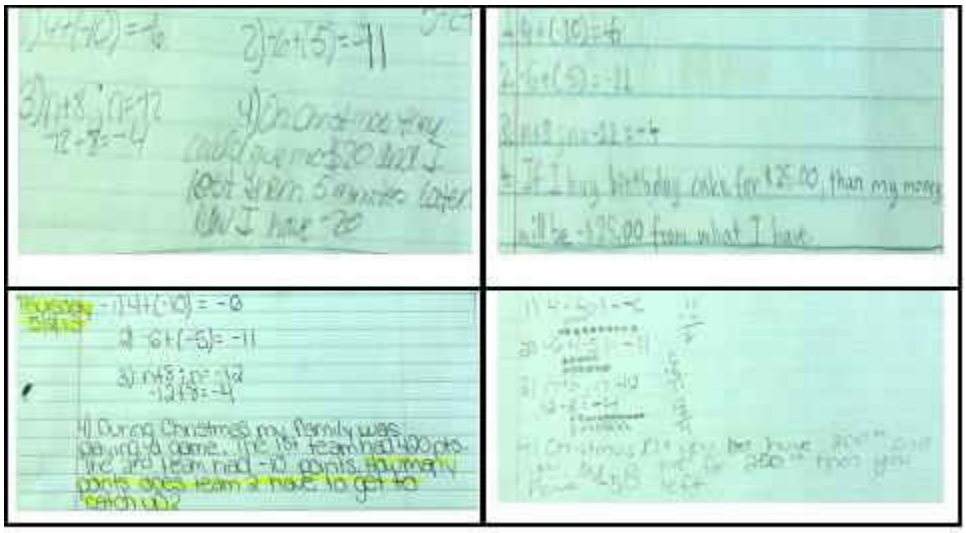
To practice using the notes without chips (using rules for adding), Mr. John provided the class with new problems to explore.

The goal of the fourth day was to explore the concept of subtracting integers. In the bell work, Mr. John provided the class with addition problems to review what was taught the day before. He gave the students a choice for how to solve the problems:

> For today's bell work, I am going to give you a choice. You can solve it using the chips or you can solve it using the steps that we came up with yesterday.

Mr. John wanted to see how many students would use representation versus steps to solve the problems. He noticed that many of the students used the steps that were developed the day before to solve the problems from bell-work.

Table 20: Samples of Students' Bell-work



In the table above, only one student used the counters. When going over the bell work, Mr. John devoted little time to reviewing it. He asked students to write their answers on the board, but he did not require them to explain. However, someone wrote the wrong answer for problem number one (4 + (-10) = 6). In the following excerpt, Mr. John facilitated students' reading the arguments of others to see if they make sense.

Mr. John: For problem number 1, Amber wrote +6. How many people agree with number 1?
7 hands go up...
Mr. John: How many people disagree?
More hands go up!
Mr. John: Tyquan, why do you disagree?
Tyquan: I got -14.
Mr. John: -14; how many people agree with that?
No hands go up...
Mr. John: Woo lordy...(*students giggle)* Who disagrees and got something different besides -14 and +6? Melvin?

Melvin: -6.
Mr. John: Melvin got -6, how many people agree with that?
Lots of hands go up?
Mr. John: Okay, let's see whose right. We got three different answers. Who can tell me, what are my rules for adding integers with different signs? Shanna, go ahead.
Shanna: Take the sign of larger number and subtract the two numbers.
Mr. John: Very good. Who can tell me what she just said, who was listening? Isabel?
Isabel: She said...take the sign of larger number and subtract the two numbers.
Mr. John: Perfect. What's the sign of the larger number?
Class: (-).
Mr. John: Okay. Now, ignore the signs and subtract the numbers. So what do we get?
Class: -6.
Mr. John: The answer should be -6, so if you did not get that you need to make the change in your bell work.

In the above excerpt, Mr. John missed the opportunity to facilitate students' engaging in critiquing the reasoning of others. Instead of having students make sense of wrong answers, he referred to the rules of adding and the correct answer. The last problem of the bell work allowed students to share something from their home culture and connect it with a negative integer. The question asked the students to describe a negative integer situation that could happen during their favorite holiday. The student responses were very similar to the mall situation from the second day. One student referred to running out of plates for hot dogs at a family barbeque. Another student referred to going over her budget when buying Christmas gifts. Mr. John embraced their situations by giving them a high five after they shared.

During the transition into the lesson on subtracting integers, Mr. John directed the students to get into quick groups (pairs). He explained that working in pairs, the students would draw out the chips to solve the problems. His explanation is below:

> Today is going to be different. Last time you guys used chips, this time you don't. Today you guys are going to be drawing the chips on the white board. I am going to give you guys a problem. I want you and your partner to come together and come up with a way to draw or describe the problem that I give you using chips on your white board....One rule...I am going to let you guys struggle a little bit like you did two days ago in our

groups of 4. I am going to give you one instruction and one instruction only....You cannot cancel out chips today. That's all I am going to tell you. Now, I am going to put up a problem.

1) 4 - 3 2) -3 - (-1)

Mr. John clearly wanted his students to demonstrate subtraction. To demonstrate it, students needed to use chips to represent the minuend (the start) and chips away from it. Instead, many of the students made the mistake of representing both the minuend and the subtrahend (the change). This is evidenced in the excerpt below where Mr. John helped two male students make sense of subtraction.

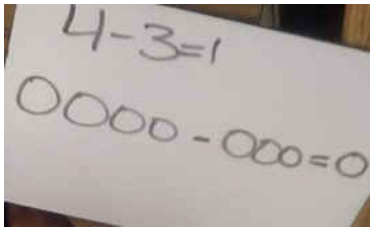


Figure 16: Example of Group work for 4-3

Mr. John: So what did you guys think? So, explain what you guys did here?
Melvin: This is the 4 and this is the 3, then we subtracted and got 1.
Mr. John: Well show me how you subtracted. I just see 4 white chips and 3 red chips. I don't see how you guys subtracted; I don't see where one is left over. ……You and your partner talk about that. I will be back to check on you.

As he walked around, he observed many groups doing the same thing. When reviewing the problem as a whole class, Mr. John asked the groups to hold up their white boards to display their solutions. Then he demonstrated how the students should be subtracting three from four by posing the question to the class, "How am I going to show taking away three." The class walked him through the demonstration at the board. The picture below shows the result of taking three from four.

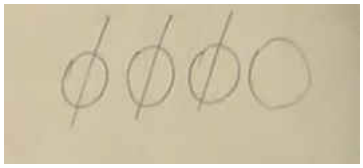


Figure 17: Mr. John's Demonstration of 4-3

Mr. John wanted the students to be clear on how to demonstrate subtracting chips before moving onto problem two (-3 – (-1)). While working on the next problem, he found some students not following the demonstration from the previous problem. This is evidenced in the excerpt below where Mr. John helped two female students make sense of subtraction.

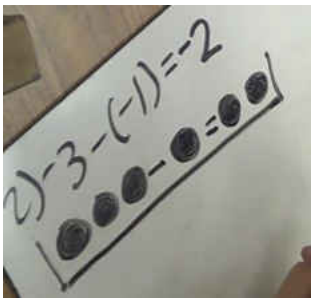


Figure 18: Example of Group work for -3-(-1)

Mr. John: How are we doing over here ladies?
Ladies: Good.
Mr. John: Okay, show me what you got.
Ladies: We kept the sign and subtracted 1 to get -2.
Mr. John: This is a good representation of chips but it's just showing that you show the Integers; however, it does not show me how you got this answer. Do you see what I am saying? How can I go from the first pile to having this amount left? That's what I want you to think about. I am going to come back and check on you.

When Mr. John came back to check on the female students, they changed their diagram to show subtracting -1.

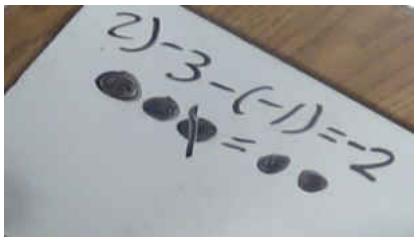


Figure 19: Second Example of Group work for -3-(-1)

Mr. John gave the girls a high five for getting the correct answer. In order to bring the class back together, Mr. John used the following phrase "hip-hop" and the students replied "hooray". This is indicative of the classroom culture that he has established in his classroom and his call-response system to gain the attention of his students. He reviewed the problem (-3 – (-1)) with the whole class. For homework, the students were expected to use pictures of chips to compute subtracting integer problems.

On the last day, Mr. John spent the class period reviewing problems from the bell work. The problems from the bell work assisted him and the students in formulating the rules for subtracting integers. The bell work consisted of the following problems:

1) -6 + 9 2) -10 – (-4) 3) 5 – 10 4) -4 – 2

Mr. John instructed the students to use pictures (representing chips) to show their work for each problem. Before reviewing the problems from the bell work, he instructed the students to get into quick groups (pairs) to compare their answers. This facilitation supports students' engaging in critiquing the reasoning of others. Mr. John reminded the students of not cancelling out when subtracting, rather crossing out. While walking around, he assisted a student having trouble with problem three (5 – 10) because she did have enough to cross out. In the following dialogue, Mr. John used context in order to help the student make sense of subtraction.

Raquel: How can we do number 3 if we you can't subtract 10?
Mr. John: So, How can I represent the first integer with chips? Let's do it that way first.
..Raquel writes down five white chips...

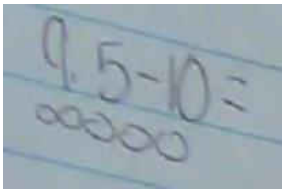


Figure 20: Raquel's Demonstration for 5-10

Mr. John: Okay then, the subtraction means we can do what with those chips?
Raquel: *silence*
Mr. John: What did we talk about yesterday?
Raquel: Crossing out.
Mr. John: Okay, you cross out how many?
Raquel: 10.
Mr. John: Go ahead and do that see what happens.
..Raquel crosses out 5 because that was all that was available…

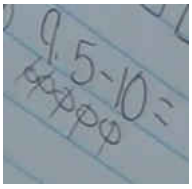


Figure 21: Raquel's Second Demonstration for 5-10

Mr. John: Okay, I still need to cross things out, and there nothing there....Is there anything I can add to that?
Raquel: Positive numbers.
Mr. John: Well if these were positive numbers to begin with……And let's say this is worth +5, 5 dollars but you need about 10 dollars, you crossed off the 5 you had, what kind of chips can you add that we can..
Raquel: Negative.
Mr. John: Ooh..negative chips, how many negative chips will we have to add to that?
Raquel: 5.
Mr. John: Good, let's do that.
Raquel draws 5 shaded chips indicating negative 5.

Figure 22: Raquel's Third Demonstration for 5-10

Mr. John: Now, what do you have left over?
Raquel: -5
Mr. John: Good, so, that's what you can do when you run out of chips to cross out, you always add the opposite chips to it.

Raquel: Okay

The use of context assisted the student in understanding how the answer would be negative 5. As he walked around assisting other students on this exact problem, Mr. John had to resort to the use of context over and over again to help his students demonstrate subtraction using counter chips. He used the context of owing money to your mother. They got it immediately.

After allowing the students to work with their partners, he decided to have the pairs share out to the class. He selected specific pairs to present their solutions at the board. The pairs had to draw out their explanations and explain their reasoning to the class. Instead of having the class critique the problems presented, Mr. John asked questions to move learning forward. Below is an example of that dialogue:

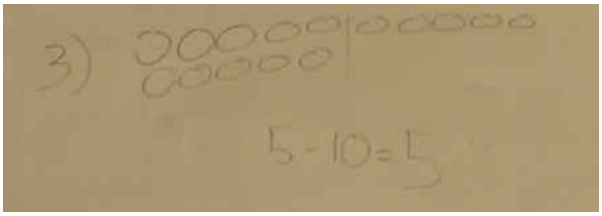


Figure 23: Michelle's Demonstration for 5-10

Mr. John: So what did you do?
Michelle: I have 10 positive cause there are 10 positive cause there are 10 positive and 5 underneath; I evened it out, so I can have these all together and these left over. the ones that are left over a positive.
Mr. John: So let me ask, what do we start off with?
Michelle: 10...well 5.
Mr. John: When you subtract, are you allowed to change the order?
Michelle: No.
Mr. John: No, so what's a good number to start with.
Michelle: 5.
Mr. John: So let's try that. Let's start with 5 on top.
…Michelle modifies picture to start with five on top
Mr. John: Now, what does subtraction sign mean, what did Michelle tell us the subtraction sign means when you are dealing with chips.
Michelle: To cross out.
Mr. John: Okay cross out, let's try crossing out 10 and see what we get from the 5 you have on top.
…Michelle crosses out...

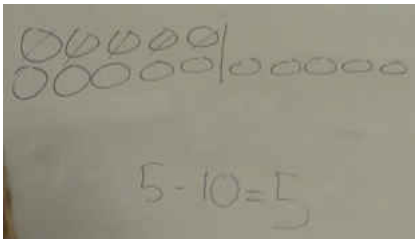


Figure 24: Michelle's Second Demonstration for 5-10

Mr. John: Aww…..we run into a problem right, so let me give you a scenario with this problem: If you have 5 dollars in your pocket, we will say that is what the five white chips stand for at the top. But, you owe our mom 10, so when you walked in the door from school today and your mom was expecting that 10 dollars. So lets' say those five chips represent the five chips in your pocket, you just crossed them out, what is the only thing you can add to those five chips that are going to give a good answer of what you are going to have left over

Michelle: Part of the 10

Mr. John: Okay, so what part of the 10 are you going to put up there?

Michelle: 5.

Mr. John: But, are you going to have 5 in your pocket when you are done giving your mom 10?

Michelle: No.

Mr. John: So what kind of 5 are you going to have

Michelle: Negative

Mr. John: Oooh...so how are we going to show that with pictures...well let me ask you guys (the class). What is something she can do, since she has crossed off the five chips, she still needs to cross off another five. How can she show that since she doesn't have any more chips to cross out?

...Below is a picture of the solution that the class agreed upon…

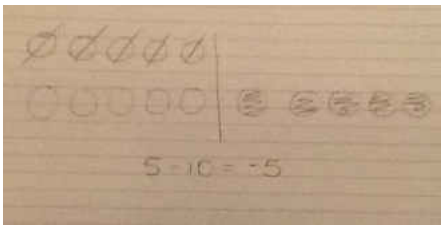


Figure 25: Michelle's Third Demonstration for 5-10

Mr. John showed his ability to move learning forward through the use of questioning. Not only did he use questioning, but he also used context, which is something he did not plan to use in the lesson. For example, he allowed the students to use context in their scenarios for bell work,

however, for the lessons, context was not used. The use of context assisted the students understanding subtraction. On the other hand, in the next excerpt, Mr. John did not resort to context. Because of this, his students struggled with understanding subtraction without having positives to begin with.

