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District Certified Culturally Responsive Elementary Teachers and Their Mathematics Teaching Practices

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In this case study, the researcher examines how three elementary teachers, all certified by their school district in culturally responsive teaching (CRT) through professional development (PD) opportunities, implement CRT in mathematics. The study was designed to understand 1) the CRT certification process and structures that were intended to support teachers in the focal district, and 2) how the teachers were enacting CRT in mathematics based on these experiences. Data were collected via interviews, questionnaires, observations, teacher journals, and other reportable data. The teachers were enacting CRT practices that aligned with Hammond's (2015) Ready for Rigor framework, which includes awareness, learning partnerships, community of learners, and information processing. Yet, at times, the teachers engaged in CRT practices that were more thoroughly captured in other literature, including that in mathematics education. Thus, the researcher created an adapted model to display these findings about practice across four quadrants. From these findings, researchers in mathematics education may gain a more informed understanding of how elementary teachers may enact CRT in mathematics based on their backgrounds and experiences with a district-developed and applied certification model, rather than a researcher-designed PD with selected participants of practicing teachers.

KEYWORDS: culturally responsive teaching, mathematics education, teacher professional development, qualitative case study

Elementary school experiences set the stage for students regarding what it means to be a participant within a classroom community of learners. This critical time is also when students start to form beliefs about what it means to do mathematics and begin to develop their mathematical identities (Aguirre et al., 2013; Boaler, 2016). Additionally, for most early elementary students, attending school heightens their awareness of cultural differences, especially those between home and school (Civil, 2014). Therefore, it is pivotal that elementary teachers foster the

development of students' mathematical identities (e.g., Borman & Overman, 2004) and cultural identities (e.g., Moll et al., 1992). Gutiérrez (2018) says that "students should be able to feel whole as a person- [able] to draw upon all of their cultural and linguistic resources- while participating in school mathematics" (p.1). Thus, mathematics education has to reimagine and rehumanize how it serves historically marginalized learners (Goffney et al., 2018). This focus on teaching practices with historically marginalized learners has led to revived researchers' interest in studying critical pedagogies including culturally responsive teaching (CRT).

Although the theoretical framework for CRT has informed the educational community for quite some time, scholars (e.g., Hammond, 2015) continue to discuss the challenges of how to operationalize CRT. In the field of mathematics education, in particular, limited research on the teaching practices of culturally responsive teachers in pre-kindergarten through 12th grade has been conducted (Thomas & Berry, 2019). Bonner (2014) offers three reasons for why this might be the case, including: 1) the majority of the works are specific to one population such as African American learners (e.g., Ladson-Billings, 1994); 2) there is a broad focus on content and practice, making it non-mathematics-specific (e.g., Gay, 2010); and 3) the works remain largely theoretical (e.g., Greer et al., 2009). Additionally, there is a dearth of work addressing support structures (Thomas & Berry, 2019) and professional development (PD) opportunities (Bartell, 2011) intended to build caring relationships with learners and teachers' enactment of CRT. As such, this is an area that requires further attention.

The purpose of this case study is to examine CRT practices in elementary mathematics with three teachers who have been locally recognized and certified in CRT by their school district. Furthermore, the intent is to examine the CRT certification process in the focal district and the structures that supported the teachers in their enactment of CRT with historically underserved students.

Literature Review: Culturally Responsive Teaching

Theory of Culturally Responsive Teaching

Before examining CRT within the scope of this research study, it is important to ensure a clear understanding of this framework. CRT is defined as "using the cultural knowledge, prior experiences, frames of reference, and performance styles of ethnically diverse students to make learning encounters more relevant to and effective for them. It teaches to and through the strengths of these students" (Gay, 2010, p. 31). Gay (2010) outlines six tenets of the CRT framework:

> 1. Validating and Affirming: Teachers see their students' cultural differences as assets. They not only value the students' individual cultural

heritages, but they also use such knowledge to establish learning communities, inform teaching practices, and develop partnerships between school and home.

2. Comprehensive: Teachers are expected to "teach the whole child" for which students develop skills while maintaining their cultural identities (p. 32). There is an emphasis on maintaining high expectations both for the individual and for the group.

3. Multidimensional: Teachers have to attend to "curriculum content, learning context, classroom climate, student-teacher relationships, instructional techniques, classroom management, and performance assessments" (p. 33).

4. Empowering: "Teachers must show students that they expect them to succeed and commit themselves to making success happen" (p. 34).

5. Transformative: Students have to learn how to "analyze the effects of inequities… and become change agents committed to promoting greater equality, justice, and power balances among ethnic groups" (p. 37).

6. Emancipatory: Students are liberated from the single story of the truth and enabled to see from multiple cultural perspectives.

Gay (2010) cites Gloria Ladson-Billings' framework on culturally relevant pedagogy (CRP) as foundational to the framing of CRT. CRP is defined as "a pedagogy that empowers students intellectually, socially, emotionally, and politically by using social referents to impart knowledge, skills, and attitudes" (Ladson-Billings, 1994, pp. 17-18). CRP is a "pedagogy of opposition, not unlike critical pedagogy but specifically committed to collective, not merely individual empowerment" for which "the primary aim of CRP is to assist in the development of 'relevant black personality' that allows African American students to choose academic excellence yet still identify with African and African American culture" (Ladson-Billings, 1995, p. 160; Ladson-Billings, 1994, p. 17). A first step to enacting CRP is for teachers to develop sociocultural consciousness and care, prior to engaging in the tenets of CRP. Then, they can engage in the tenets that include: 1) providing educational self-determination (high expectations); 2) honoring and respecting the students' home culture (cultural competency), and 3) helping students understand the world as it is and equipping them to change it for the better (critical consciousness).

It is important to emphasize that the line between these two frameworks (CRP and CRT) often becomes blurred in the literature as researchers use the

language interchangeably and attempt to combine the frameworks (e.g., Aronson & Laughter, 2016). For instance, Gay (2010) stated,

> Although called by many different names, including *culturally relevant*, … and *responsive*, the ideas about why it is important to make classroom instruction more consistent with cultural orientations of ethnically diverse students, and how it can be done, are virtually identical" (p. 31).

Another example includes Bonner (2014) who labeled her work as culturally responsive while explaining that it was, "largely guided (theoretically and practically) by the work of Gloria Ladson-Billings and others who have developed foundational ideas of CRT in the literature" (Bonner, 2014, p. 380). Furthermore, scholars (e.g., Hammond, 2015) have introduced frameworks that claim to make CRT (combining tenets of CRT and CRP) more operationalizable in non-content-specific ways. All of these reasons make it challenging to distinguish between CRT and CRP in recent work. It is important to note such an overlay in literature due to how CRT was defined by the participants in this study.

In this study, my objective was to work with teachers who were certified by their school district in CRT. The professional development (PD) for the certification drew upon the work of Ladson-Billings, Gay, and other researchers who are cited as influential in the development of a CRT framework. As such, Ladson-Billings' framework on CRP, which is foundational within the CRT framework, was included in the study because of how it was operationalized with the study's participants. This study is grounded in the theoretical framework for CRT, both in theory and practice.

Operationalizing Culturally Responsive Teaching

While the theoretical framework of CRT has been used to inform educational research for decades, researchers continue to grapple with how to apply such theory to practice to see more responsive and equitable instructional opportunities for historically marginalized learners. Hammond (2015) claims that her work addresses a gap in the literature by making explicit, "the natural intersection between so called brain-based-learning and CRT" (p. 4). Hammond (2015) states that, "cognition and higher order thinking have always been at the center of CRT [citing both Gay's and Ladson-Billings' work] … [but], neuroscience offers a way to understand and organize our CRT practice" (p. 4). In her *Ready for Rigor Framework,* Hammond (2015) examines four practice areas or quadrants of CRT including: awareness (top left), learning partnerships (top right), information processing (bottom left), and community of learners and learning environment (bottom right). Hammond's work in educational, practitioner spaces has been reaching and widely

circulating. While there are numerous terminologies within this framework that could be examined, in what follows, I have focused on those that are most relevant to the study and the certification program and/or not as commonly discussed in the field.

In Hammond's (2015) framework, *awareness* is the first quadrant and the place to start as teachers reflect upon their intentions and examine their implicit biases by *widening their interpretation aperture* and *identifying triggers*. Widening one's interpretation aperture means that teachers, "let in more alternative explanations for students' learning behaviors and social interactions that look different from [their] own" (Hammond, 2015, p. 59). Identifying triggers means that teachers become aware of situations (often brought on by cross-cultural miscommunications) that cause them to be emotional and/or reactive, and they learn how to manage such emotions. In this first quadrant, Hammond also addresses the need to understand the three types of culture that are modeled with a tree, such that *deep culture* represents the roots, *shallow culture* represents the trunk and branches, and *surface culture* represents the leaves. Hammond (2015) claims that CRT must focus on *deep culture* or the "collective unconscious beliefs or norms that can cause intense emotional impact on trust"; she argues that by focusing on deep culture, a teacher can attend to universal patterns or similar *cultural archetypes* in a class that may be inclusive of learners of many different cultures (p. 24).

Information processing and *building intellectual capacity* are located in Hammond's (2015) third quadrant. Hammond (2015) emphasizes four macro-level instructional strategies, including: ignite (getting the brain's attention), chunk (making the information digestible), chew (actively processing new material), and review (applying the learning). Hammond (2015) discusses how CRT techniques can be embedded within these strategies, as well as the need for students to engage in cognitive routines that incorporate the sequencing of information in specified structures (i.e., similarities and differences, whole-to-part, relationships, and perspectives).

Despite the parallels Hammond has drawn between her work and CRT, there are tensions between how Hammond (2015) discusses student achievement in relation to the "achievement gap" and how district leaders have interpreted such comments. In Hammond's (2015) work, there is a strong emphasis on embracing CRT to close the achievement gap, which has made it an influential text in the certification program in William County (pseudonym), the focal district for this study. However, Hammond (2015) defines the achievement gap in terms of the identified differences in analytic readiness and effective information processing of learners based on their prior learning opportunities. Thus, she argues for rigorous teaching to build brainpower focused on high-order thinking, creative problem-solving, and analytic reading and writing skills as called for by standards-based teaching practices. While she discusses state standards, she is not advocating for

raising scores on standardized tests. Hammond stated, "You cannot call yourself a 'culturally responsive' educator if your purpose is to raise test scores rather than to liberate young people's spirits and ignite their intellectual curiosity" (Twitter, 28 August 2019). This tension between how Hammond (2015) discusses the achievement gap and how district leaders adopt such terminology was evidenced in the study. While Hammond (2015) examines CRT across disciplines, my purpose was to focus on mathematics in particular.

Culturally Responsive Mathematics Teaching in Practice

Although there have been numerous works (e.g., Ladson-Billings, 1994; Siddle-Walker, 2000) in education that have informed our understanding of teaching students from diverse backgrounds, the implementation in mathematics has been limited (Bonner, 2014; Thomas & Berry, 2019). Recent scholars (e.g., Bonner, 2014) have offered hypotheses for why there has been limited work in mathematics education focusing on CRT and have attempted to address such concerns in their research.

In the culturally responsive mathematics teaching (CRMT) framework, which was inductively constructed by Bonner (2011), teachers must first examine their own assumptions and truly believe in their students. Then, they are able to engage in the four cornerstones of instruction, which include relationships and trust, communication, knowledge, and reflection and revision (Bonner & Adams, 2012). These cornerstones are not mutually exclusive but always interact with one another. Knowledge includes mathematics content knowledge, pedagogical content knowledge, mathematics knowledge for teaching (Delaney et al., 2008), and knowledge of learners. This is the cornerstone that is unique to CRMT and makes it content-specific. Bonner and Adams (2012) illustrated the model center as the place where students are constantly involved in a cycle of pedagogy and discipline, including that of a warm demander. In a later work, the CRMT framework was revised, following a study with three participants, to include power (Bonner, 2014). Power refers to the "fluidity of power in the classroom" and the "shared power with students" (Bonner, 2014, p. 393). Although Bonner's work (2011; 2014; Bonner & Adams, 2012) has been used to generalize CRMT, there is a dearth of research focused on mathematics teaching and learning.

Thomas and Berry's (2019) qualitative meta-synthesis focused on peer-reviewed research articles that reported on studies grounded in CRP and/or CRT, preK-12 in mathematics education in the United States. As of February 2016, there were only 12 articles (including Bonner and Adams (2012) and Bonner (2014)) meeting the search criteria of high rigor as determined by the appraisal rubric in Thunder and Berry (2016). Thomas and Berry (2019) synthesized and interpreted the findings from these studies to understand how researchers interpret mathematics

teaching practices that support CRP and CRT. The five findings from that study include: care, context, cultural competency, high expectations, and mathematics instruction. A major finding for context and cultural competency was how teachers gained knowledge of the learners' lived experiences, cultural practices, linguistic resources, and funds of knowledge (Civil, 2014), and how the teachers worked to incorporate such knowledge into their mathematics teaching practices.

The implications of the meta-synthesis indicate that researchers still have a very limited understanding of what CRT and CRP look like in mathematics classrooms. In particular, it is unclear whether developing critical consciousness is emphasized in mathematics classrooms. The finding "mathematics instruction" suggests that there is a strong relationship between the enactment of CRT in mathematics and standards-based teaching practices (NCTM, 2000; Walkowiak et al., 2018; Thomas, 2021). However, more work needs to be done to examine what mathematics teaching practices, including the use of mathematics representations (Berry et al., 2017) and discourse, are most interconnected with supporting CRT (Thomas et al., 2024). Additionally, "It is not clear in what ways context and support within school [and district] communities are central elements in CRP and CRT" (Thomas & Berry, 2019, p. 29). As evidenced in the meta-synthesis, the relationship between care and CRT is highly supported in the literature. In Bartell's (2011) research synthesis, she discussed how care must be received by the students, noting the interconnection between care and affirmation. Furthermore, Bartell (2011) discussed the importance of care with awareness or building relationships by knowing your learners mathematically, racially, culturally, and politically that lead towards more equitable mathematics education. Bartell (2011) stated, "… little published work documents professional development models effective in supporting teachers in developing caring relationships with their students in the ways described [in the synthesis]" (p. 66).