-4 – 2

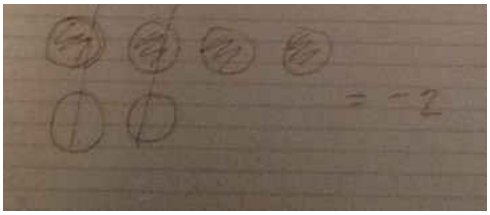


Figure 26: Maribel's Demonstration for -4-2

Mr. John: Okay, so show me what you did?
Maribel: I did 4 negatives and 2 positives and then I crossed out the 2 negatives and 2 positives.
Mr. John: Are we allowed to do that? Are we allowed to cross off one negative chip and one positive chip?
....Silence…
Mr. John: I am just asking.
....Silence…
Mr. John: I like what you did with the picture, you have 4 negative chips and 2 positive chips. But are we allowed to cross off a red and a white chip?
...silence....
Mr. John: Let's take a vote. How many think we are allowed to cross off chips here? How many people say yes?
....No hands raise…
Mr. John: So if we are not allowed to do that...what's the only thing we can do? Cause we can't cross things out, lets help Maribel out with this?
Amy: You have to add 2 positive chips, but you can't add them positive, they are going to have to be negative because….
Mr. John: Woo..you are confusing me and everybody else. Let's try to be real simple. Since I cannot take away chips here and I cannot cancel things out, what can I do? Like in 5 words…
Amy: *(counting her fingers)* You have to add 2, I mean subtract two positive chips.
Mr. John: You have to subtract chips. We just said we can't do that and we can cancel things out, why can't I cross off any of the white or shaded chips?
Amy: Because you didn't have two positive to start with, so how can you add, I mean subtract 2 positives when you didn't have 2 to start with

Mr. John: That's what I am asking you, that's what I am asking the whole class. Poor Maribel, we are trying to help her, but you guys are not doing that you are making it worse. Remember with subtraction we can only cross things out we cannot cancel, what was the rule for crossing things out?

Ryan: …You can only cross out negatives with negatives and positives with positives.

Mr. John: The only thing you can do is add. The answer is -6

…Below is a picture of what was left on the board after the discussion…

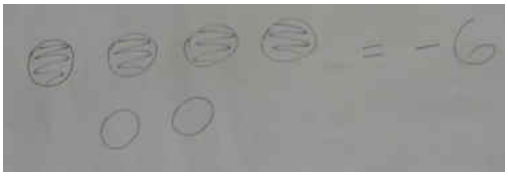


Figure 27: Mr. John's Demonstration for -4-2

Another major point in both excerpts is the misconception of the teacher on his use of the counter chips to demonstrate subtraction. The misconception only surfaced when working with specific subtraction problems. After reviewing bell-work, Mr. John transitioned the class to note taking for subtracting integers. He used the answers from the bell work to derive the rules for subtracting integers. He calls it "Same, Change, Opposite"; he related it to dividing fractions (Keep, Change, Flip). He stated that in dividing fractions, we resort to multiplying because it is easier to multiply. It is the same for subtraction. We resort to adding because it is easier to add. He demonstrated use of the subtraction algorithm with the very last problem (-4 – 2); this problem became -4 + (-2). The class agreed the answer is -6.

Student-to-Student Interactions

Within Ms. Jane's week-long lesson on designing sneakers, organized student-to-student interactions did not take place. However, interactions between students were captured in Mr. John's classroom. Throughout the week-long lesson, he directed his students to work in groups of two, three, or four. Below are two excerpts of students collaborating with one another: (a) the

first one consists of a group of girls discussing -4 + 3; and (b) the second one consists of a group of three students (one girl and two boys) discussing problems from bell-work (provided below).

-4 + 3

Excerpt One

Amy: It's gonna take away one of the negatives because 4 minus 3 equals -1.
Raquel: Are you sure your thoughts right?
Amy: Yeah, seriously!
Mikayla: Okay, it will be -1
Amy: Yeah, that's what I'm saying…there is only 1 left.
…Pausing to draw out chips…
Isabella: There will be 6, 3 positives and 3 negatives, so how would that equal 1?
Amy: Look! There are four chips (drawing them on paper). If you have a debt of $4, but you add 3 to your bank account, you are going to have 1 more of the debt left, which is -1.
Isabella: Oh, I see.

Bell-work
1) -6 + 9
2) -10 – (-4)
3) 5 – 10
4) -4 - 2

Excerpt Two

Casey: Positive 3; Positive 6 for number 2; number 3 is negative 5.
Kelvin: How did you get 6 for number 2.
…Pause…
Roberto: No it's not negative 5, it's only 5 minus 10.
Casey: 5 minus 10, how can you do 5 minus 10. It's 10 minus 5; wait, 5 minus 10.
Kelvin: You guys don't remember, they said always do the biggest number and subtract it by the smallest number.
Casey: Nope, it's going to be a negative number.
Kelvin: It will?
Casey: Yeah, You can't take away 10 from 5
Kelvin: You are right.
…Pause, Roberto doesn't agree; group converses with Mr. John; he redirects them to explain their thinking to each other…
Casey: It think it is negative 5 because if you have five, and you subtract 10 from 5, that takes care of 5 of those (demonstrating with pictures of chips). But then you are going to have negative 5 left because there are no more whole numbers
Roberto: Yeah, the only problem for me is I don't know for sure 5-10, but if we…(writing 10 minus 5 on mini white board).

Casey: You switched it around but it is not switched around; 5 minus 10 is not 10 minus 5.
Roberto: You are right.

Both excerpts are indicative of Mr. John's increased ability to facilitate students' engaging in constructing viable arguments and critiquing the reasoning of others. They are also indicative of Mr. John's students engaging in practices consistent with SMP3. The following SMP3 indicators were employed by Mr. John's students during student-to-student interactions: (1) justify solutions and communicate them to others; (2) ask careful questions to clarify the arguments of others; (3) use definitions and previously established results; (4) read the arguments of others to see if they make sense; (5) actively listen to the arguments of others; (6) recognize and use counter examples and (7) respond to the arguments of others. Although the degree to which these indicators were employed varied, the students demonstrated "somewhat" of an ability to engage in SMP3.

The above instructional realities provided insight into Ms. Jane and Mr. John's week-long lessons. The next section provides insight into Ms. Jane and Mr. John's perceptions of these realities.

Teacher Perception of Their Realities (Informal Interviews & Journal Prompts)

Planning with Students' Cultures in Mind

Both participants displayed some aspects of CRT teacher characteristics and facilitated some aspects of CRT instructional practices. However, they implemented them in different ways. The focus of Ms. Jane's lesson was centered on her students' interest. On the other hand, the foci of Mr. John's lessons were on integers where at different times he incorporated his students' cultures into his lessons. During PD, Ms. Jane often asked about ideas of getting to

know her students. While planning the week-long lesson, she took the time to converse with her students and gain knowledge of their interests. This was evidenced in the excerpt below from an informal interview:

> …I talked to them. During standardized testing it was a little bit easier. We played Catch Phrase, so I had them in a big group and we played Catch Phrase and it was really surprising how some of them I thought would participate and some of them I thought wouldn't and they really did so they were trying to like guess the word and stuff and then we played charades and stuff, and I really have just kind of talked to them. I didn't set up a formal survey or anything but just kind of got to know them a little bit that way I guess like an informal survey.

While getting to know them, she learned that they took interest in sneakers, sports, and sports' celebrities. As a result, she decided to combine those topics into one lesson, while at the same time "show off their personality". Ms. Jane provided this phrase in the following journal prompt response, which asked her to describe the CRT instructional strategies used.

> I tried to get to know my students and relate to them and I have learned they are really into sneakers and sports so I tried combining the two. Also used a way they can create their own to show off their personality.

Prior to and during PD, Mr. John demonstrated knowledge of his students and their abilities. However, he expressed not actually incorporating their cultures into lessons. When he did he felt that he learned a lot about his students and his students learned a lot about each other. This was evidenced in the excerpt below during an informal interview:

> When I first started participating in this study, I had no idea that asking questions about math and a student's culture would open so many doors for them into their learning realm. But it really does. The first time I asked questions about math and culture was during a bell work assignment that I gave shortly after I learned about culturally embedded questioning. Students were asked "what 3-D shapes do you see or notice around the house during your favorite holiday or special celebration that you and your family participate in?" Right away I noticed student faces start to light up and really think about what was being asked. It was taken one step further when we started sharing answers with one another…Students also got to learn from one another because different

> holidays from different cultures and brought to light the different cultures that existed in the classroom and how 3-D shapes were connectors between those cultures.

As a result of this experience, Mr. John decided to include questions about students' cultures within bell work activities for the week-long lesson. In the following expert, he expressed how he used bell work to connect with his students' cultures:

> So bell work is rather trying to really connect those questions with their culture. Like yesterday we talked about if they have money to spend in the mall, and they can go anywhere they wanted so they take their pop culture into effect. You know like they can go to the music store. If they were into shoes, they could go to the shoe store. So I want to give them a good amount of money that they can buy things that they're into….So like I had people buying shoes. I had people buying outfits. I had people buying CD's, video games… So that's how I tried to pull culture through the bell work. And to really make them think about the lesson in the real world situations and to pull from their culture…. Like I wanted to give them questions that gave them freedom to really think about what I was asking. To think about how, what we were doing in class ties in to real world situations and like to pull that culture in.

When describing their ability to use CRT, both participants addressed the description differently. Ms. Jane felt that she was average in her ability to use CRT. She described that the use of her sneaker design lesson had a major impact on her students' engagement and attentiveness. Below are a few of Ms. Jane's comments from her journal prompt:

> Helped get students interested and view math in a real world situation.
>
> They really enjoy sneakers and process of things which helps attentiveness and engagement.
>
> Think they are pretty engaged in designing their sneaker and thinking about the process of how to design a sneaker.

When rating herself on her ability to use CRT to support student engagement on a scale from one to five with five being excellent, she rated herself at three, which is considered average. Mr. John rated himself as average as well. However, in his description, he felt that he needed to

improve upon it more. He described that the more he used it, the better he would get at it. Below are few of Mr. John's comments on his journal prompt:

> Since I am still learning a lot about CRT, I still need plenty of improvement but as each lesson passes I feel I get better and better with CRT.
>
> I try to incorporate what students' like into my lessons and planning such as music, movies, video games, etc. I still have a lot to learn, but that is what it takes to get better.

The difference in their comments may have to do with how they planned lessons with students' interest in mind.

Facilitating Mathematical Task that Support SMP3

Both participants described ways that their students engaged in SMP3 throughout their week-long lesson. In the daily journal prompt, they rated their students' ability to construct viable arguments and critique the reasoning of others. On a scale from one to five with five being excellent, Ms. Jane rated her students with a two on their ability to construct viable arguments. Her daily description is provided in the table below (*descriptions are sequenced including daily ratings*):

Table 21: Ms. Jane's Daily Ratings on her Students' Ability to Construct Viable Arguments

Day	Descriptions	Ratings
1	How they collected data, but could have asked better questions to let them explain why they used the method they used-I didn't give them much choice.	2
2	When talking with their partners about the article (could have had specific questions). Also class discussion and questions asked, for example, If it only costs $20 to make a shoe, why do you pay $80.	2
3	As students worked together and I came around, some of them were able to answer my questions and come up with why? For example, why they picked the price that they did?	2
4	When explaining how they were designing and manufacturing their shoe. For example, one student was talking about the investment he wants to make and how he needs commercials, etc. to make it popular for people to buy.	2
5	Talked about the different prices they wanted to use for their sneaker and why. For example, wanted to be 250, allow only cost 50, so they can make more money and be able to make more shoes.	2

As Ms. Jane reflected daily on her students' engagement in constructing viable arguments, she became a little more descriptive by providing examples of how her students engaged in the practice. She also reflected on her practice by suggesting how she could have enhanced her students' engagement in constructing viable arguments. In an informal interview, she elaborated more:

> I don't think I did as well as I could have done because I was thinking about it because I was reflecting yesterday about the things I did, well the sheet (*referring to journal prompt)* that you gave us, and I could have been better ….When I showed like the way that they categorize, like did their display, why they chose that? I didn't do that well, which I realized after the fact. (Laughter). But like why they chose to put in a table. Like that way they would justify their answering and I know that they did it a little bit when they were working together as a partner but I didn't facilitate that talk very well, if that makes sense?

In this excerpt, Ms. Jane is referring to the first day when she instructed her students to work in pairs to collect and display data. Although her students engaged in constructing viable arguments, she felt that her teaching practice did not facilitate the process well. As a result, it is

evidenced in the latter descriptions as to how she tried to improve upon her ability to facilitate her students' constructing viable arguments.

Similarly, when rating her students' ability to critique the reasoning of others, her rating varied. On the first day, she did not provide a rating as she wrote, "Not sure." In her description for that day she explained, "I didn't create much of a way for them to do this; kind of when working with their partners and deciding what to do with their data." Ms. Jane's reflection on her practice is evidenced again. Although her students may have critiqued each other's reasoning by deciding how to collect and display data, Ms. Jane was not deliberate in her facilitating them to do so. On the next days, she rated her students' ability to critique the reasoning of others with a two with the exception of a rating of three on day three. Her daily descriptions from the journal prompt are provided below:

Table 22: Ms. Jane's Daily Ratings on her Students' Ability to Critique the Reasoning of Others

Day	Descriptions	Ratings
1	I didn't create much of a way for them to do this; kind of when working with their partner and describing what to do with their data.	Not sure
2	Able to do this in partner work, could have gone better; will improve with time as students work together more.	2
3	They did pretty well telling others what they thought and their reasoning for it.	3
4	When working together each make arguments about why they want to design their shoe and what materials they want to use.	2
5	When designing, they asked others about their opinion and what they would do.	2

When designing they asked others about their opinion and what they would do.