PD has been discussed (e.g., Timmons-Brown & Warner, 2016) as a viable yet understudied area for impacting teachers' cultural and linguistic responsiveness (e.g., Song & Coppersmith, 2020). Timmons-Brown and Warner (2016) focused on a two-day conference on CRP that included conversations with Geneva Gay, Jacqueline Irvine, and Lawrence Clark, and examined the influence of the conference on practicing teachers. Through surveys and follow-up interviews (one-year post conference), Timmons-Brown and Warner (2016) found that even a short PD-related experience can improve teachers' confidence in their understanding of CRP and professional growth in understandings of differentiation, funds of knowledge, and desire to build relationships with learners. Song and Coppersmith (2020) discussed the importance of cultural and linguistic responsiveness PD and school and district-level support structures for in-service teachers. They were not seeing teachers from their teacher training program adequately addressing the needs of English

learners, largely due to mediating artifacts at the school and district level (Song & Coppersmith, 2020).

Purpose of the Study. Given that educational researchers still have a limited understanding of what CRT looks like in practice in mathematics education, I sought to conduct this study in an effort to expand upon the literature by linking research and practice (Cai et al., 2017). Furthermore, by focusing on CRT in elementary mathematics classrooms with teachers who have been certified in CRT through PD in a focal district, this study was designed to address a gap in the literature. Most teachers participating in research have been self-identified or researcher-identified rather than certified by district policies and supported by division-level structures in becoming culturally responsive.

Research Questions

1) How do teachers in William County become fully certified in CRT, and what structures support teachers in their enactment in the focal district?

2) How do three elementary teachers, who have been certified in CRT, implement mathematics teaching practices? How does the mathematics instruction support CRT?

Methods

For this study, I followed a case study design (Yin, 2018), examining three elementary mathematics teachers in William County who received certification within the same PD cohort and later worked to provide CRT practices for their learners. The purpose of this study was to learn about the certification process and district-level structures that supported teacher development and implementation of CRT, as well as the teachers' enactment of CRT in their mathematics classrooms.

Site: William County

The William County school district is located in a southeastern state and is known for its diverse student population, which includes over 90 spoken languages. The county completely surrounds the city center and is part of a sizable metropolitan area. According to the state's Department of Education, there are approximately 14,000 students enrolled in elementary schools in William County, from preK-5. Student demographics for preK-5 include Indigenous (<1%), Asian (5%), Black (11%), Latinx (13%), Native Hawaiian & Pacific Islander (<1%), Non-Latinx/biracial/multi-racial (6%), and White (65%). It should be noted that segregation is evident, such that elementary schools closer to the city center are more diverse than

those in the rural outskirts. Thus, geographic location and histories of urban areas are influential in the discussion of urban education (Martin & Larnell, 2013). Both elementary schools in this study were closer to the city center, and such diversity, with respect to race, ethnicity, and language, is evident in course demographics outlined below. Despite such diversity, the achievement of historically marginalized youth has been a major concern for the district due to state-level politics and accreditation standards. Regrettably, district leaders have situated conversations pertaining to student achievement around the "achievement gap" and urban concerns constructed from educational discourse, broader societal constructs, and that imagined (Leonardo & Hunter, 2007; Thomas & Sebastian, 2023).

Defining urban is complex, especially given the ways in which various actors in the district are operationalizing such constructs. Building on Milner (2012), the district, and in particular the city center, would be on a continuum of urban emergence and urban characteristics due to challenges and population. My own conceptions within this work "extend beyond the geographical contexts into the lives of people within the multitude of cultural, social, and political spaces in which mathematics teaching and learning takes place" (Matthews, 2008, p. 2), believing that such teaching must focus on the success and agency of urban students and attention to their social, cultural, and mathematical identities (Martin & Larnell, 2013).

William County's CRT Certification

In an effort to address student achievement in William County, leaders at the district level created a CRT certification program for preK-12 teachers, administrators, and counselors. Dr. Wayne (pseudonym), the Assistant Superintendent for School Community Empowerment, stated, "We have created a homegrown model, but it's research-based and evidence-based." In Spring 2016, four teachers represented the inaugural class of district-certified teachers. As of Spring 2019, 40 individuals had received certification. Of the certified teachers who are still teaching within the county, the majority are working at the elementary level, and no secondary mathematics teachers have received certification.

To become fully certified in CRT by the district, the teachers had to participate in approximately 20 hours of PD. Based on observations of PD opportunities, it was evident that the modules were developed by drawing upon the work of Gay (2010), Ladson-Billings (1994), Hammond (2015), and other scholars (non-content specific). In what follows, I will describe the general overview of the certification (Thomas & Sebastian, 2023).

First, teachers had to attend approximately eight hours of PD across three modules that focused on: 1) recognizing one's cultural lens, 2) engaging diverse learners, and 3) ensuring equitable parent participation. Individuals could attend

separate, smaller PD sessions for each module but were encouraged to attend a full-day event at the beginning of the school year. During the full-day event, division leaders alternated with presenting and leading activities while the participants were seated at round tables in groups of six to eight and engaged with the materials. Many of the activities were pulled from resources in Hammond (2015) to model and converse about differing levels of culture, examining one's own lens, and practices to build partnerships.

Second, individuals had to attend monthly (August-May) cohort meetings led by district leaders that were approximately one hour long. The purpose of these meetings was to unpack readings (e.g., Hammond, 2015) and engage in reflective activities in collaboration with colleagues. The three characteristics of the CRT certification program were: 1) acknowledging and incorporating the importance of cultural heritage for all students while reflecting on their own personal cultural influences; 2) providing multicultural instruction and differentiation for relevance and rigor; and 3) building positive learning partnerships with students and families. It was also possible to receive micro-certification by focusing on only one characteristic with a separate cohort.

Third, to become certified, individuals had to submit a portfolio in which they 1) demonstrated proficiency in the three characteristics of CRT and 2) showed "evidence of increased student achievement due to successful application of CRT strategies" (CRT Certification Model, 2015). Thus, the candidates engaged in a written reflection, in essay format, to document their growth in perspectives with CRT based on PD experiences and readings. They also spent the year within the program collecting achievement data on students to show growth with candidate-selected learning objectives, which was submitted in a report-style format.

Last, these portfolios and accompanying oral presentations, which generally included PowerPoint presentations, were evaluated at the district's Equity Conference each spring. The Equity Conference included further PD and individual presentations for each candidate. The candidates each had to present to their peers and a panel composed primarily of district leaders to determine whether their work (portfolio and presentation) was satisfactory. It should be noted that multiple individuals had completed the PD and presented at the Equity Conference but were not granted certification. Thus, the district took great pride in the rigor of the program and the quality of the portfolios presented.

Structural supports for becoming culturally responsive. Receiving certification was only part of the initiative when referring to the structures in William County that were designed to support individuals in becoming culturally responsive. There were structures in place that were intended to continually influence the teachers' learning and implementation of CRT. The structural hierarchy of

support and the county's Equity Model that had been in place for several years at the time of the study are illustrated in Figure 1 (Thomas & Sebastian, 2023).

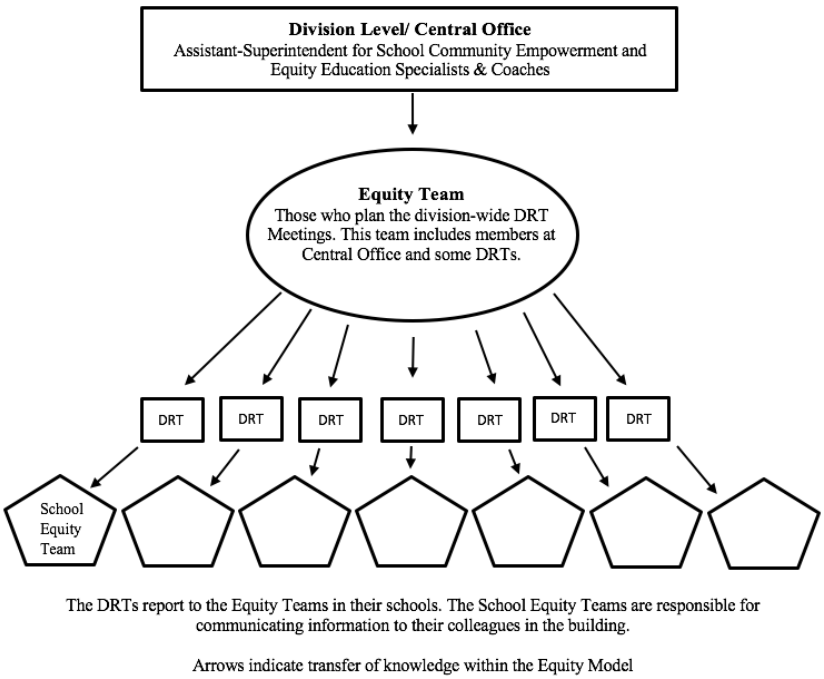

Figure 1. Equity Model (Adapted from Thomas & Sebastian, 2023)

At the top of the model are those at the division-level in central office, including Dr. Wayne and the equity specialists, Nick, Ashley, and Amy (pseudonyms), with each specialist assigned to specific schools each year. Following the division-level is the Equity Team for the county. These people (including those at central office) work together to plan for monthly division-wide diversity resource teacher (DRT) meetings. In 2019-2020, the Equity Team made it a priority for all PD to have a focus on CRT issues, and so they started referring to this level as the CRT Leadership Team. The DRT meetings each month are open to the public but are also specifically considered PD for folks who are DRTs or who are there for the CRT cohort meetings that break out during the second half. DRTs represent their schools and support smaller equity teams within their buildings. Up until the 2019-2020 school year, DRTs did not have to have CRT certification.

However, all DRTs must now have full CRT certification or be in the process of obtaining certification. It is also worth noting that the district had instructional coaches assigned to specific regions; however, only some of these instructional coaches were CRT certified. This means that in some regions, the instructional coaches could also come into classrooms and assist teachers with developing

their CRT practices in specific disciplines. There was not a distinguishable difference between district-level and administrative support at elementary schools, such as River and Willow Elementary (pseudonyms) (discussed below), and neither school were assigned mathematics instructional coaches that were certified in CRT. In the following section, I discuss the sample for this study, including the certified teachers.

Sample

For this study, I engaged in purposeful, criteria sampling to secure the consent of three elementary teachers who taught mathematics and were fully certified in CRT by the district across different grades and experiences. The three teachers in this case study were Skylar, Elizabeth, and Clay (pseudonyms). All three teachers were part of the Spring 2019 cohort to receive certification and were actively engaged in district structures to support CRT enactment. In Fall 2019, all three teachers were recruited for leadership positions in the district's Equity Model; Skylar and Clay both served as DRTs for their schools, and Elizabeth was a member of the CRT Leadership Team.

Skylar. Skylar was a pre-kindergarten teacher at River Elementary. She is a Black woman in her mid-30s, and she had taught for six years. Skylar identified with her lineage of strong, independent, Black women, and being a native of the geographic region of the focal district. She is "moderately" fluent in Spanish.

As a pre-kindergarten teacher, Skylar had a full-time aide in the classroom who was a White woman of German descent in her late-40s. At the time of the study, there were 18 students in Skylar's classroom including: 11 Latinx, 5 Black, and two of Middle Eastern descent. Additionally, 50% of the class was Spanish speaking. There were 11 boys and 7 girls, and Skylar indicated that many of the students came from "low-income homes."

Skylar did not have experience with CRT PD prior to receiving certification but it was clear that embodying such practices was what drew her to teaching. Data does not exist to document her practices before the certification.

Elizabeth. Elizabeth was a third-grade mathematics teacher at River Elementary. She is a Black woman in her late-20s, and she had taught for five years. She had been recognized by the district as being a distinguished teacher with honors during 2018-2019. She also described herself as being "moderately" fluent in Spanish.

Elizabeth taught in a multi-age classroom of second and third graders (her co-teacher was micro-certified in CRT), but she only had third graders for mathematics. Elizabeth described the students in her class by saying that nine were Black, one was White, two were multi-racial, one was Asian, and seven were Latinx. Further, eight students received English as a Second Language (ESL) services and one

student received special education services. She was very intentional about noting that none of the students were identified for the gifted program, and she stated that nearly 50% of the students were of low socioeconomic status, receiving free and reduced lunch.

Elizabeth was part of another study in her first, three-years of teaching in which the researchers were examining how novice teachers "take up" ambitious mathematics practices. Thus, data could become available for Elizabeth to observe her mathematics instruction from before she became certified.

Clay. Clay was a fourth-grade teacher at Willow Elementary. He is a White man in his late-40s who identifies strongly with being Jewish. He was in his 11th year teaching and is bilingual in English and Spanish.

Clay was part of a Spanish Immersion program at Willow, but he did not have a co-teacher; therefore, he had flexibility to teach mathematics in English since he planned all content. Clay had 20 students, 13 Latinx and seven White. The 13 Latinx students all came from homes of low-socio-economic status. In the class, three students had individualized education plans and 10 received ESL services.

In 2017-2018, Clay participated in micro-certification for CRT prior to going through the full PD for certification the following year. Yet, as with Skylar, data are not available to examine his practices before either certification.

To incorporate multiple perspectives, I also draw upon the voices and the actions of district leaders including Dr. Wayne, and equity specialists, Nick and Ashley.

Data Sources

In this study, I drew upon observations and unstructured interviews from district PD as well as questionnaires, journal protocols, classroom observations, and interviews of the three teachers. Each of these data sources are described in detail within this section.

District-level. During 2018-2019 school year, I spent approximately 20 hours collecting data by speaking with district leaders including the equity specialists, as well as by attending district-level PD to learn about the certification process in William County. For each event, I took detailed double-column fieldnotes, received copies of handouts, and at times, received access to online resources. This initial phase of the study informed the design of the case study and the data collection process. During the summer of 2019, I began collecting data (as outlined below) with teachers.

Mapping cultural reference points questionnaire. In order to gain an understanding of how teachers were pushing themselves outside of their own cultural boundaries, I had to first understand each teacher's cultural reference point. I utilized Hammond's (2015) posed questions (outlined on page 56) to have the teachers

reflect upon their surface culture, shallow cultural beliefs, and deep cultural values. These questions were distributed to the teachers following the first semi-structured interview (discussed later) and they were collected prior to my first-class observation. These questions were somewhat personal, and so, it was important to develop a rapport with the teachers prior to asking them to share their reflections. As such, the teachers were asked to respond to the questions that they felt comfortable answering and submit the protocol either in-person or digitally.