In the latter descriptions, Ms. Jane was referring to her students working on their sneaker designs. She gave her students three days to complete the project. During that time students were conversing and working on their design. Ms. Jane walked around listening to her students'

conversations to identify times when her students engaged in critiquing the reasoning of others. Therefore, in the descriptions above, she was general rather than specific as she did not connect the student engagement practice to a specific time during instruction. In an informal interview, Ms. Jane was asked to reflect on her students' engagement in SMP3 over the week-long process. Her response is below:

> (*Referring to constructing viable arguments*) I would say they did ok. I don't think they did fantastic but when they were telling me like about the pricing thing, like why they wanted to pick, some of them did give me a variable like I want to make an investment. I want to be able to buy commercials and I want to be able to do these things…Some of them, well I want to sell mine for $9.99. I'm like ok, but how are you going to make the shoe? Like well I want it to be cheap because I want everyone to buy it…..So those kinds of things so I think that they did a little bit better because they've never really been I guess given the opportunity. I mean they have but not in that loose way.
>
> (*Referring to critiquing the reasoning of others)* They did ok when they were talking about it in partners. It wasn't very structured I guess I would say. Like they didn't actually have like a discussion but I also think that they did get to kind of have a discussion during the articles, when they picked what they would share, when they picked how they would organize the data in the beginning, and how they wanted to display it. But putting them in groups more would help them with that.

In both responses, Ms. Jane concluded by reflecting on her instructional practice. By giving her students the opportunity to construct viable arguments during an open-ended task, she felt that her students did okay. By putting them in groups more, students would be able to critique the reasoning of others in a more structured way. While describing her students' engagement in SMP3, Ms. Jane consistently referred to her practice.

In Mr. John's journal prompt, he provided varied ratings on his students' ability to engage in SMP3. The daily ratings for constructing viable arguments were two, one, four, and four, respectively. Mr. John provided daily descriptions in his journal prompt, which is provided in the table below:

Table 23: Mr. John's Daily Ratings on his Students' Ability to Construct Viable Arguments

Day	Descriptions	Rating
1	*N/A – Test given on this day*	
2	During their group activity, students had to draw a picture or visual representation of how they added integers, which gave them evidence to come up with viable arguments to discuss at the end of the lesson.	2
3	I was trying to get my students to come up with viable arguments to verify the steps that we would come up with in class, but that didn't happen. I think it was my questioning that needed to change and be better so my kids would understand where I was going with the lesson.	1
4	As I walked around the room today, I noticed that students were engaging a lot better with one another in small groups of 2. I saw them talking about how to show subtractions on their whiteboards and also how different subtraction was than addition.	4
5	Since students were used to working with the chips, they seemed to have a smooth transition with constructing arguments with subtracting integers also. They were using their drawings to validate their theories and arguments as I walked around the room.	4

In Mr. John's descriptions, he was very specific in relaying how his students constructed viable arguments using the chips to add and subtract integers. He rated the second description really low as his students struggled with formulating the steps for adding integers. As indicated, he described that the students' struggle was a result of his instruction. However, on the other days, his students appeared to be successful at constructing viable arguments while working in groups. In relation to his students critiquing their classmates' reasoning, Mr. John's daily ratings were three, two, four and four. These ratings along with daily descriptions are provided in the table below.

Table 24: Mr. John's Daily Ratings on his Students' Ability to Critique the Reasoning of Others

Day	Descriptions	Rating
1	*N/A – Test given on this day*	
2	After the group activity, we discussed answers to the problems and for groups that had the wrong thought process other groups were able to critique their classmates.	3
3	My class today did not do well critiquing others. I tried to have students expand on the ideas of their peers during a class discussion but they froze and couldn't answer any questions at all.	2
4	I observed students while in their groups critiquing their partners with positive comments if their idea was unclear or didn't make sense. I also noticed that when students were being critiqued on their drawing that they handled it well and corrected their mistakes. They were learning from their peers.	4
5	Students engaged well with critiquing their partners in small group setting by using their picture, but critiquing their peers as a whole class setting did not go well.	4

Based on his ratings and descriptions, Mr. John was somewhat confident in his student's abilities to engage in SMP3. However, at times, it seemed to be a struggle when conducting whole group discussion. Mr. John expressed this in his overall reflection during an informal interview. His response is below:

> *(Referring to constructing viable arguments*) I found that with smaller groups I think they were able to construct a little bit better arguments than they were with the bigger groups cause that's what I try to do with them each day. The first day, I wanted to do groups of 4 to see how that would work. Then I went to groups of 2. Then today I was going to put them in groups of 2, but then I wanted to get them into groups of 1 to make sure they got their own focus on what they were doing… I heard a lot of good talk as I walked around….coming up with different arguments and like when they didn't agree with what their partner had or partners had they would really talk about it and they would say so ok well what about this? What about that? Today I tried to pull them all together in a class discussion and have groups come up and show what they did and have the actual, the whole class see and be able to come up with different things and I think I saw a better result like when they were in their own groups than when I pulled them out today to have groups show what they did in front of the whole class. The whole class kind of had a hard time this whole week. When I put them together as a whole group, they will not help me out. Like I'm having to prompt them like and prompt them and prompt them and then I go into either like elementary like questioning and they still are like a deer in headlights. They don't know what to say sometimes and I'm just like, you guys are killing me.

During this time, he expressed lots of frustration with trying to conduct whole class discussion while facilitating students' engaging in SMP3. He felt that his lesson was not successful because of this struggle. This was evidence in his statement below:

> (*Referring to critiquing the reasoning of others)* So that's where I think this week has really bombed for me. It's like when I'm trying to have the class discussion, which I thought would be the highlight of the lessons because when we were having the class discussions we could all take from what other people were doing but, man when we got into the classroom discussion they would just, they didn't know what to say.

This struggle also affected how successful his class was at critiquing each other during whole class discussion. During the interview, he was asked if the struggle for his students had something to do with his change in expectations for them. He contributed this struggle to the change in his teaching style, which is connected to his expectations of them. This is evidence in another statement during the informal interview:

> My teaching style! Yeah. Well that's how I usually teach anyway. Like we have a lot of class discussion and I try to have like an open forum, maybe not by the letting them struggle part and then bringing them up, that style, that's been changed. So that could be a big reason. I'm sure.

Although the discussion is centered on his students' engagement in SMP3, Mr. John continued to reflect on his practice. This was evident in both Ms. Jane and Mr. John's reflections on their students' engagement in SMP3. As a result, their reflections provided insight on teacher practice. They expressed that their teacher practice affected their students' engagement in SMP3.

Student Response to Week-long Lesson

For the most part, both participants felt that their students responded well to their lessons. Ms. Jane stated that her students were actually excited about math and really wanted to finish their assignment. Although they had a hard time moving around and working in groups, they

were very excited and more engaged than they had ever been. Ms. Jane described her students' response daily in her journal prompt:

> I felt at first the students were hard to focus, but were excited about the topic, which usually doesn't happen; they also had the opportunity to move around and work cooperatively, which was a struggle but I think will get better with practice.
>
> They seemed to be more engaged. They had a little trouble with sharing and reading the article in math but overall seemed more on task and interested in the topic.
>
> They were actually excited about math and completing their sneaker design-want to finish their work. A few had trouble starting but once going, worked well.
>
> They were more excited to get to work; they were very critical on themselves and want to be perfect. Before, they weren't as focused on details and perfection but are taking more time and not rushing through the project
>
> They were more engaged and interested in actually completing the project. They wanted to come to class and work; also working on it at home and in other classes.

Ms. Jane also explained that the other teachers had heard all about the project and said that her students were really excited about going to her class. As indicated by her responses, Ms. Jane's lesson had an impact on her students' engagement. When referring to one particular student, who normally acts out and is not interested, Ms. Jane stated that he was very engaged throughout the sneaker design project. Ms. Jane shared this information in the following excerpt during an informal interview:

> Joshua has been a challenge this year, very bright child…at the beginning I had problems with him participating, we have tried to set up parent conferences, but we haven't been able to get in contact with the parents too much…something happened, I don't know what it is, but…acting out, not talking to me, sit and put his head down sometimes and not talk to me at all. This was good (*referring to the sneaker design lesson)*, he actually communicated, he actually presented, that's good…I was surprised when he wanted to present because I have been struggling a lot with that this year.

Ms. Jane's students were more engaged, but at times, according to Ms. Jane, they struggled with their behavior.

On the other hand, Mr. John described his students as struggling. He felt that his students struggled with exploring mathematical concepts before note taking. They were used to him giving all the steps. Mr. John described this in the following excerpt from an informal interview:

> Like before when I would give them the steps and give them all the things they needed and they only would do problems. If, when the light bulb went on, it wasn't really, it was like oh they understood that problem because I was right there with them. But when they come to the problem, with an answer on their own from doing it this way, having to struggle, and then coming to it without any notes, it really sticks with them… You know that's what I've found so. But it's kind of nice. I'm loving it, but I just see them struggling… And then I start to struggle because I'm like ok I don't know how much to let them struggle.

This difference in his instructional style created some dissonance for his students. Daily descriptions of his students' responses to the lessons were recorded in his journal prompt and are provided below:

> They responded to this lesson in the way I thought they would. My students didn't feel comfortable struggling and having to find the answers on their own but I think they got a better understanding this way *(referring to his change in lesson delivery).*
>
> Students did not respond well at all today during the lesson. Today my students seemed tired and confused compared to yesterday and the days before.
>
> Students responded a lot better today than they did yesterday and better than the students last year at this time of the school year. They were more engaged and understood the concept than previous lessons.
>
> My students responded pretty well to today's lesson. Students struggled today having to use prior knowledge from yesterday's lesson and couldn't really tell me what to do during our class discussion. When I came up to groups and saw what they were doing, it seemed that they grasped what was going on, but the class discussion didn't reflect that.

These descriptions provide insight on how Mr. John described his students' responses to the week-long lesson and are consistent with Mr. John's description related to his students' engagement in SMP3. For the most part, his students were more engaged in the lessons and demonstrated a better understanding of adding and subtracting integers. However, they struggled

with the change in his teaching style. In the following excerpt from an informal interview, Mr. John expounded more on his students' responses to the lessons compared to previous lessons:

> I think that I was really a little bit nervous to do it like this time where I would like let them really struggle like that but I thought yesterday like with all my classes it went pretty well, the engagement as far as the lesson, using the chips, and having nothing to go on. I mean I really saw a lot of light bulbs going off while they were in the groups and that's why I'm excited like with a lot of the homework to see if it really connected with them. You know because the engagement seemed to be really good. You know it's just hoping that they could apply it to…. But I noticed when I started adding integers and from this week on like the rest of the chapter is where I'm going to be using a lot of what I learned with you guys. I'm seeing a big difference so far. I mean just them in class, yesterday I mean I saw a lot of light bulbs go off. Even, especially the ones that were struggling. When they struggled and they showed me with their chips how to do it, they were like oh ok… And I didn't use the chips last year so I just put the steps myself when you add 2 integers add, you know what I mean, and we did a lot of the examples and I tried to pull out real world examples but it was just nothing like this year you know.

This response was indicative of Mr. John's students' engagement overall. The change in his teaching style allowed his students to struggle. Through their struggle, according to Mr. John, the students gained a better understanding of adding and subtracting integers.

Teacher Reflection

During a final interview, Ms. Jane and Mr. John provided a brief reflection of their week-long lesson. Ms. Jane stated:

> I went more off the cultural and the uniqueness more than I did the math for this project. I wanted to include more mathematics, but I was stuck almost, so I would have liked to include more. I think next year, and every year I will kind of build upon it, but I think it is a good way to get my feet wet. But I would like to do different things, we didn't get into the measuring those kinds of things this year because my kids are behind….I think their engagement increased a lot. I think they were more into it; not only were they more into it, they wanted to finish it, and that's hard sometimes in math. They just do it, they're like I'm done, I don't care if I finish it or not. These projects, I felt that more wanted to turn it in. I still have some kids that won't turn it in, but most of my classes a lot were really excited to turn it in. Besides math assignments (*referring to other math*

> *assignments)*, they wanted to turn it in, because it meant something and they got to show it off. And I know some of them didn't want to present…

The focus of Ms. Jane's reflection was on how her use of a culture increased her students' engagement. The sneaker design lesson was used as a catalyst for learning. In another excerpt, Ms. Jane reflected on how she would like more time for PD in order to receive practical examples of CRT and SMP3. Her statement is provided in the excerpt below:

> *(Referring to the PD)* I think it was good, I think more time, maybe to be in depth a little bit more in depth or more specific ways that I can actually, like I understand the culture thing but maybe more specific ways of getting to know my students, like a survey or something that you have really done. I liked the idea that you did, like where would I see you in 10 years? ….I would like to do something like that, that way I'll get to know them better…I think I would do that at the beginning of the year. And also constructing reasoning with others, like how do you set up different grouping for that, if that makes sense, like specific ways I can groups my kids that you found that work, so that they feel comfortable with discussing and also staying on task.

This response was indicative of Ms. Jane's desire to solicit more support on implementing CRT and facilitating SMP3. When reflecting on his week-long lesson during an informal interview, Mr. John stated:

> I thought I had some ya know good lessons and some bad ones… I really love like making them stronger. I really see a lot of them trying to come up with ya know their answers and their ideas and working in groups and be able to talk about it; and some of them it's like a half an hour. Some of them I really see them like having a hard time with it and they don't try. That's what I'm gonna do next year is like if I establish that at the beginning I think it will work wonders in the classroom. I just think the benefits aren't showing through right now because I'm just starting it. Like I really want dive into what I've learned with you guys. I just wanted to dive into it and since I have everything I've learned, I would just, each day I would try to just like incorporate a little bit more and more…. So the kids aren't used to it…. Ya know having them struggle like that, so that's why I think some of the lessons have been bombing. But I have been seeing good highlights. Ya know. Like when the light bulbs go on like when I'm walking around when I do it this way they really go on right!

The focus of Mr. John's reflection was on his attempt to implement mathematical talk in his

lessons and allowing his students to struggle. He felt that the students benefit from the struggle. Both Ms. Jane and Mr. John spoke about how they plan to improve upon their practice for next year. Ms. Jane stated that she wanted to improve upon how to integrate both mathematics and culture together. While Mr. John stated that he wanted to improve on creating a culture where students engage in mathematical talk while reasoning with one another. This was evidenced in both their reflections above and is indicative of where Ms. Jane and Mr. John were in relation to implementing CRT and facilitating SMP3.

Summary

Data collected over the course of this study provided insight into the instructional styles of Ms. Jane and Mr. John. It was evident that a transformation occurred for both teachers and their students' engagement was enhanced. A detailed analysis was conducted and analyzed across both cases. Themes emerged and will be discussed in the next chapter.