Teacher journals. A tenet of being a culturally responsive teacher is practicing self-reflection and building awareness (Hammond's quadrant one). Although teachers have to be reflective upfront, one of the key components of CRT is focused on how teachers react in the moment and how they use those experiences to inform their teaching practices in the future, as seen in Bonner's (2011) emphasis on revisions and reflections. Therefore, following each of the observed mathematics lessons, I asked that the teachers briefly reflect, (taking 10-15 minutes) using a journal protocol. The journal protocol was created to address the following: 1) whether the teachers perceived that they had to *widen their interpretation aperture*, 2) whether they experienced a *trigger* or an emotional reaction, 3) their own perceptions of how they incorporated CRT into their mathematics instruction, and 4) whether the lesson went as planned or where impromptu adaptations were made in the moment to account for students' needs and/or interests. Journals were collected in person and digitally. Through examination of these journals, I was provided a glimpse into each teacher's CRT mindset and the events and/or experiences that each teacher pondered when contemplating the question, "how can [I] show up differently in [my] relationship with students?" (Hammond, 2015, p. 53).

Interviews. The purpose of conducting the first round of teacher interviews was to understand the teachers' experiences in the CRT certification program and to examine how the teachers perceived their enactment of CRT in mathematics education. The first interview (Summer 2019) was semi-structured and lasted approximately 30-60 minutes (protocol in Appendix A). I conducted a second round of interviews (approximately 30-60 minutes) with all teachers, following observations to further unpack some of the emerging themes and findings, as it pertains to each teacher's CRT practices and to discuss support structures in the district. The second interview protocol is in Appendix B.

Classroom observations. By conducting classroom observations, I was able to observe what CRT looked like in practice and what factors were mediating instruction at the classroom level. I was able to observe the actions of the teacher inclusive of both how she gained knowledge about her students and how she used such knowledge to inform her teaching practices. Additionally, through observations, I gained a deeper understanding of the teacher-student interactions and whether those interactions led to positive learning partnerships and classroom environments. I used an observation protocol (Appendix C) drawing upon tenets of

CRT to observe each teacher's mathematics lessons (1.5 hours per day) for two consecutive weeks (the approximate time of a mathematics curriculum unit). I video recorded each lesson and collected data using double column fieldnotes. In two months (September and October), I was in Clay's class for 15 hours and both Skylar and Elizabeth's for 16.5 hours each.

Other reportable events. Other reportable events in this study are multifaceted. This category of data sources consists of notes from informal, unstructured interviews and conversations. Additionally, during classroom observations, I collected copies of assignments, student work samples, and photographs. I also continued to be involved in community partnerships and attended division meetings and school-wide equity meetings; such involvement led toward additional data collection points in these public spaces.

Researcher Positionality and Researcher as Instrument

As a former mathematics teacher, I am invested in work that focuses on teaching practices in preK-12 that make mathematics more accessible, equitable, and empowering for learners. My work on the qualitative metasynthesis discussed in the literature review provided insight into how limited literature is in our field and how imperative it is that we take steps to link research and practice to operationalize CRT in mathematics classrooms. I am not a proponent of using terminology that focuses upon the "achievement gap" or language that insinuates "gap gazing" (Gutiérrez & Dixon-Román, 2011, pp. 21-34) in any capacity as it does not adequately represent the inequities experienced by children in mathematics. However, it would be misleading to the audience to not acknowledge that district leaders within this study used language addressing the "achievement gap" in conversations and on documents for the certification program (Thomas & Sebastian, 2023). As the researcher, I was disappointed that key stakeholders in the certification program were not always intentional in framing the purpose as addressing the opportunity gap and the ways in which learners have been historically marginalized, and as a means for using CRT to best serve historically marginalized learners in achieving academic excellence.

I acknowledge my role as the researcher as an instrument. As the instrument, I administered the interview and observation protocols and made interpretations about all data sources throughout the entire research process. Thus, as Emerson et al. (1995) argue, my own "assumptions, interests, and theoretical commitments enter into every phase of writing...and influence decisions that range from selecting which events to write about to those that entail emphasizing one member's perspective on an event over those of others" (p. 167). However, I have made every effort to confront my own assumptions, engage in a systematic and iterative

reflective process, and triangulate data sources to address the nature of subjectivity in social science work (Erickson, 1986).

Data Analysis

For this study, I engaged in four phases of data analysis. Prior to collecting data with teachers, I worked to understand the district CRT certification. In this initial phase, I analyzed all double column fieldnotes, unstructured interviews with district leaders, copies of handouts, and online resources to make meaning of the PD opportunities, experiences, and supports. The questionnaire and the design of the interview protocol were influenced by my preliminary analyses of content covered in district trainings.

In the second phase of analysis, I analyzed data gathered from the questionnaires and the first-round of interviews with teachers. Both data sources were reread and analyzed, and I wrote memos to help me understand the teachers' cultural reference points and their own perceptions of their instruction and district experiences prior to conducting observations. I used these analyses to inform the classroom observations to help me to identify moments when teachers might engage in CRT on a personal, reflective-level, such as pushing themselves to think about scenarios from the cultural reference points of their learners versus their own.

The third phase of data analysis occurred concurrently with the collection of observation data and included my fieldnotes and memos (Corbin & Strauss, 2008; Miles et al., 2014). Following each day's observations, I read through my fieldnotes and the teachers' journal responses and examined the documentary evidence, writing memos and notes on what I observed and looking for patterns. I used the journals to examine each teacher's awareness, and whether the teacher was acknowledging similar incidences (triggers, strategies, etc.) as myself during the observations or whether there were patterns of alignment. I also triangulated data sources, attending to how such patterns corresponded to each teacher's questionnaire and interview, writing analytic memos to indicate initial themes across data sources. I used these analyses to inform the design of the second interview protocol. Both rounds of semi-structured interviews with teachers were recorded and transcribed.

The fourth phase of analysis was completed immediately after the completion of data collection and consisted of coding the transcripts, fieldnotes, journal prompts, questionnaire responses, and teachers' CRT portfolios from certification. To code data, I used Dedoose, a qualitative data analysis program, along with analytic memos to synthesize the codes and identify patterns in the data (Miles et al., 2014). I used a combination of deductive and inductive coding, such that initial codes were a priori codes, generated from the tenets of CRT and the research questions, while other codes emerged from data sources while looking for patterns,

useful grouping, and emergent explanations (Corbin & Strauss, 2015; Miles et al., 2014). Throughout this process experts in CRT reviewed excerpts and provided feedback on codes. I engaged in three rounds of coding and wrote analytic memos throughout the process to document my thoughts and emerging themes.

In the final codebook, there were four high-level codes: *district certification*, *structures and supports*, *CRT practices*, and *standards-based mathematics instruction* with varying sub-codes for each. Codes that were identified by focusing on the *district certification* include portfolio development and presentation and district-level PD opportunities. Codes for *structures and supports* that were influencing classroom instruction include rules and/or expectations/challenges, divisions of labor, communities (district, school, and classroom levels), and resources/tools. Codes specific to the *CRT practices* looked at care, critical consciousness (with students and parents), cultural competency, teacher awareness and reflection, gaining knowledge of learners, high expectations, partnerships (with learners and families), and power. Codes based on *standards-based mathematics practices* (i.e., explanation and justification, connections and application, discourse, cognitive demand, mathematical tools and representations, and problem solving) and learners' mathematical identity development were used to examine patterns of alignment with CRT. When examining the mathematical tasks specifically, codes emerged related to the relevance or meaningful connections for learners and whether the teacher was engaging in opportunities to differentiate the tasks based on learners' needs.

Once all data was coded, I built visual organizers to help make sense of the patterns that I was seeing and wrote memos to continue to track my thinking (Miles et al., 2014). As I began to formulate explanations for patterns, I also looked for rival explanations (Yin, 2018). Due to the complexity of the data, I engaged in member checking to ensure themes reflected the teachers' experiences and consulted regularly with colleagues to discuss alternative explanations. I examined patterns across data sources and compared confirming and disconfirming evidence, adjusting my findings until all of the evidence was accounted for.

Credibility

Since I was the sole researcher on this study, I engaged in numerous practices to establish and ensure credibility. From 2018-2020, I kept a methodological log to document all decision points within the research process. Furthermore, I engaged in peer debriefs and consulted with experts in the field about the study's design, data collection processes across multiple phases, and data analysis including emerging codes, themes, and patterns to ensure trustworthiness. Furthermore, data sources were triangulated (as described in data analysis) to document emerging patterns and themes.

Based on all of these methodological processes, I outline what I learned about culturally responsive teaching in mathematics classrooms in the succeeding section.

Findings: Culturally Responsive Teaching in Mathematics Classrooms

During my time working in the classrooms with the teachers, it became evident that their conceptions of CRT were highly influenced by Hammond (2015) and their PD experiences and cohort discussions of her *Ready for Rigor* framework. The findings are outlined in Figure 2.

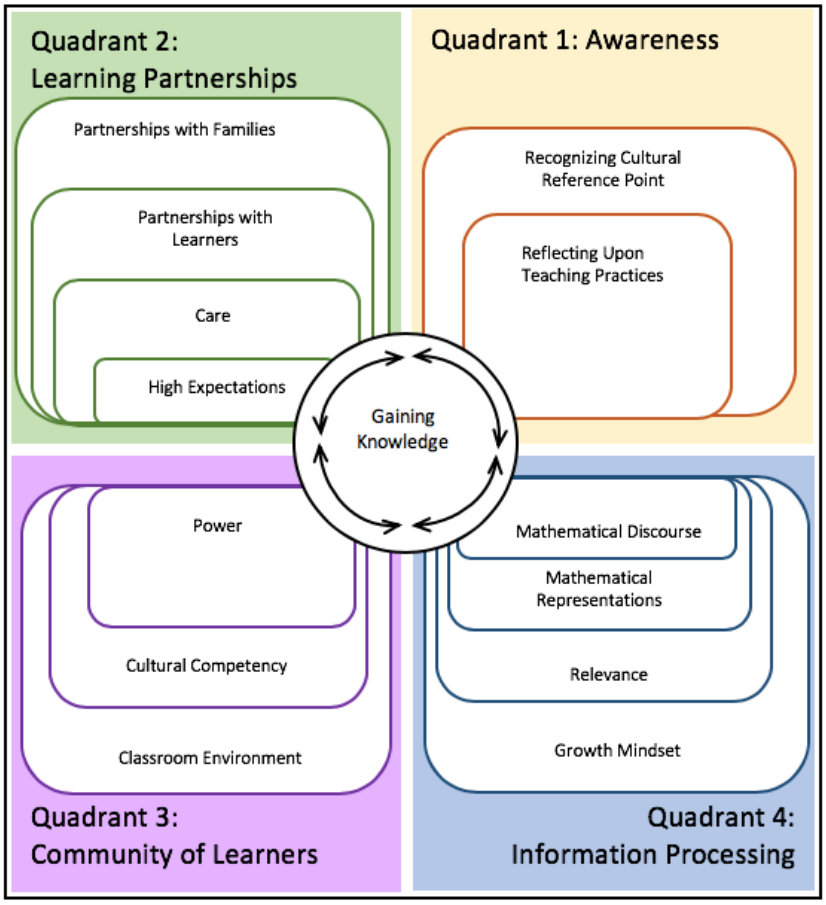

Figure 2. CRT in Elementary Mathematics Classrooms

However, similar to other works surround CRT, some of the components of each quadrant exemplified particular tenets that are more thoroughly captured in other literature (e.g., Gay, 2010; Ladson-Billings, 1994). The quadrants have been

reorganized (in numerical order) to mathematically model the coordinate plane and the ways in which the teachers went about building CRT at the beginning of the year (September-October). However, it is important to acknowledge that after the initial phase (of consecutive order), this is viewed as a continuous cycle without particular attention to order. These quadrants are not mutually exclusive, nor are the domains within each quadrant. Additionally, *gaining knowledge* has been placed at the center to further emphasize its importance across all quadrants and practices. Within the findings, I use excerpts from the three teachers to examine teaching practices. I have attempted to represent each teacher respectively. While there are numerous data points that could be utilized as evidence for each finding, I have selected excerpts that seem most appropriate.

Quadrant 1: Awareness

Awareness was demonstrated in the ways in which the teachers gained knowledge of themselves and their own cultural lens, especially during PD related experiences, and the ways in which they were reflective in their mathematics teaching practices.

Awareness of cultural reference point. During the certification program, *all* teachers were required to engage in critical reflection of their own cultural reference points. Some of the reflections were in preparation for their cohort meetings while others became the compilation of their essays for the CRT portfolios. These essays were intended to serve as models for ways in which the teachers were gaining awareness of who they are, and in return, beginning to understand how their own cultural experiences influence their perceptions and their teaching practices. Elizabeth also spoke about how listening to other people present at the CRT Equity Conference made her reflect more deeply upon her own perspectives.

> The ones [presentations] that I found the most fascinating were schools where their population might be majority White because for me, something that I had not considered was this idea that culture is not [just] like a race thing. Especially because I work at River Elementary, which is an extremely diverse school. It's super easy to consider culturally responsive teaching to be about race, when in reality, some of the things that I heard teachers facing with like individualist attitudes with students that are very dependent in math were happening in my room and were things that I was still charting through. (Interview 1, August 2019)

In this quote, Elizabeth, a Black woman, highlighted the fact that the program made her reflect upon cultural differences that were not rooted in race. Additionally, it can help educators/researchers recognize how students who may be very independent in general lack confidence in their mathematical abilities. Therefore, it was important for Elizabeth to acknowledge that in some cases, this lack of confidence

seems be rooted in stereotypes and stereotype threat that are grounded in other cultural norms (i.e., gender and/or socio-economic status).

In addition to having access to the teachers' portfolios, the questionnaire from Hammond (2015) was used to examine ways that the teachers were reflecting upon their deep cultural values on communication, "doing school," self-motivation, effort, and intelligence. In Clay's questionnaire, he wrote about how his values connected to effort were deeply rooted in ideals that his father had instilled, such as "If you work hard, you will be successful. By the same token, people who did not have as much, were viewed as people who did not work as hard." While Clay no longer believes that effort is the ticket to the American Dream and acknowledges social injustices, he knows that his values are deeply rooted and that he has to work to be patient with students who do not exert the amount of effort that he would deem appropriate. While all three teachers spoke of the importance of effort, as discussed in the section on high expectations, Clay's statements stand alone in their deficit point of view. Therefore, it is evident how pivotal it is for teachers to be overtly aware of their deep cultural values or previously held beliefs and how they might conflict with their students'.