CHAPTER 5: ANALYSIS, CONCLUSION, & IMPLICATIONS

Introduction

In this study, the researcher explored how teachers' use of culturally responsive teaching (CRT) practices support student engagement in practices consistent with Common Core State Standards, Standards for Mathematical Practice Three (SMP3). To accomplish this, a collective case study was conducted of two sixth grade teachers of minority students that attempted to implement CRT to support students' constructing viable arguments and critiquing the reasoning of others. The following questions guided this research:

1. What is the nature of the relationship between teachers' use of CRT practices and students' engagement in constructing viable arguments?
2. What is the nature of the relationship between teachers' use of CRT practices and students' engagement in critiquing the reasoning of others?

This chapter begins with a cross case analysis to highlight the findings of this study. The goal of this narrative is to synthesize the findings in relation to each research questions. The following paragraphs will also detail the implications of the findings, identify the limitations of the study, and outline recommendations for advancing this line of mathematics education research.

Findings across Cases

This study consisted of three phases: (a) Pre-Professional Development; (b) During Professional Development; and (c) Post-Professional Development. The first phase assisted in establishing a baseline for professional development (PD). Initial interviews and classroom observations provided insight into each teacher's instructional style as well as his or her

knowledge and use of culturally responsive teaching (CRT) practices. The interviews and observations helped the researcher to design the PD. Classroom observations also took place during PD; these observations were conducted to capture changes, if any, in each teacher's instructional style and his or her use of CRT while going through PD. After the completion of PD, classroom observations, interviews, journal prompts, and student artifacts were gathered and used to document CRT and students' engagement in SMP3. The classroom observations, interviews, and journal prompts were transcribed and coded for emerging themes across both cases. The following themes became evident in describing the nature of the relationship between CRT and students' engagement in SMP3: (a) shift in teacher practice; (b) depth and breadth of the knowledge of CRT and SMP3; (c) teacher reflection and reception and (d) classroom management. Each of these themes will be discussed in the proceeding paragraphs.

Shift in Teacher Practice

There was a clear and observable shift in the teachers' use of CRT practices as a result of the PD. The shift was manifested across all three phases of the research study. While the magnitude of the shift varied from one teacher to the next, both participants demonstrated a change in their use of CRT practices to promote student engagement in SMP3. Furthermore, it became clear that the teachers' reflection on their practice and the engagement of the students through the lens of CRT was connected to changes in the nature of instruction and the level of student engagement in SMP3. It seemed that the observed shifts suggested that professional development activities enhance teachers' ability to use CRT to effectively engage students in meaningful mathematical learning activities.

According to the data presented in Chapter 4, there was an observed change in both Ms. Jane and Mr. John's use of CRT practices. Prior to the PD, they both demonstrated some aspects

of CRT teacher characteristics; Mr. John exuded more than Ms. Jane. However, during and after PD, they demonstrated more aspects of CRT teacher characteristics. The CRT teacher characteristics were derived from research (Applin, 2005, Gay, 2000; 2002; Ladson-Billings, 1994a; 1994b; 1995; NCCREST, 2006; Villegas and Lucas, 2002; and Ma, 1999) noted in chapter two. In the following table, the shift in the CRT teacher characteristics employed by Ms. Jane and Mr. John are presented. Of the 6 characteristics, a shift occurred in both teachers' cultural competence and their constructivist view of learning.

Table 25: Shift in CRT Teacher Characteristics

CRT Teacher Characteristics	Before PD	During PD	After PD
Socio-cultural consciousness	• Awareness of one's own identity and prejudices (Jane/John) • Ability to examine and confront personal negatives toward any group (Jane/John)		
Affirming Attitude towards diverse students	• Respect for cultural differences (Jane/John) • Appreciation for cultural differences (Jane/ John) • Use positive body language when student speaks of family or culture (Jane/John) • Listen to students offer examples of their home life or family to illustrate points or answer questions while displaying a positive body language (Jane/John)		
Commitment and Skills to Serve as a Change Agent	• Identifies personal biases and guards against bias in teaching and planning. (John)		
Culturally Competent	• Intimate knowledge of students (John) • Ability to maintain high expectations (John) • Ability to understand student perceptions (John)	• High expectations (Jane) • Ability to use cultural differences as a catalyst for learning (John)	• Knowledge of students (Jane) • Understand student perceptions (Jane) • Ability to use cultural differences as a catalyst for learning (Jane)
Constructivist Views of Learning	• Ability to scaffold knowledge through students' experiences and the content at hand (John)		• Demonstrates the ability to see their students' actions develop their own perspectives (Jane/John) • Ability to scaffold knowledge through students' experiences and the content at hand (John)

CRT Teacher Characteristics	Before PD	During PD	After PD
Knowledge of the Subject Matter	• Displays awareness of basic mathematical concepts and ideas in relation to the principles of mathematics (Jane/John) • Displays the knowledge to connect mathematical concepts to procedures (Jane/John)		

In table 25, the indicators of the CRT teacher characteristics that were employed are provided including a description of who demonstrated it. The "Before PD" column was informed by the indicators that were displayed prior to PD. The "During PD" column was informed by the indicators that were displayed while the teachers participated in PD. And, the "After PD" column was informed by the indicators after PD during the week-long observation. Although the level to which the teachers displayed the indicators varied, the fact that they demonstrated some aspects of the indicators was important to note in this table, as the design of the table captures a difference in each teachers' displayed teacher characteristics.

According to table 25, both Ms. Jane and Mr. John shifted in their cultural competence. Prior to PD, Ms. Jane did not demonstrate any indicators of cultural competence. While planning her sneaker design lesson (after PD), she became more knowledgeable of her students. Through the lesson, she was able to demonstrate the ability to maintain high expectations for her students, understand their perceptions, and use their interests as a catalyst for learning. On the other hand, prior to PD, Mr. John demonstrated three of the five indicators of cultural competence. He was very knowledgeable of his students and their backgrounds. However, the ability to use his students' cultural differences as a catalyst for learning was demonstrated during PD. Mr. John instructed his students to share 3D perspectives from their worlds. Additionally,

Ms. Jane and Mr. John demonstrated an increased ability to see their students' actions develop their own perspectives. However, only Mr. John demonstrated an increased ability to scaffold mathematics content through students' experiences. Ms. Jane demonstrated this during whole class discussion on the cost and price of sneakers. Mr. John demonstrated this characteristic through the use of manipulatives (counter chips). This shift in Ms. Jane and Mr. John also resulted in a shift in the teachers' instructional practices.

The shift in the CRT instructional practices employed by Ms. Jane and Mr. John are presented in the following table. As noted in chapter two, the CRT instructional practices were derived from research (Applin, 2005, Gay, 2000; 2002; Ladson-Billings, 1994a; 1994b; 1995; NCCREST, 2006; Villegas and Lucas, 2002; and Ma, 1999). Of the seven instructional practices presented in chapter two, three of them are shown below as three of the practices (student-centered, positive interactions, redesign the curriculum) were subsumed in the facilitator of learning. A shift occurred in all CRT instructional practices below.

Table 26: Shift in CRT Instructional Strategies

CRT Instructional Strategies	Before PD	During PD	After PD
Culturally Validated	• Assists students in developing a positive self-efficacy about their ability to do mathematics (Jane/John) • Assists students in positioning themselves in the learning of mathematics (John) • Uses students characteristics as a focus for learning (John) • Displays student work and other artifacts illustrating personal and cultural identity of students (Jane/John)	• Uses students characteristics and experiences as a focus for learning (John)	• Uses students characteristics and experiences as a focus for learning (Jane/John)
Culturally Mediated	• Mediates controversial intercultural issues among students to enhance any culture, group, or person while affirming individual heritages. (John) • Prompts student to student interaction among students of different cultures (Jane/John)	• Prompts student to student interaction among students of different cultures (Jane)	
Facilitation of Learning	• Uses diverse teaching strategies (Jane/John) • Maintain positive interactions within the classroom (John) • Actively listens to students' questions or comments (Jane/John)	• Maintain positive interactions (Jane) • Student centered (John) • Actively listen to students' questions and/or comments (John) • Redesign the curriculum (Jane)	• Student centered (Jane/John) • Actively listen to students' questions and/or comments (Jane/John) • Redesign the curriculum (Jane)

The derivation of table 26 is similar to table 24. The CRT instructional practices that were employed by Ms. Jane and Mr. John throughout the study (before, during, and after PD) are provided. As with table 24, the teachers varied in their level of demonstration of the indicators; however, demonstration of any aspect of the indicators warranted documentation above, as the

design of the table captures a difference in each teacher's instructional style. Indicators that were employed at a deeper level (an increased ability) were listed more than once across the table.

According to table 26, a shift in both Ms. Jane and Mr. John's instructional practices was observed. Ms. Jane demonstrated an increased ability to facilitate learning. Her sneaker design lesson was informed by her students' interests, which indicated her ability to redesign the curriculum. Throughout this lesson, she supported a student-centered environment, where she allowed student responses to lead class discussions. Through the whole class discussions, she demonstrated an increased ability to actively listen to students' questions and/or comments in a way to move learning forward. This was evidenced in Ms. Jane's week-long lesson on day two when she conducted a whole class discussion on the articles that the students had read. Students were able to reflect on their own thinking in relation to sneaker design. Ms. Jane also demonstrated an increase in her ability to maintain positive interactions within the classroom. Before allowing students to present their sneaker designs to the class, Ms. Jane established audience rules, such as "Don't raise your hands when someone is presenting."

Mr. John also demonstrated an increase in his ability to facilitate learning. Prior to the PD, he facilitated "somewhat" of a student-centered environment. However, during and after PD, Mr. John demonstrated a greater ability to actively listen to students' comments and/or questions in a way to move learning forward. Although there were some missed opportunities, he demonstrated the ability to use students' mistakes as springboards for learning. Through whole class discussions of adding and subtracting integers, he allowed students' questions and/or answers to drive the learning process.

In regards to culturally mediated and validated instruction, Mr. John exuded more of these types of instruction then Ms. Jane, prior to PD. Therefore, his shift was mainly due to his increased ability to prompt student-to-student instructions and use students' experiences as a focus for learning. Mr. John consistently allowed students to reflect on their backgrounds and experiences through bell work. Similarly, Ms. Jane demonstrated an increase in her ability to prompt student-to-student interactions among students from different cultures. On the other hand, prior to PD, she did not demonstrate evidence of this strategy. After PD, Ms. Jane demonstrated the ability to use students' experiences as a focus for learning. Through her sneaker design project, she was able to tap into her students' interests and use them as a focus for learning.

The shifts in Ms. Jane and Mr. John's culturally responsive teaching practices are indicative of their desire to improve their teaching practices to support their students' learning. One of the six principles of teacher change proposed by Stigler and Hiebert (1999) is to "make improvement the work of teachers" (p. 135). They stated, "Teachers must be the primary driving force behind change" (p. 135). By observing the shift in their instructional practices, it is imperative to document the change in their student engagement practices as it relates to SMP3. In the following table, the shift in Ms. Jane and Mr. John' students' engagement is presented.

Table 27: Shift in Students' Engagement Practices

	Before PD	During PD	After PD
Construct Viable Arguments	• Use stated assumptions, definitions, previously established results (Jane/John)	• Justify their solutions and communicate them to others (John)	• Use stated assumptions, definitions, previously established results (Jane/John) • Justify their solutions and communicate them to others (Jane/John) • Can recognize and use counter examples (John) • Respond to the arguments of others (John)
Critique the Reasoning of Others	• Analyze situations by breaking them into cases (John)	• Read arguments of others and decide whether they make sense (John) • Ask careful questions to clarify arguments of others (John)	• Actively listen to the arguments of others and decide whether they make sense (John) • Ask careful questions to clarify the arguments of others (Jane/John) • Ask careful questions to improve the arguments of others (Jane) • Read arguments of others and decide whether they make sense (John)

In table 27, the indicators of Ms. Jane and Mr. John's students' engagement in SMP3 are provided including a description of whose students demonstrated it. The "Before PD" column was informed by the indicators that were demonstrated prior to PD. The "During PD" column was informed by the indicators that were demonstrated while the teachers participated in PD. And, the "After PD" column was informed by the indicators demonstrated after PD during the week-long PD. Although the level to which their students engaged in the indicators varied, the fact that they demonstrated some aspects of the indicators is important to note in this table, as the design of the table captures a difference the student engagement practices. Only indicators that

were employed at a deeper level (an increased ability) were listed more than once across the table.

According to table 27, a shift in Ms. Jane and Mr. John's students' engagement practices was observed. Ms. Jane and Mr. John demonstrated an increase in their ability to facilitate students engaging in constructing viable arguments and critiquing the reasoning of others. As in table 25 and 26, the shift in their CRT practices was connected to the shift in their students' engagement in SMP3. During the week-long lesson, Ms. Jane prompted her students to construct viable arguments by collecting and displaying data on their classmates' sneakers. More specifically, they demonstrated the ability to use definitions and to justify their reasoning. In addition, while presenting their shoe designs, students were instructed to critique the reasoning of others by asking careful questions to clarify and improve the arguments of others. Throughout Mr. John's week-long lesson, he prompted his students to construct viable arguments related to adding and subtracting integers using counter chips. This was done while working in groups as well as while presenting their solutions to the class. Mr. John's students were justifying and communicating their solutions while using definitions. Mr. John also engaged students in critiquing the reasoning of others by having them work in groups to reach an agreement. Moreover, during whole class discussion, Mr. John instructed students to read the arguments and actively listen to the arguments of others to see if they make sense. During student-to-student interactions, Mr. John's students actively listened to one another, read their classmates arguments (using mini-white boards), and asked questions to clarify their classmates' arguments.

As indicated in the tables above, a shift was observed for both teachers in their use of CRT and their students' engagement in SMP3. Although not all CRT and SMP3 practices were

demonstrated, change occurred over a six-week period. This small change is supported by Stigler and Hiebert's first principle: "expect improvement to be continual, gradual, and incremental" (p. 132). Because the focus of teacher change is on student learning, it is expected to occur in small increments rather than dramatically. Stigler and Hiebert write, "Because teaching is a system that is deeply embedded in the surrounding culture of schools, any changes will come in small steps, not in dramatic leaps" (p.132). The shift in teacher practice supported the shift in student engagement. This finding is also consistent with the research of Hufferd-Ackles, Fuson, and Sherin (2004). They identified four levels (0-4) of teacher change in creating a classroom environment where students engage in mathematical talk. Prior to PD, both Ms. Jane and Mr. John were at level zero, which is illustrated by teacher-directed instruction with minimal, teacher-led questions. During PD, Mr. John moved to level one, where he began to pursue student thinking. He focused more on students' mathematical thinking and less on answers. However, he was still the only person asking questions; interactions remained between the teacher and student. After PD, Ms. Jane moved to level one and Mr. John began moving to level two. Although he struggled at level two, Mr. John continued to ask open-ended and probing questions. He also prompted student-to-student talk as students discovered using counter chips to add and subtract integers. Even though Ms. Jane and Mr. John did not reach the fourth level of Hufferd-Ackles at al (2004), a shift in their practice did occur. As the teachers displayed more CRT teacher characteristics and demonstrated more CRT instructional practices, their students demonstrated more student engagement practices consistent with SMP3.

The particular shifts in the teachers' practices are connected to specific components of the PD. As listed in the previous chapter, a baseline for PD was established, so the components of PD include: (a) specific CRT practices; (b) mathematical tasks; (c) formative assessment; and

(d) student collaboration. Specific CRT practices included a focus on cultural competence, display of constructivist views of learning, culturally validated and mediated instruction, and facilitation of learning. Use of these CRT practices extended support for the teachers to facilitate SMP3 through strategic and deliberate planning with the students in mind. Within the planning process, the teachers needed to consider the remaining components of PD. The mathematical tasks should start with where the students are and connect with cultural experiences. They must also be "problematic", which require creativity and deep mathematical thought, communication, and metacognition on behalf of the students (Hiebert et al, 1997, p. 9). Using formative assessment, teachers solicit students' mathematical thinking through the use of questioning (Hufferd-Ackles et al, 2004; SCME, 2012). Good questioning explicates explanations and justifications of mathematical thinking from students and assists in moving learning forward. And, lastly, through the use of group work, students are provided opportunities to collaborate with one another, discover new strategies, and evaluate each other's thinking. In the following table, Ms. Jane and Mr. John's shifts are mapped to specific components of PD.

Table 28: Connecting CRT Shifts to Components of PD

CRT Teacher Characteristics	Component of PD
Ability to maintain high expectations (Jane)	CRT (cultural competence)
Knowledge of students (Jane)	CRT (cultural competence)
Ability understand student perceptions (Jane)	CRT (cultural competence)
Ability to use culture as a catalyst (Jane/John)	CRT (cultural competence) Mathematical tasks
Ability to see students' actions develop their own perspectives (Jane/John)	Constructivist views of learning Formative assessment
CRT Instructional Practices	**Component of PD**
Uses students characteristics and experiences as a focus for learning (Jane/John)	CRT (culturally validated instruction) Mathematical tasks
Prompts student-to-student interaction among students of different cultures	CRT (culturally mediated) Student collaboration
Maintain positive interactions within the classroom (Jane)	CRT (facilitation of learning)
Facilitate a student-centered environment (Jane/John)	CRT (facilitation of learning) Formative assessment
Actively listen to students' questions and/or comments (Jane/John)	CRT (facilitation of learning) Formative assessment
Redesign the curriculum	CRT (facilitation of learning)

The shift in their instructional style was clearly supported by professional development that focused on the use of CRT to support SMP3. Research on professional development (PD) for inservice teachers indicates a positive impact on reform-based teaching practice (Heck, Banilower, Weiss, & Rosenberg, 2008; Huffman, Thomas, & Lawrenz, 2003). This positive impact on teacher practice was demonstrated in both Ms. Jane and Mr. John. The professional development in this study provided them with an initial understanding of CRT and SMP3 and made them more conscious in their lesson planning and delivery. In order to nurture and progress this shift, additional professional development and support will be needed (Guskey, 2002; Heibert et al, 1999).

Depth and Breadth of the Knowledge of CRT and SMP3

Culturally Responsive Teaching

When examining the depth and breadth of the knowledge CRT in Ms. Jane and Mr. John, it was evident that not all teacher characteristics or instructional practices were employed by them. This was illustrated in the tables above. From the tables above, it is evident that Mr. John exuded more CRT practices than Ms. Jane prior to PD. However, when examining each teacher's week-long lesson, only certain aspects of CRT were emphasized by each teacher. The following table provides insight on Ms. Jane and Mr. John's implementation of CRT during their week-long lessons. Their differences in implementation revealed some short-comings in CRT, and some practices were not demonstrated.

Table 29: Implementation of CRT during Week-long Lessons

	Strong Change	Weak Change	No Change (Remained)	Not Demonstrated
Ms. Jane	• Culturally Competent • Redesign the Curriculum • Student-centered • Maintain Positive interactions • Actively listen to students' questions and/or comments	• Constructivist View of Learning • Culturally validated • Culturally Mediated	• Socio-cultural Consciousness • Affirming Attitude towards Diverse students • Diverse Teaching Strategies	• Commitment to Serve as a Change Agent • Knowledge of Mathematics Teaching
Mr. John	• Student centered • Actively listen to students' questions and/or comments • Maintain Positive interactions	• Constructivist View of learning • Culturally Validated	• Culturally Competent • Socio-cultural Consciousness • Affirming Attitude towards Diverse students • Commitment to Serve as a Change Agent • Diverse teaching strategies • Knowledge of Mathematics Teaching • Culturally Mediated	• Redesign the curriculum

In table 29, the researcher derived its content from tables 25 and 26. The "Strong Change" column represented the CRT practices that were demonstrated by each teacher after PD and contained over half of the indicators for that characteristic or instructional practice. The "Weak Change" column represented the practices that were demonstrated by each teacher after PD and contained up to half of the indicators for that characteristic or instructional practice. The "No Change" column represented the CRT practices that were observed prior to PD without any changes in the indicators after PD. The "Not Demonstrated" column represented the CRT practices that were not demonstrated during the week-long lesson.

During the week-long lesson, as indicated in the table above, Ms. Jane demonstrated more strong changes than Mr. John. Although they demonstrated use of some CRT practices, they did not demonstrate all of them. In order to plan the lesson, Ms. Jane concentrated on getting to know her students, which in turn gave her the ability to redesign the curriculum to reflect her students' interests. As a result, Ms. Jane used students' cultures as a catalyst for learning, which is key in implementing CRT lessons. On the other hand, Mr. John incorporated students' cultures within the bell work, where students came up with scenarios from their backgrounds that highlighted negative integer situations. However, these scenarios were not connected to the topic of Mr. John's lessons on adding and subtracting integers. Therefore, he did not use students' cultures as a catalyst for learning. Rather, he just simply incorporated their cultures into the lesson. Although Ms. Jane was able to use students' cultures as a catalyst for learning, she did not connect the lesson to mathematics. More specifically, her lesson did not include an instructional focus on mathematics. Although Mr. John's students did mathematics, they struggled with making sense of some of the problems, as they were not connected to a context. To assist students in understanding, he had to resort to context. This is a clear indication of how using students' cultures and experiences as a catalyst for learning is so important when implementing culturally responsive teaching. As a result, Mr. John did not demonstrate an ability to redesign the curriculum (defined as supplementing the lesson with materials other than the mathematics text as a means to create lessons that are reflective of students).

The CRT framework encompasses teacher characteristics and instructional practices. Both the teacher characteristics and the use of these instructional practices use students' cultures as a catalyst for learning (Applin, 2005, Gay, 2000; 2002; Ladson-Billings, 1994a; 1994b; 1995;

NCCREST, 2006; Villegas and Lucas, 2002; and Ma, 1999). Therefore, in order to conduct a fully culturally responsive environment, teachers must strive to obtain all the characteristics and use all instructional practices remembering key is using students' cultures as a vehicle for learning. It is evident from table 28 that Ms. Jane did not display knowledge for teaching mathematics nor did she display a commitment to serve as a change agent. It is also evident that Mr. John did not demonstrate an ability to redesign the mathematics curriculum as his week-long lesson focus was not reflective of his students.

Again, it became evident that Ms. Jane and Mr. John varied in their depth and breadth of understanding of CRT practices. As a result of these variations, each teacher demonstrated different abilities to engage students effectively. This observation suggested that, while the demonstration of specific characteristics of CRT correlate to proficiency in the use of certain practices, teachers should develop all of the CRT characteristics and make use of each of the CRT instructional practices to effectively engage students in the SMP3. The lack of any of these characteristics or the inability to use each of the practices to some degree undermines culturally responsive teaching and ultimately SMP3, especially when working with students from diverse backgrounds.

Standard for Mathematical Practice 3

When examining the student engagement of Ms. Jane and Mr. John's students, it was evident that not all SMP3 practices were employed. Table 30 provides insight on the SMP3 practices that were employed by the students in Ms. Jane and Mr. John's classes during their week-long lessons. The strongest change for both teachers was their students' increased ability to justify and communicate their thinking to one another. Through student-to-student interactions, Mr. John's students also demonstrated an increased ability to actively listen and

read others' arguments to determine if they made sense; these were indicated as strong changes for Mr. John.

Table 30: Student Engagement Practices Employed during Week-long Lessons

	Strong Change	Weak Change	No Change (Remained)	Not Demonstrated
Ms. Jane's students	• Justify their solutions and communicate them to others (1E)	• Ask careful questions to clarify the arguments of others (2C) • Ask careful questions to improve the arguments of others (2D)	• Use stated assumptions, definitions, previously established results (1A)	• Make conjectures and build logical progression of statements to explore the truth of their conjectures (1B) • Analyze situations by breaking them into cases (1C) • Can recognize and use counter examples (1D) • Respond to the arguments of others (1F) • Reason inductively, making plausible arguments that take into account the context from which data arose (1G) • Actively listen to the arguments of others and decide whether they make sense (2A) • Read arguments of others and decide whether they make sense (2B)
Mr. John's students	• Justify their solutions and communicate them to others (1E) • Actively listen to the arguments of others and decide whether they make sense (2A) • Read arguments of others and decide whether they	• Can recognize and use counter examples (1D) • Respond to the arguments of others (1F) • Ask careful questions to clarify the arguments of others (2C)	• Use stated assumptions, definitions, previously established results (1A) • Analyze situations by breaking them into cases (1C)	• Make conjectures and build logical progression of statements to explore the truth of their conjectures (1B) • Reason inductively, making plausible arguments that take into account

	Strong Change	Weak Change	No Change (Remained)	Not Demonstrated
	make sense (2B)			the context from which data arose (1G) • Ask careful questions to improve the arguments of others (2D)

The contents of table 30 are derived from teacher-student interactions and student-to-student interactions. The "Strong Change" column represented the SMP3 practices that were employed by the students and frequently observed throughout the week-long lesson and during PD, but not prior to PD. The "Weak Change" column represented the SMP3 practices that were employed by the students and observed at least once throughout the week-long lesson and during PD, but not prior to PD. The "No Change" column represented the SMP3 practices that were employed by the students and observed prior to PD as well as during the week-long lesson. The "Not Demonstrated" column represented the SMP3 practices that were not observed during the week-long lesson.

As described in chapter two, student engagement practices that are consistent with SMP3 contain indicators, which were defined by CCSSO and NGA (2010). Students engaging in SMP3 construct viable arguments (labeled 1 in table 30) and critique the reasoning of others (labeled 2 in table 30). There are seven indicators for students' engaging in the construction of viable arguments; each of these is labeled in table 30 using capital letters A thru G, respectfully. Of the seven indicators, Ms. Jane's students employed two of them, while Mr. John's students employed four of them. Similarly, there are four indicators for students' engaging in critiquing the reasoning of others; each of these is labeled in table 30 using capital letters A thru D, respectfully. Of the four indicators, Ms. Jane's students employed two of them, while Mr. John's

students employed three of them. In the following paragraphs, descriptions of how these practices were employed by the students are provided.

Constructing Viable Arguments

Prior to PD, both Ms. Jane and Mr. John's students engaged in some aspect of using stated assumptions, definitions, and previously established results, which is the first indicator of students' constructing viable arguments. As described in chapter four, both Ms. Jane and Mr. John's students engaged in this practice as the problems from the bell-work/warm-up were reviewed. In addition to this indicator, Mr. John's students also demonstrated the ability to analyze situations by breaking them apart, which is another indicator of students' constructing viable arguments. This practice was also evidenced while reviewing problems from bell-work. Although these practices were employed by their students prior to PD, they were an indication of Ms. Jane and Mr. John's initial understanding of constructing viable arguments as well as their ability to facilitate these practices within their classrooms at that time.

During and after the PD, both teachers demonstrated an increased ability to facilitate students constructing viable arguments by prompting their students to justify their solutions and communicate them to others, which is the fifth indicator of students' constructing viable arguments. During PD, Mr. John began prompting his students to explain and justify their reasoning while reviewing problems from bell-work. After PD, they both prompted this practice. Ms. Jane asked her students to explain and justify when her students shared their ways of collecting and displaying data on day one of the week-long lesson. In addition, her students were also required to explain and justify their sneaker design choices in text as well as verbally while sharing with the class. Mr. John consistently prompted his students to explain and justify their ways of reasoning throughout the week-long lesson on adding and subtracting integers. His

students employed this practice during both whole group and small group discussions. Additionally, Mr. John's students demonstrated the ability to recognize and use counter examples as well as to respond to the arguments of others during student-to-student interactions. All were evident from the excerpts provided in chapter four. Although all indicators were not employed by their students, the ability to facilitate students' engaging in mathematical talk, i.e. justifying their solutions and communicating them to others, is a relevant finding as it is consistent with the focus of the Common Core State Standards, which is to develop mathematically proficient students.

As discussed above, three of the indicators were not observed in either Ms. Jane or Mr. John's classroom. This fact may be a result of the incapability between the indicators and the content of the week-long lessons. On the other hand, the fact that both teachers shifted in their ability to facilitate their students' engagement in justifying and communicating their solutions is indicative of the professional development that they received. More specifically, it was indicative of the mathematical task and formative assessment components of PD (described in earlier section), which were inclusive to all CRT instructional practices.

Critiquing the Reasoning of Others

Prior to PD, neither Ms. Jane nor Mr. John's students engaged in critiquing the reasoning of others. On the other hand, during PD, the shift in Mr. John's instructional practices assisted him in facilitating his students' engaging in critiquing the reasoning of others. While reviewing bell-work, Mr. John had his students share their solutions with the class and explain their reasoning. He prompted the students to read their classmate's solutions on the board and determine whether they made sense. He prompted his students in asking questions to clarify their classmates' solutions. Both these student engagement practices are indicators of students'

critiquing the reasoning of others. As a result, Mr. John's students demonstrated an increased ability to critique the reasoning of others during PD as the indicators shifted from none of four to two of four. Conversely, Ms. Jane's students did not demonstrate any indicators of critiquing the reasoning of others during PD.