Reflecting upon mathematics teaching practices. The journal prompts were used to understand how the teachers were being critical of their practice and working to make revisions. What is also noteworthy is how the teachers gained knowledge through their interactions with students and used this to revise their practice. This domain aligns with Thomas and Berry (2019) on high expectations for teachers and Bonner (2012) with reflections and revisions. In the following reflection, Skylar talks about her CRT practices in a lesson where her pre-K learners voted for their favorite apple type (after tasting each), by placing the color of apple of their choice on the class pictograph and collectively analyzing the data prompted by Skylar's questioning. In particular, it becomes clear that she is pondering what she should have done differently to best reach the needs of her students.

> … I noticed that this was one activity that I didn't put in English and Spanish. I think, I was rushing when making the materials. Because my class is about half Spanish speaking children, I try to incorporate their language as much as possible. That is the one CRT thing I wish I had done differently.

As observed in Skylar's response, she was demonstrating awareness surrounding her communication with students. The journal prompts allowed for me to gauge awareness on many different CRT practices including that of high expectations which was most discussed in this format when the teachers reflected upon triggers (generally behavioral).

Furthermore, the teachers provided insight into effective mathematics teaching practices through their journal responses. For instance, it was a common occurrence for the teachers to talk about how students discussed mathematical

representations or strategies that they had not thought of, but how they worked to incorporate the mathematics into the lessons, to examine any misconceptions, and/or to let their voices be heard. The following excerpt, taken from Elizabeth's journal prompts, is an example of such.

> … I'd thought that my students would only use the strategies I'd taught them for multiplication and division, but one of my students used a strategy that I hadn't considered. A student skip counted backwards by 6's starting with the product of 10 times six to get to the answer of seven times six because he realized that the answer to that was closer than making seven groups of six. It changed my perspective of what application looked like for my students.

What is not documented in this sample evidence is how Elizabeth discussed the boy's strategy with the entire class and later followed-up with the boy who utilized this strategy to learn more about his funds of knowledge and to further understand applications that were relevant to his lived experiences.

Quadrant 2: Learning partnerships

The quadrant of learning partnerships is about how the teachers were forming collaborative relationships with parents and students. When developing learning partnerships with students, the teachers were primarily practicing care and holding students to high expectations both academically and behaviorally. Furthermore, in order to form such partnerships, the teachers were continually gaining knowledge from families and students to inform their practices.

Partnerships with families. Prior to the beginning of the school year, all of the teachers discussed how they made attempts to connect with families before their students ever walked through their doors. All three of the teachers worked to set up home visits with the students' families. During the first interview, Skylar stated that she had two full-days of home visits scheduled, so that she could spend approximately 30 minutes with each family and informally gather information about learners. Likewise, Elizabeth and Clay both emphasized the informality of these visits and how vital they were in building the bridge between home and school.

While these initial interactions with families were crucial, all of the teachers discussed the variety of ways in which they were constantly attempting to strengthen such partnerships, especially through use of effective technological resources. For instance, Clay spoke of how he used the ClassDojo application to keep the lines of communication open with his families. Skylar acknowledged how she used the Bloomz application to share pictures, flyers, and updates with her parents and how she appreciated the app because it translated such resources into the parents' native language; Elizabeth used Bloomz as well and sent out weekly emails

to let parents know of their children's progress in mathematics and to reach out for advice when needed.

Furthermore, the teachers engaged in additional practices to gain knowledge from families, to keep them informed, and to collaborate. Both Skylar and Elizabeth highlighted how they generally sent home surveys to parents to gain knowledge about students and to plan for events, including dates and times that worked best for parents to participate. Similarly, at Willow Elementary, Clay was actively involved in organizing and hosting parent nights, where one had recently focused on multiplication and division strategies.

Social and educational capital. As Black women, both Skylar and Elizabeth were continually reflecting upon their own experiences and the experiences of historically marginalized youth. As a result of their perspectives, both women placed an emphasis on working with families to gain social and educational capital. Skylar made the following statement:

> We're partners for life and just because your child goes on to kindergarten I will always be here as a support. It's funny because I've had parents who I taught their child in second grade three years ago contact me when they need help or they're trying to navigate the system. And so, I really emphasize that with these preschool parents, because a lot of them this is their first child… As an educator, I am very cognizant about the influence I have on the lives of my preschoolers and their families. I want to take on the role of being their support and advocate.

As demonstrated within the previous excerpt, Skylar took the role of helping her families to develop social capital and navigate such systems quite seriously.

Unlike Skylar, Elizabeth spoke often about being a data driven person. This had caused her to grapple with the role of data and test scores with the CRT certification. However, she mentioned how standardized tests, though culturally bias, are the ticket to educational capital in such unjust social structures. She acknowledged on several occasions how being successful on such assessments opened many doors for her in terms of her own educational endeavors. Therefore, she advocated for helping parents and students understand the weight of these tests, particularly as we think about tracking in mathematics. Elizabeth's focus on helping families to understand educational systems pertaining to testing demonstrates early stages of her working to develop critical consciousness.

The development of critical consciousness (Ladson-Billings, 1994) was not evident with elementary students, aligning with other literature (Thomas & Berry, 2019). Likely, because the teachers did not feel that such conversations were appropriate or viable with elementary-age students. However, it is noteworthy that two of the teachers were very upfront about developing *consciousness* with parents.

Partnerships with students. Developing partnerships with students was consistently demonstrated by the teachers in how they modeled care for their students and in how they built upon those rapports to hold their students to high expectations.

Care. Care was witnessed in similar ways as defined by Thomas and colleague (2019) such that teachers were engaged in "a continuous cycle of working to establish a rapport, using knowledge gained from that rapport to inform teaching practices, and then, reflecting upon teaching and learning to understand learners' mathematical knowledge" (p. 26). Furthermore, having care means that the teachers would go the extra mile to gain knowledge about their students' experiences and honor each student's background and values even if it means that they have to push against their own. For instance, during my first several days in Clay's classroom, I noticed a Latinx boy who was triggering Clay (noted in his journals); from an outside perspective, I was initially concerned because the boy defiantly refused to join group discussions, would sit alone playing with manipulatives, and would at time throw the base-ten rods. With every outburst, Clay reacted patiently and positively with care, asking the boy what he could do to meet him half-way as a learning partner. One day after class, Clay shared with me that the boy did not like being part of a Spanish immersion class and he did not like having to speak Spanish. The boy had entered school in non-Spanish speaking classrooms, and by second-grade, he could no longer communicate effectively with his exclusively Spanish speaking parents. Thus, his parents had insisted that he be placed in the Spanish immersion program moving forward. Therefore, Clay spoke of the importance of honoring the boy's turbulent relationship with school. By the end of my observations, the boy was actively involved in the classroom community and even taking on leadership roles to help Clay. In this example, Clay engaged in *care with awareness* (Bartell, 2011).