During the week-long lesson, after PD, both Ms. Jane and Mr. John's students engaged in critiquing the reasoning of others. Ms. Jane's students engaged in asking careful questions to clarify and/or improve the arguments of their classmates, which are two of the four indicators for critiquing the reasoning of others. During the sneaker design presentations, Ms. Jane's students were required to formulate questions to ask their classmates in relation to their sneaker design. These questions helped to clarify and improve their classmates' decisions related to their sneaker design. The answer to these questions informed voting preferences. In addition to the two practices demonstrated during PD, Mr. John's students also engaged in actively listening to their classmates' arguments to determine whether they made sense. All three practices were employed throughout Mr. John's week-long lesson (excerpts are provided in chapter 4). While learning about adding and subtracting integers, Mr. John's students worked in small groups, where they were instructed to evaluate integers and reach an agreement on their solutions. In order to reach an agreement, the students engaged in actively listening to the arguments of others as well as reading the arguments of others to decide whether they made sense. Mr. John's students demonstrated an increased ability to critique the reasoning of others as they demonstrated three of the four indicators.

Although all indicators of critiquing the reasoning of others were not employed by their students, the ability to facilitate students' engaging in mathematical talk, i.e. actively listening

and asking questions of one another, is an important finding as it is consistent with the focus of the Common Core State Standards, which is to develop mathematically proficient students.

Summary of Depth and Breadth of the Knowledge of CRT and SMP3

As defined in chapter 2 by CCSSO and NGA (2010), standard for mathematical practice three (SMP3) focuses on students' engaging in mathematical talk within the mathematics learning process. More specifically it focuses on teachers facilitating students' engagement in explaining, justifying, and communicating their ways of reasoning with one another. This type of engagement requires a major shift in classroom environments and promotes mathematical independence among students. The shift in Ms. Jane and Mr. John's instructional styles assisted them in facilitating this type of engagement within their classrooms. Of the seven indicators for constructing viable arguments, Ms. Jane and Mr. John's students demonstrated three of them. Of the five indicators for critiquing the reasoning of others, Ms. Jane and Mr. John's students demonstrated three of them. Like CRT, use of all the indicators of SMP3 is necessary for facilitating mathematical talk. Although some indicators may lend themselves easily to specific mathematical topics/concepts, teachers must strive to facilitate the use of all of them remembering that the key is conducting a classroom discourse where students are explaining, justifying, and communicating their ways of reasoning with one another including both student-to-student interactions as well as teacher-to-student interactions. Therefore, classroom tasks must be strategically selected. In both classrooms, indicators of SMP3 were observed during teacher-to-student interactions. However, observations of SMP3 during student-to-student interactions were observed in Mr. John's classroom only.

As with CRT, Ms. Jane and Mr. John's depth and breadth of knowledge of SMP3 varied. As a result of these variations, each teacher facilitated it differently as the focus and topic of their

lessons were not parallel. This observation highlights that while the facilitation of specific SMP3 student engagement practices correlate to proficiency in the use of certain practices, teachers must facilitate the use of each practice to effectively engage students in SMP3. The lack of any of these practices undermines the depth and breadth of students' engagement in SMP3.

Teacher Reflection and Reaction

Throughout the week-long lesson, Ms. Jane and Mr. John reflected on their abilities to use CRT and to facilitate SMP3. Additionally, they reflected on their students' engagement in SMP3 as well as their students' response to the change in their instructional styles. Larrivee and Cooper (2006) explained that the primary goal of reflection on teacher practice is to "create deeper understanding and insight, forming the basis for not only considering alternatives, but also for taking action to continually improve practice throughout one's teaching career" (p. 6). The reflections of Ms. Jane and Mr. John indicated their openness to change and improvement of their practice. These reflections were captured during two informal interviews and daily journal prompt reflections during their week-long lessons. They were grouped in three categories: (a) reaction to the use of CRT; (b) reaction to facilitating SMP3; and (c) reaction to week-long lesson overall.

Reaction to use of CRT (teacher and students)

When considering their students' cultural perspectives while planning their week-long lessons, Ms. Jane and Mr. John held different positions on how they used them. By getting to know her students while planning for her lesson, Ms. Jane used her students' interests to drive her lesson decisions. She reported that her lesson had an impact on her students' engagement and attentiveness. Her students were excited about the sneaker design project and really wanted

to complete it. Prior to this lesson, Ms. Jane explained that her students were not as focused on details and perfection. She also explained that her students were excited about coming to math class for a change. When speaking about the increase in her students' engagement, she referred to the transformation of an African-American male in her classroom. She highlighted that he surprised her; through the sneaker design lesson, he began communicating with her again and wanted to participate. Because of the positive response from her students, she rated herself as averaged in her ability to use CRT. The increase in her students' engagement and interest level gave her confidence in her ability to use CRT.

Like Ms. Jane, Mr. John rated himself as average in his ability to use CRT. Although the focus of his week-long lesson did not reflect his students' cultural perspectives, he planned to incorporate their cultural perspectives during bell-work. This was probably due to his first attempt to consider students' cultures in math. During this initial attempt, Mr. John explained that his students' "faces started to light up" as they were learning about the cultures of their classmates. He explained that this was an eye opening experience for him, as he did not expect this response from his students. This experience directed Mr. John to incorporate students' cultural perspectives during bell-work activities of his week-long lesson. He felt that his students responded well to the lesson and were more engaged. Although, he rated himself as average in his ability to use CRT, he explained that he needed to improve upon it more. Mr. John's reflection of his practice indicated his desire for continuous improvement of his teaching practices. The positive responses of their students echoes literature related to culture and student engagement (Cobb & Hodge, 2002; Gutierrez & Rogoff, 2003; Hand, 2003) as well as literature related to culturally responsive teaching (Gay, 2000; 2002; Ladson-Billings, 1994a; 1994b; 1995; NCCREST, 2006; Villegas and Lucas, 2002).

Reaction to use the facilitation of SMP3 (teacher and students)

When reflecting on their ability to facilitate SMP3 and their students' ability to engage in SMP3, Ms. Jane and Mr. John also expressed different levels of success. For the most part, Ms. Jane rated her students with a two out of five, with five being excellent, in their ability to facilitate students' constructing viable arguments. Reflecting on the first day of the week-long lesson, she explained that she did not facilitate this practice very well. Ms. Jane stated that she should have asked better questions to have her students explain their thinking. She shared in an informal interview that she discovered this fact while reflecting using the journal prompt. This point is consistent with Larrivee and Cooper (2006); they explained that the use of journal writing allows teachers to recognize their contribution to classroom experiences. For days two through five, she adjusted her teaching and was able to provide specific examples as to when her students constructed viable arguments. In relation to critiquing the reasoning of others, Ms. Jane did not rate her students' ability on the first day as she explained that she did not create an opportunity for this practice to happen. When reflecting on her students' ability to engage in SMP3, she expressed that they did "okay", especially with the practices being something new. For critiquing each other, she stated that she did not structure the lesson for it to happen. She felt that it would work better when the students are in groups. Moreover, she expressed that both she and her students would improve in their abilities regarding SMP3 with time. Ms. Jane's response indicated her desire to build upon and improve her teaching practice.

Although, at times, his students struggled, Mr. John was more confident in his ability to facilitate SMP3. For constructing viable arguments, Mr. John's ratings on his students' ability increased daily (from two to four with five being excellent). He provided specific incidences of when his students engaged in this practice; his students constructed viable arguments

individually and collaboratively. On day three and five of the week-long lesson, Mr. John described his students as struggling because they had a difficult time answering his probing questions. In his reflection, he contributed their struggle to his questioning. He explained that he needed to improve upon his questioning so his students would do better with constructing viable arguments. Like Ms. Jane, Mr. John's response was indicative of his desire to change and is consistent with findings from Larrivee and Cooper (2006). Mr. John was also somewhat confident in his ability to engage students in critiquing the reasoning of others. His students' ability ratings were not consistent as he rated them lower on the third day of the week-long lesson; his ratings were three, two, four, and four, respectively. As with the previous practice, he described specific incidences during his week-long lesson where his students engaged in critiquing each other. He explained that working in groups his students engaged more successfully in this practice; however, during whole class discussion, his students were not as successful. He contributed their struggle to the shift in his instructional style. When reflecting on SMP3, both teachers referred to their instructional delivery. Ms. Jane and Mr. John explained that their level of questioning might have had an impact on how their students engaged in SMP3. From their reflections, it follows that improvement on their questioning may enhance their students' ability to engage in SMP3. This finding is consistent with the work of Osterman and Kottkamp (2004). They explained that reflection enables teachers to realize the benefit of "increased personal capacities for learning and improvement" (p. 21). Both Ms. Jane and Mr. John improved upon their practice and exhibited a desire for continuous improvement. Reflection on their practice increased their personal capacities for improvement.

Overall reflection to week-long lesson (teacher)

Reflecting on the overall lesson, Ms. Jane stated that she focused more on the students' cultures than on the mathematics. Although she wanted to include more mathematics, she explained that she was stuck. This response indicated Ms. Jane's desire to use mathematics within her sneaker design lesson; however, the focus of the lesson was not appropriate for the specified grade level. Her focus on students' interest highlighted her eagerness to use CRT. She expressed for this experience, she was "getting her feet wet" as this was her initial attempts of using CRT and facilitating SMP3. She expressed a desire to improve upon the experience by incorporating more mathematics into the lesson. Overall, she stated that the sneaker design lesson meant something to her students and that's why their engagement increased. She concluded that she wanted to improve upon her use of both CRT and SMP3 together; and, with more support she would like to incorporate what was learned in her classroom next year. Ms. Jane's desire for continuous improvement and support is consistent with research on teacher change (Guskey, 2002) in that teacher change is gradual and warrants continued follow-up and support.

Mr. John explained that he conducted good and bad lessons throughout the week-long lesson. Although his students struggled with the shift in his instructional style, he felt that his lessons made them stronger. He explained that not all the benefits of facilitating SMP3 were manifested; however, he further explained that this was probably because he is at the initial stage of facilitating SMP3. Mr. John stated that if he established this culture of student engagement at the beginning of the school year, then the benefits would manifest. Like Ms. Jane, his desire to improve upon his practice is indicative of his willingness to change his instructional style (Guskey, 2002).

Summary of Teacher Reflection and Reception

Research related to self-reflection on instructional practices through written expression can prove purposeful (Wink, 2005). This was evidenced in both Ms. Jane and Mr. John reflections. It assists teachers in expanding their professional toolkits and making instructional adjustments as necessary (Jaworski, 1994; Larrivee & Cooper, 2006; Osterman & Kottkamp, 2004). Daily reflections allowed them to improve upon their practice the following day. By reflecting on their experience, they gained a desire to improve upon their instructional practice at the beginning of the next school year to create a classroom culture that supports use of CRT and students' engagement in SMP3.

Classroom Management

Throughout the classroom observations (prior, during, and after PD) of this study, it was evident that Ms. Jane and Mr. John differed in their classroom management styles. Prior to PD, although their typical lesson flow was similar (bell-work, lecture, practice), the student activity and classroom transitions varied. In Ms. Jane's classroom, there existed a lot of unrelated student activity and disruptive behavior throughout her lesson. Although she tried to address disruptive behavior, she also ignored some of it. While teaching, she had to constantly refocus and redirect her students. During transitions, Ms. Jane used a timer to assist her with time management. However, substantial time was wasted as she had to stop the lesson to redirect her students. For observations during PD, Ms. Jane increased in her ability to maintain positive interactions among the students. However, she did this by constantly pausing the lesson; she would stop talking for a short period of time, until the students became quiet without correcting behavior. These pauses were a big interruption to the flow of the lesson. While attempting to implement CRT practices and facilitate SMP3 during their week-long lessons, classroom

management continued to be a problem. According to classroom observations and Ms. Jane's journal prompts and interview responses, Ms. Jane strategically selected the sneaker design lesson to connect with her students' experiences. It was evident from classroom observations and Ms. Jane's journal prompts that student engagement increased in her classroom. Her students became more interested in participating in the lesson and completing the sneaker design. However, without structure, consistency, and reinforcements established within the environment, the management of the classroom became a problem. When Ms. Jane presented her students with an open-ended task on the first day of the week-long lesson, her students struggled with getting on task. It was evident in classroom observations and in Ms. Jane's journal prompts that directions were not clear and the students were confused. The task was for the students to work in pairs to collect and display data on sneakers worn in the classroom. While the students were making sense of the directions, they began making negative comments about their sneakers. Some of the students used profanity as well. Instead of Ms. Jane correcting this negative behavior, she ignored it hoping the students would eventually settle down. Ms. Jane commented about this in her journal prompt stating that the students struggled with getting started.

Initially, Ms. Jane allotted two days for her students to work on their sneaker designs. As the students worked on their designs, they were grouped with their friends, which lead to unrelated conversations. Many of the male students used online searches of specific shoes they wanted to design; these searches assisted them in their designs. The male students appeared to be motivated, but they spent a lot of time researching, which delayed them in completing their designs. Ms. Jane observed this but was okay with it because her students seemed to like the project. As a result, she provided an additional day for them to work on their designs.

Towards the end of the lesson, the students were instructed to present their projects to the

class. Ms. Jane ensured that the class established "good audience rules;" she referred to these rules throughout the presentations. Ms. Jane demonstrated an increased ability to maintain positive interactions among students. In addition, she demonstrated an increased ability to facilitate students' critiquing the reasoning of others by instructing the students to formulate questions in relation to their classmates' presentations. As the students asked questions, they were clarifying their classmates' sneaker design decisions and informing their own votes. While asking questions, a few students gave negative comments criticizing their classmates' decisions. For instance, if a student said that his sneaker would cost $25, one of his classmates would reply, "That's cheap! You must sell it at Wal-Mart." For these types of comments, Ms. Jane did not address them, instead she ignored them. This example undermined SMP3 as students must be comfortable in communicating their ways of reasoning to the learning process.

Although Ms. Jane's attempt to implement CRT practices and facilitate SMP3 within her classroom, the struggle with classroom management made it difficult to fully incorporate CRT instructional practices and effectively facilitate SMP3. This highlights another dimension to the classroom transformation. From the beginning to the end of the study, it was evident that Ms. Jane improved in her ability to use CRT practices and facilitate SMP3. She made a clear attempt to get to know her students, which is one indicator of cultural competence. However, she fell short of classroom structure, consistency and reinforcement, and full cultural competence. According to the aforementioned studies (Simonsen et al, 2008; Milner & Tenore, 2010), these components are essential to effective classroom management. Without structure, consistency, and reinforcements in place, a breakdown in the social culture of the classroom as defined by Hiebert et al (1997) is created. This leads to a breakdown in one of CRT's instructional

practices: maintaining positive interactions within the classroom. Students must be comfortable with communicating and engaging in mathematical talk during the learning process.

On the contrary, Mr. John's classroom management style appeared to be well structured throughout the classroom observations of this study. Prior to PD, it was evident that Mr. John had already established a positive social culture of the classroom. For the most part, his students were attentive and on task. Although the class seemed to be teacher-centered, the students were well behaved. Students did not speak unless they were called upon by Mr. John. Before answering questions, the students raised their hands. The students appeared to be comfortable with sharing answers and asking questions. Classroom transitions were smooth. Transitioning from bell-work to lessons and from whole class to small groups was completed within seconds. During PD, Mr. John began incorporating students' cultures into his lessons and conducted a more student-centered environment. Before beginning a lesson on three-dimensional solids, Mr. John asked his students to come up with examples of solids from their worlds. As students shared their examples, one student made a statement that cones are the same as pyramids. This statement sparked a whole class discussion. Mr. John demonstrated an increased ability to conduct a student-centered environment as well as an environment where students are comfortable with communicating in mathematics. The transformation in Mr. John's instructional style did not undermine his classroom management. Rather, his students began learning about their classmates' backgrounds and experiences, which brought about a sense of respect and validation among the students. This was evident from classroom observations and Mr. John's journal prompts. Overall, it was evident from classroom observations that Mr. John's classroom management encompassed structure, cultural competence, and consistency and reinforcement prior to PD.

After PD, while attempting to implement CRT practices and facilitate SMP3, Mr. John's classroom management continued to be well structured and effective. His students were attentive and always on task. On the first day of the week-long lesson, he instructed his students to establish ground rules for working in groups. While reviewing those rules, he provided explanations to expound on his students' suggestions. Mr. John explained to his class that throughout the week they would be involved in a lot of group activity, so those established ground rules set expectations for the classroom management during group work. Throughout the week, Mr. John referred to those rules. His students were cooperative, which was evident from classroom observations. Although the amount of group work increased and was different for his students, classroom management was not a problem. The students consistently participated by raising their hands and going to the board to answer questions. They appeared to be comfortable with working in groups. This effective classroom management was consistent throughout the week. As a result, Mr. John's shift in his instructional style to implement CRT and facilitate SMP3 did not negatively impact the classroom environment.

At times, Mr. John struggled with asking questions to facilitate SMP3 and moving learning forward. In addition, his students struggled with Mr. John's shift in his instructional style. This was evidenced from classroom observations and Mr. John's journal prompt. His students were used to Mr. John providing all the steps to do mathematics problem. This created cognitive conflict. However, this cognitive conflict is consistent with what Hiebert et al (1997) described as the nature of mathematics tasks. Although the students experienced dissonance, this did not affect the classroom management structure. Mr. John's students continued to follow directions and work up to Mr. John's behavior expectations for them.

Although Mr. John's attempt to implement CRT practices and facilitate SMP3 within his classroom, his struggle was not related to classroom management. Rather, his struggle was related to his depth and breadth of knowledge of CRT and SMP3. In his reflection and informal interviews, he explained that he would improve upon his ability to use CRT and facilitate SMP3 as he gained more practice with both. This highlights the importance of classroom management. According to the studies of Simonsen et al (2008) and Milner and Tenore (2010), effective classroom management encompasses structure, cultural competence, consistency, and reinforcements. It was evident from classroom observations that Mr. John's classroom environment encompassed all four. As a result, the shift in his instructional style was smooth.

According to the aforementioned cases of Ms. Jane and Mr. John, classroom management played a major role in implementing CRT practices while facilitating SMP3. Use of CRT practices includes maintaining high expectations for students and positive interactions within the classroom. These practices are important as they help to establish the culture of the classroom environment. Furthermore, these practices include structure, cultural competence, consistency, and reinforcements within the environment (Gay, 2000; 2002; Ladson-Billings, 1994a; 1994b; 1995; NCCREST, 2006; Milner & Tenore, 2010). This establishment helps to create a healthy classroom culture where students are comfortable with engaging in mathematical talk, which is important when facilitating SMP3.

Study Limitations

A challenge of qualitative case study research is the construction of a specific case, which is identified by the researcher (Creswell, 2007). The researcher defines the bounded systems and determines the worthiness of the study. As a result, one limitation for this study is inherited from its research design. A second limitation is the timing at which the study was conducted. With a

short time limit, the selection of participants became increasingly important so that participants would have more CRT. However, the participants in this study lacked many CRT characteristics, which is also a limitation. The focus of this study was to describe the relationship between teachers' use of CRT to support student engagement. Although the selected teachers displayed the likelihood of using CRT, not all CRT practices were employed during the week-long lesson, so the classroom environment was not fully culturally responsive. Without the use of all CRT practices, a teacher undermines culturally responsive teaching. A third limitation is that the study was limited in scope; it focused on two middle school teachers in a particular school. A fourth limitation is mathematics teacher content knowledge. A finding in this study was that the teachers struggled with questioning to support meaningful mathematical discussions. Research on teacher content knowledge supports the notion that teachers' ability to facilitate "math talk" learning communities is connected to their content knowledge. Knowledge of the subject matter is a characteristic of CRT; however, the design of this study did not account for variations of mathematics teacher content knowledge.

Conclusion and Implications

This study explored the relationship between teacher practice and student engagement. More specifically, it explored two mathematics teachers' use of culturally responsive teaching practices to engage diverse students in constructing viable arguments and critiquing the reasoning of others. The following questions were used to guide this study:

1. What is the nature of the relationship between teachers' use of CRT practices and students' engagement in constructing viable arguments?
2. What is the nature of the relationship between teachers' use of CRT practices and students' engagement in critiquing the reasoning of others?

Four themes emerged from this study: (a) shift in teacher practice; (b) knowledge of the depth and breadth of CRT and SMP3; (c) teacher reflection and reception; and (d) classroom management. The findings highlight the nature of this relationship and will be discussed in the proceeding paragraphs.

Answering the Research Questions

As teachers transition to implement the Common Core State Standards, special attention must be given to the Standards for Mathematical Practice as they define specific student engagement practices that are essential in developing mathematically proficient students. This study is specific to SMP3: constructing viable arguments and critiquing the reasoning of others. This standard requires a shift in classroom environments where students engage in mathematical talk during the learning process. As a result, the social culture of the classroom and selected mathematical tasks become of great importance especially in environments of diverse students. A finding in this study suggests that a shift in teacher practice will support this reform. Both teachers demonstrated a shift in their practice; they demonstrated an increased ability to use CRT practices and an increased ability to facilitate students' engagement in SMP3. This was an expected finding as it echoes the research community as it highlights the notion that the center of change in a mathematics classroom is teacher practice (Hiebert et al, 1999; Huffer-Ackles et al, 2004). The shift in teachers' instructional practices resulted in a shift in their students' engagement in constructing viable arguments and critiquing the reasoning of others. As the teachers displayed more CRT teacher characteristics and demonstrated more CRT instructional practices, their students demonstrated more student engagement practices consistent with SMP3. The shift in teacher practice was clearly supported by professional development (Guskey, 2002), which included four components: (a) CRT; (b) mathematical tasks; (c) formative assessment; and

(d) student collaboration. Furthermore, it became clear that the teachers' reflections on their practice and the engagement of the students through the lens of CRT impacted the changes in nature of instruction and the level of engagement of students in SMP3. The observed shifts suggest that professional development activities may enhance teachers' ability to use CRT to effectively engage students in meaningful mathematical learning activities.

Another finding was that the participating teachers demonstrated varying levels of proficiency in the use of CRT instructional practices. It was particularly evident that each teacher exhibited a different set of CRT teacher characteristics and employed different CRT indicators. Variations in these characteristics and indicators related to each teacher's ability to engage students effectively. It became apparent that while the exhibition of specific CRT characteristic and practices draw a parallel to the skillful engagement of students in certain aspects of SMP3, teachers must demonstrate all characteristics and practices to engage students in activities that reflect all indicators of SMP3. Inversely, the lack of any of these CRT characteristics or the inability to use each of the practices to some degree undermines CRT as well as the depth and breadth of student engagement. This expected finding suggests that ongoing support and practical experiences should be provided during and after professional development to assist teachers with carrying out these practices within their classrooms (Guskey, 2002). It is important to note that professional development may provide an initial understanding of reform and make teachers more conscious; however, ongoing PD would provide teachers with more exposure to shape and modify their instructional styles.

The relationship between CRT and students' engagement in SMP3 is greatly impacted by the teacher's classroom management. This unexpected finding provided another lens on current research related to CRT and SMP3. Research on classroom management has shown that

teachers can maintain a positive classroom environment and increase student engagement through the use of evidence-based classroom management practices (Simonsen, Fairbanks, Briesch, Myers, & Sugai, 2008; MacSuga & Simonsen, 2011; Milner & Tenore, 2010). Bridging these studies of Simonsen et al (2008) and Milner and Tenore (2010) highlighted the notion that managing a positive/effective classroom environment where all students can participate encompasses structure, cultural competence, consistency, and reinforcement. Linking this research to the observations of this study highlighted classroom management. Use of CRT practices includes maintaining high expectations for students and positive interactions within the classroom (Gay, 2000; 2002; Ladson-Billings, 1994a; 1994b; 1995; NCCREST, 2006; Villegas and Lucas, 2002). These practices are important as they help to establish the culture of the classroom environment. This finding suggests that when implementing CRT and facilitating SMP3, special attention must be given to classroom management.

This study highlights three distinct points that relate to the nature of the relationship between teachers' use of CRT and their ability to engage students in SMP3. The relationship is strengthened by professional development with a focus on reflective practice and is greatly impacted by classroom management and teachers' depth and breadth of the knowledge of CRT and SMP3. The research findings suggest that teachers that make use of all components of CRT are more likely to effectively facilitate students' engagement in all indicators of constructing viable arguments and critiquing the reasoning of others, especially when working with students from diverse backgrounds.

Potential Study Implications

The findings of this study have several implications for efforts to support teachers' use of CRT practices to facilitate students' engagement in SMP3. It is the researcher's position,

supported by observations, that the shifts exhibited by the teachers are related to professional development and the subsequent teacher reflection. One implication of this study is that teachers will need strong support during timplementation of CRT. As the teachers in this study began to use CRT within their classrooms, they became more receptive to it as they observed a positive reaction from their students. In this study, the teachers were surprised by the reaction of their students in their first attempt to incorporate culture in learning and were open to improve on their practice with time. It follows that during initial attempts of implementing reform-based teaching practices, teachers are more opened to change. Therefore, continued follow-up and support are needed as they are essential to teacher change (Guskey, 2002).

The teachers in this study found that the use of CRT had a positive impact on their students' engagement. This speaks to the engagement gap between students of color and student of non-color, which provided a frame for this study. Because there are only two classrooms in this study, more research should be conducted on how CRT might be successful in engaging students of color in a mathematical talk community. Facilitating a community of mathematical talk includes questioning and explanations of mathematical thinking. The teachers in this study struggled with responding and asking questions as a means to further students' thinking. Teachers' ability to support students' communicating in mathematics is greatly impacted by their content knowledge and pedagogical knowledge (Fennema & Franke, 1992; Hill, Sleep, Lewis, & Ball, 2007; Schoenfeld, 1998; Ma, 1999). Another avenue of professional development is to help teachers attain knowledge of mathematics as well as knowledge of routines to support students' communicating in mathematics.

Another finding in this study highlighted the importance of classroom management when implementing reform-based teaching practices. Both teachers shifted in their instructional styles

to use CRT and facilitate SMP3; however, their classroom environment impacted their success. Without the establishment of structure, consistency, reinforcements, and cultural competence, the shift in the instruction may result in classroom dissonance, where negative student behavior issues take place. This in turn creates a classroom management problem, in which most of the time spent will be to order the classroom rather than on implementing reform-based teaching practices. To that regard, when creating teacher change, it is important for teachers to consider how their classrooms are managed. Support for classroom management may include peer teacher support, administrative support, and professional development.

Conclusion

The purpose of this study was to explore the relationship between teachers' use of CRT practices and students' engagement in SMP3. Research literature highlight a need to reform teaching practices in a way to transform instruction that raise the performance of all students including students from diverse backgrounds. The Common Core State Standards were designed to include challenging mathematics content and to engage students in application of mathematics knowledge through higher order thinking as a means to develop mathematically proficient students. A reformation of instructional practices with a focus on teachers' use of CRT practices is key to establishing learning environments that promote this level of engagement for students from diverse backgrounds. This is best achieved when students are engaged in a way that is connected to their cultural experiences. This study found that a shift towards the use of CRT instructional practice can be enhanced by professional development along with reflective practice. Furthermore it provides evidence that a teacher's ability to employ CRT instructional practices effectively is greatly impacted by their classroom management skills.

APPENDIX A: IRB APPROVAL LETTER

University of Central Florida Institutional Review Board
Office of Research & Commercialization
12201 Research Parkway, Suite 501
Orlando, Florida 32826-3246
Telephone: 407-823-2901 or 407-882-2276
www.research.ucf.edu/compliance/irb.html

Approval of Human Research

From: **UCF Institutional Review Board #1**
FWA00000351, IRB00001138

To: **Tashana D. Howse** and Co-PI: **Mercedes Sotillo**

Date: **March 01, 2013**

Dear Researcher:

On 3/1/2013, the IRB approved the following to human participant research until 2/28/2014 inclusive:

Type of Review:	UCF Initial Review Submission Form
Project Title:	A Case Study: Constructing Viable Arguments and Critiquing the Reasoning of Others in a Mathematics Classroom
Investigator:	Tashana D Howse
IRB Number:	SBE-13-09132
Funding Agency:	
Grant Title:	
Research ID:	N/A

The scientific merit of the research was considered during the IRB review. The Continuing Review Application must be submitted 30days prior to the expiration date for studies that were previously expedited, and 60 days prior to the expiration date for research that was previously reviewed at a convened meeting. Do not make changes to the study (i.e., protocol, methodology, consent form, personnel, site, etc.) before obtaining IRB approval. A Modification Form **cannot** be used to extend the approval period of a study. All forms may be completed and submitted online at https://iris.research.ucf.edu .

If continuing review approval is not granted before the expiration date of 2/28/2014, approval of this research expires on that date. When you have completed your research, please submit a Study Closure request in iRIS so that IRB records will be accurate.

Use of the approved, stamped consent document(s) is required. The new form supersedes all previous versions, which are now invalid for further use. Only approved investigators (or other approved key study personnel) may solicit consent for research participation. Participants or their representatives must receive a copy of the consent form(s).

In the conduct of this research, you are responsible to follow the requirements of the Investigator Manual.

On behalf of Sophia Dziegielewski, Ph.D., L.C.S.W., UCF IRB Chair, this letter is signed by:

[%electronic_signature%]
IRB Coordinator

APPENDIX B:
CULTURALLY RESPONSIVE TEACHING INTERVIEW PROTOCOL

Culturally Responsive Teaching
Interview Protocol

Initial Interview Questions

Instructional Practice/Style & Planning

1. How do you view your role as a mathematics teacher?

2. How do you normally plan to teach a mathematics lesson?
   Follow-up:
   a. Describe your methods for selecting curricula, materials, projects, activities, and/or assessments.
   b. How, if so, do your students play a role in your selection process?
   c. What resources do you draw upon when teaching students from various backgrounds?

3. Describe your typical mathematics lesson implementation from beginning to end.
   Follow-up:
   How often do you integrate cooperative learning, manipulatives, technology, and/or mathematics literature into learning?

4. Describe your expectations for student learning.
   Follow-up:
   How do you address students who struggle with mathematics?

5. How do you assist your students in seeing themselves as good in mathematics?
   Follow-up:
   a. How do you perceive your students' response to your mathematics instruction?
   b. Describe your students' feelings toward mathematics?

6. During mathematics instruction, describe your students' engagement?
   Follow-up:
   a. What types of student engagement do you prefer when you are teaching?
   b. What types of student engagement do your students' prefer?

7. What type of motivation strategies do you use to engage your students?
   Follow-up:
   Do you utilize open-ended questions? How do your students respond to them?

Knowledge of Students

8. In general, how would you describe your students, i.e. skills set, prior knowledge, general characteristics, parental involvement, support structure, academic performance compared to other students?
   Follow-up:
   How do you learn about your students and their backgrounds?

9. Describe the learning styles of your students.
   Follow-up:
   What strategies do you use to accommodate the diverse learning styles of your students?

10. What do you see as the greatest impediments to your students' learning?
    Follow-up:
    What do you do to off-set or address these impediments in your classroom?

11. How would you characterize your success or effectiveness as a teacher as it relates to your students' outcomes, i.e. standardized testing or academic progression?

12. How do you communicate high expectations for all your students?

13. What distinguishes you from other mathematics teachers?

Diversity in learning.

14. Describe the role of education and particularly the role of teachers in the social make-up of our country.

15. How would you define culture?
    Follow-up:
    a. Describe the links, if any, between culture and learning.
    b. What do you do to draw upon these connections?

16. How is culture/diversity reflected in your classroom, i.e. curriculum, instruction, or activities?

17. Describe the cultures of your students.
    Follow-up:
        a. How do you use your knowledge of your students' cultural backgrounds during instruction and/or interactions with them?
        b. Do you think it is necessary? Why or why not?

18. How would you describe your level of communication and interaction with parents?
    Follow-up:
        a. What are your strengths?
        b. How could you improve upon parental engagement to support student learning?

19. Have you heard of culturally responsive teaching? If so, what do you know about it?

20. If I define cultural competence as: 1) having intimate knowledge of students; 2) positive perspective on parents and families; 3) maintaining high expectations; 4) understanding student perception; and 5) using cultural difference as a catalyst for learning, how would you rate yourself as being culturally competent on a scale of 1 to 10 with 1 being the least and 10 being the greatest?
    Follow-up:
        What were your thoughts when you assigned yourself this rating?

Personal Background and Experience in Teaching

21. What is your race/ethnicity?

22. What is your gender?

23. What is the highest degree that you have earned? If currently in school, what degree are you seeking?

24. Is teaching your first career? If not, what were you doing prior to teaching?

25. How many years of teaching experience do you have?
    Follow-up:
        How long have you been teaching at this school?

26. Is there any other information that you would like to add or you would like for me to know that I did not ask?

Format for Informal Interviews

In addition to the initial interview, informal interviews will be conducted with the teacher after classroom observations. These questions will be derived from the researcher's classroom observations. Below is an example of the type of questions that will be asked:

Today I observed _____, can you tell me a little more about _____.

APPENDIX C: CULTURALLY RESPONSIVE TEACHING JOURNAL WRITING PROMPT

Culturally Responsive Teaching
Journal Writing Prompt

Lesson focus:

Describe the learning goal(s)?

Describe the CRT instructional strategies that you used in today's lesson.

How did your students respond to this lesson in comparison to lessons that you have taught before the professional development?

Reflect on the overall success of the lesson today. What went well? What did not go as well? How would you improve this lesson?

Directions: In the table below, please rate on a scale from 1 to 5, where 5 indicate "Excellent", 4 indicate "Good", 3 indicate "Average", 2 indicate "Poor" and 1 indicates "Very Poor". In addition, please provide a description for each question.

Questions	Circle one
Rate your students' ability to construct viable arguments.	Very Poor **1 2 3 4 5** Excellent
During instruction, describe how your students engaged in constructing viable arguments?	
Rate your students' ability to critique the reasoning of others?	Very Poor **1 2 3 4 5** Excellent
During instruction, describe how your students engaged in critiquing the reasoning of others?	
Rate your ability to use CRT to support student engagement?	Very Poor **1 2 3 4 5** Excellent
Describe how you feel about your ability to use CRT to support student engagement?	

APPENDIX D: CULTURALLY RESPONSIVE TEACHING & STANDARD FOR MATHEMATICAL PRACTICE THREE ANALYSIS INSTRUMENT

Culturally Responsive Teaching &
Standard for Mathematical Practice Three
Analysis Instrument
(CRT & SMP3 Analysis Instrument)

Part A: This section focuses on teachers' use of CRT.

CRT Teacher Characteristics Employed:

Directions: Check all characteristics that apply. Refer to Table 2 for descriptions of each characteristic. Use the space provided to document evidence of instructional practice employed.

, Socio-cultural consciousness

, Affirming attitude toward diverse students

, Serves as a change agent

, Knowledge of subject matter

Culturally competent

, Intimate knowledge of students

, Positive perspective on parents and families

, Maintain high expectations

, Understand student perceptions

, Use cultural differences as a catalyst for learning

,

Evidence of Constructivist Views of Learning:

Directions: Check all instructional practices that apply. Use the space provided to document evidence of instructional practice employed.

, Facilitator of learning

, Student-centered

, Positive interactions within classroom

, Diverse teaching strategies

, Redesign the curriculum

CRT Instructional Practices Employed:

Directions: Circle all that apply to the classroom culture. Use the space provided to document evidence of instructional practice employed.

Culturally validated instruction:

, Assists students in developing a positive self efficacy about their ability to do mathematics

, Assists students in positioning themselves in the learning of mathematics

, Uses students characteristics and experiences as a focus for learning mathematics

, Teaches mathematics concepts from multiple cultural perspectives to equally exemplify and embrace all cultures

, Displays student work & other artifacts illustrating personal and cultural identity of students

Culturally mediated instruction:

, Incorporates issues related to family, community, or schools

, Challenges students on issues related to family, community, or schools

, Mediates controversial intercultural issues among students to enhance any culture, group, or person while affirming individual heritages.

, Prompts student to student interactions among students of different cultures

Part B: This section will focus directly on student engagement.

Directions: Tally instances of each engagement practice. Describe each instance by documenting the situation/problem, the teacher actions including CRT characteristics and strategies, and the student actions.

Student Engagement Related to Standard for Mathematical Practice 3

Situation/Problem:

Construct Viable Arguments

Practice	Tally	Description of observation
Use stated assumptions, definitions, and previously established results		Teacher Actions: Student Actions:
Make conjectures and build logical progression of statements to explore the truth of their conjectures		Teacher Actions: Student Actions:

Practice	Tally	Description of observation
Analyze situations by breaking them into cases		Teacher Actions: Student Actions:
Can recognize and use counter examples		Teacher Actions: Student Actions:
Justify their solutions and communicate them to others		Teacher Actions: Student Actions:

Practice	Tally	Description of observation
Respond to the arguments of others		Teacher Actions: Student Actions:
Reason inductively, making plausible arguments that take into account the context from which data arose		Teacher Actions: Student Actions:

Situation/Problem:

Critique the Reasoning of Others

Practice	Tally	Description of observation
Actively listen to the arguments of others and decide whether they make sense		Teacher Actions: Student Actions:
Read arguments of others and decide whether they make sense		Teacher Actions: Student Actions:

Practice	Tally	Description of observation
Ask careful questions to clarify arguments of others		Teacher Actions: Student Actions:
Ask useful questions to improve arguments of others		Teacher Actions: Student Actions:

APPENDIX E: COMPONENTS OF SNEAKER DESIGN LESSSON

Name:
Period:

Sneaker Design

Name of sneaker:

Price of sneaker:

When picking a price remember how much it will cost to manufacture

Why you picked this price:

Sneaker dimensions:

Width:

Height:

Length:

Materials you want to use to make your sneakers' sole:

Materials you want to use to make your sneakers' middle:

Materials you want to use to make your sneakers' middle:

Why did you choose to use these materials:

Name:
Period:

3 Reasons why I should buy your sneaker:

1.

2.

3.

Name:
Name:
Period:

Data Collection Questions

1. Which way did you use to organize your data? Why did you choose this way?

2. Which two ways did you use to display your data? Why did you choose these ways?

3. Find the mean, median, mode, and range of the data. **SHOW ALL WORK!!**

   Mean:

   Median:

   Mode:

   Range:

Name:
Name:
Period:

Displaying and collecting Data

There are many ways to collect and display data. We have taken a pool of our favorite sneakers created and our data is displayed around the room.

With your partner I would like you to choose:

One way to organize your data

Examples:

- Frequency tables
- Tally chart

2 ways to display your data

Examples:

- Line plots
- Bar graph
- Circle graphs
- Line graph

Make sure you don't forget to provide titles, labels, and keys.

Student Name: _____

Date: _____ Period: _____

Sneaker Presentation

1. Name of Student Presenting: _____
2. Name of Sneaker: _____
3. Did the student include all the requirements? _____
4. What is your favorite thing about the sneaker?

   _____

   _____

   _____
5. What would you do to improve the sneaker?

   _____

   _____

   _____

Sneaker Presentation

1. Name of Student Presenting: _____
2. Name of Sneaker: _____
3. Did the student include all the requirements? _____
4. What is your favorite thing about the sneaker?

   _____

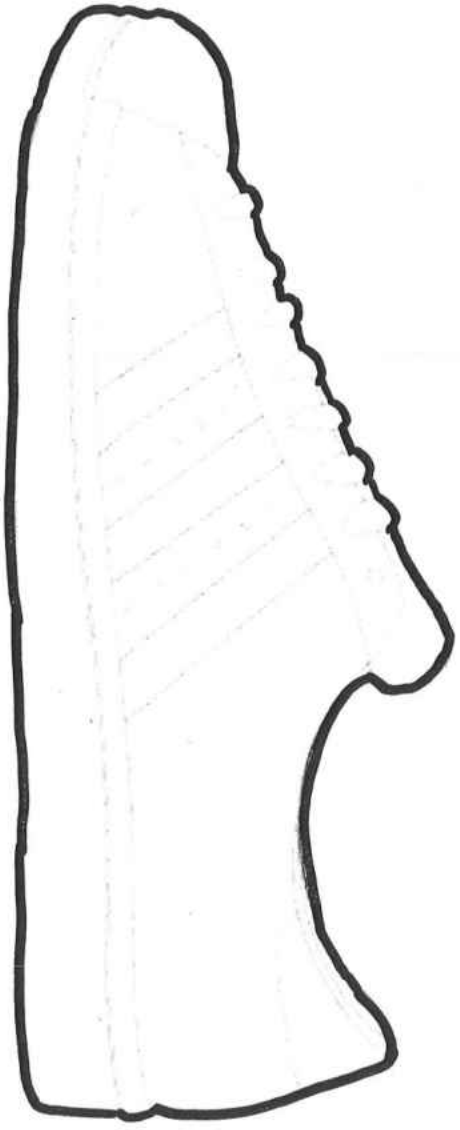
   _____

   _____
5. What would you do to improve the sneaker?

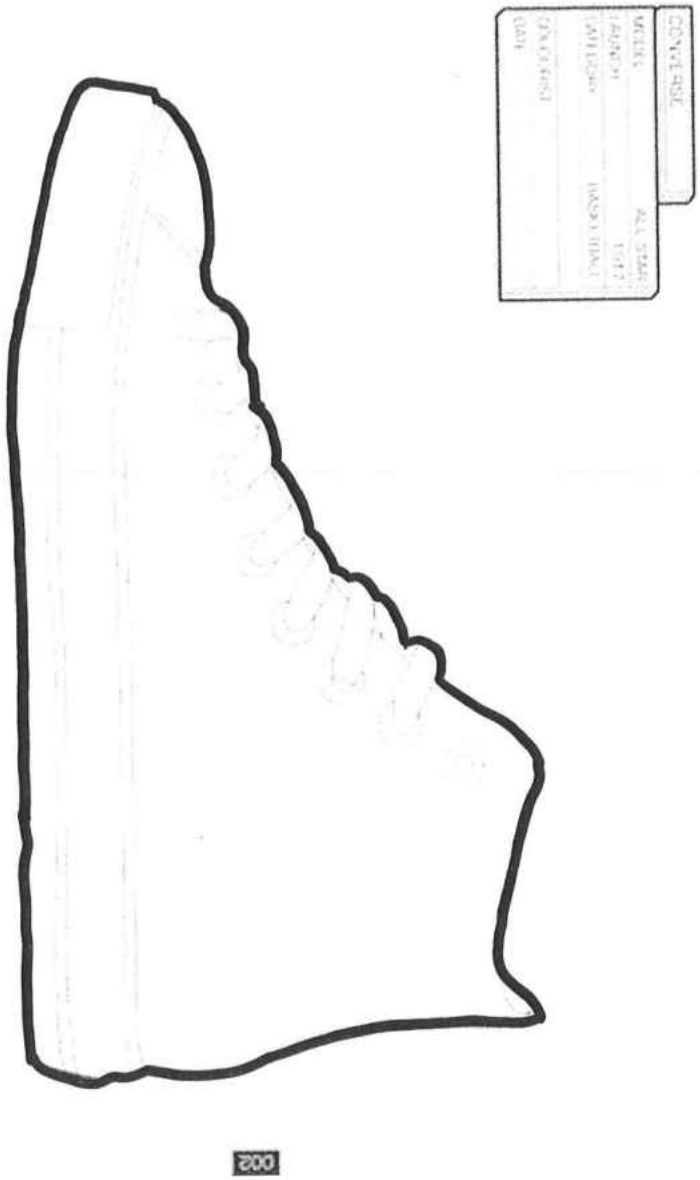
   _____

   _____

   _____




ADIDAS


CONVERSE

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