Another component of care that was observed was how the teachers used proximity to demonstrate to students that they cared for them. For instance, it was particularly noted that when the Latinx boys in Clay's class were grappling with the content and the English instruction, he would walk over to them, and gently place a hand on their shoulder and begin offering clarification in a calm tone, generally in Spanish. Elizabeth practiced proximity by making sure that she was always on the same level (literally) as her students. Thus, when the students were seated on the carpet, she was seated right next to them, both for instruction and to move around and facilitate during independent practice (this also gets into power). Likewise, Skylar almost always sat right next to the students, but at the pre-kindergarten level, Skylar did engage in far more instances of having to physically console students as a family member would, when the students had emotional reactions. For example, during a lesson in which students voted on shapes for parts of their class jack-o'-lantern, Skylar was seen later carving the pumpkin while Camila held her tightly, sobbing, and rested her head on her bosoms due to emotional distress of a family situation.

High expectations. The teachers demonstrated high expectations in the ways in which they worked collaboratively with their students to help them set goals and

to help them take ownership or establish self-determination of their mathematics learning (Ladson-Billing, 1994). This often meant that the teachers had to act as warm-demanders to push the students to establish independence and to help them understand the norms that were expected of them within their classrooms.

All three teachers in the study had conference times or "check-ins" with their students during mathematics to not only formatively assess their students but to set plans for moving forward. Although these plans looked differently across the teachers, they all embodied similar ideologies. In Elizabeth's class, these conferences took place every Friday during "ketchup and pickle" time; this was when some students worked on assignments from the week (ketchup) that were not yet completed while others had free time to play (pickle) mathematics review games (with peers). During a conference with Sophie, Elizabeth began by having the two of them reexamine previously missed quiz questions (such as 4 x 4 and 1 x 9). During the conference, Sophie displayed growth by using skip counting as a strategy to reach the correct responses. They exchanged dialogue about how skip counting was Sophie's practice skill from the previous week and talked about whether she should keep practicing that strategy. It is important to note that Elizabeth asked Sophie how she felt about the skill and why; it was positioned as being Sophie's choice. In what followed, Elizabeth had Sophie revisit other questions from the week, and they continued back and forth exchanges about what skills Sophie should focus on in the week ahead. During the entire meeting, Elizabeth celebrated Sophie's success and vocalized how proud she was of her. As the meeting drew to a close, Elizabeth did a quick survey to gain knowledge from Sophie regarding what strategies (conferences, colored tiles, memorizing, expo, ST Math, Brain Pop, and array cards) had been helpful for her in developing an understanding of multiplication. Such conferences were conducted in a similar manner with all of Elizabeth's students. It is important to note that it was evident that the mathematics tasks discussed during these exchanges were not related to students' cultural context.

In Elizabeth's class, students often became very upset with themselves if they realized that they had not earned "pickle" time. I saw numerous emotional outbursts in which the students were frustrated with themselves for not following through and holding themselves accountable. Clay's conferences were modeled similarly as Elizabeth's. However, Skylar's were more subtle in nature given the age of the students. One statement that stands out from Skylar's check-ins with her students was that when the students would say "I can't," Skylar would always correct them by saying, "you can't yet." By emphasizing the "yet," together they focused on how the students could work to accomplish such goals. Also, all teachers had similar impromptu check-ins with students about classroom norms both with independent students and/or the whole-group based upon the circumstances. It is important to state that for these teachers, high expectations were discussed, developed, and maintained through their partnerships with learners and families.

Quadrant 3: Community of learners

Establishing a community of learners means that the teachers not only attended to the physical classroom environment, but they also focused on making sure that the environment cultivated within the classroom was one of acceptance, inclusion, and empowerment for the learners.

Classroom environment. Prior to the first day of school, all of the teachers spoke of how they wanted their classrooms to be welcoming for all students. Therefore, the physical space was often a first priority. Skylar spoke of the significance of labeling everything in the classroom in both English and Spanish for learners and their parents. This practice of displaying vocabulary, instructions, tasks, and activities in both languages around the room was a common occurrence in all of the classrooms. Clay also wrote the mathematical terminology of focus for the day in both English and Spanish on a large poster and placed it on the front board. The rooms were all strikingly multi-cultural including the reading centers which included books representative of many cultures.

During the first couple weeks of school and throughout the semester, the teachers continued to make efforts to get to know their students and to make them feel at home. Many of the bulletin boards displayed student pictures, poems, and artwork that family members might have displayed on a refrigerator. In Skylar's classroom, there were also various graphs that included students' number of siblings and favorite foods and activities. By having these displays in the classroom, teachers created a welcoming environment and learned about their students, while also creating opportunities for students to learn about each other. In the sections that follow, I examine teaching practices that led to cultivating an accepting and safe classroom environment (beyond physical space) for learners.

Cultural competency. Teachers demonstrated cultural competency by gaining knowledge of their students' cultural practices and using such knowledge to inform their mathematics teaching. This domain aligns with the work of Ladson-Billings (1994) and Thomas and Berry (2019). For all of these teachers, culturally competency was demonstrated in the ways in which they incorporated movement, music, oral storytelling, and communication patterns (these components are further illustrated in section for relevance). However, drawing upon students' funds of knowledge with language through communication patterns was by far the most emphasized component of cultural competency.

During my initial interview with the teachers, the only one who said that he was fluent in Spanish was Clay; both Skylar and Elizabeth were very modest regarding their ability to speak another language. However, by observing the classrooms, it became apparent that all of the teachers were able to switch back and forth between English and Spanish with ease. When questioned about this, both Skylar

and Elizabeth used terminology that indicated that they perceive themselves as being "moderately fluent." Skylar went on to tell me about how she was entirely self-taught and how she practices with her elementary-age daughter. When questioned about her incentive she made the following statement:

> … Some families come to me and they don't speak English, their child doesn't speak English, so that just really set on my heart, like what if this were me in another country where I knew not a word this person was saying, and I am trusting them with my most prized possession, my child, and I don't have another choice. Just my families is the biggest factor.

Furthermore, in the second interview, I asked the teachers about how they make decisions as it pertains to their communication patterns and when they make decisions to switch. Clay specifically spoke of the importance of having his students hear both, both for the Spanish- speaking students to hear English and the English-speaking students to hear Spanish. He felt like this was incredibility important so that students do not fall into habits and so that labels are not attached to students. On the other hand, Elizabeth, and Skylar both grounded their statements in drawing off of the students' energy and actions. Elizabeth stated, "… when they disengage you can see it…And I think with that, it's been more of a constant piece of, 'How do I bring you in the conversation?'". The cultural competency that the teachers demonstrated across the classrooms was an intentional move of drawing on the students' funds of knowledge to reorient them with the mathematics that was being discussed and to help them to process the expectations. However, I rarely observed cultural contexts within the mathematical tasks.

Power. Power refers to how the teachers were empowering students to take on leadership roles and to develop autonomy, how they were flipping the script when it came to who possessed knowledge in the classroom, and how they were celebrating student successes. This definition of power aligns closely with the work of Bonner (2014). Additionally, there was a strong link between high expectations and power. Skylar made the following statement, "When you give students their independence, you give them power." I thought that this was a profound statement, and it models what I was seeing across all three teachers' mathematics instruction.

Leadership was a significant part of empowering students. It was common to see the students take on leadership roles within the classroom. In Skylar's class, there was a little boy named Jacobie who made a habit of having a certain disregard for the rules. I believe that his behavior was grounded in the fact that he was slightly bored provided that he seemed to be very advanced in mathematics. Skylar would challenge him and empower him by letting him take over the instruction with her guidance. In the following observation excerpt we see this unfold.

> Nine of the students are seated at a table with Skylar. The students each have ten cards. Five of the cards have pictures of objects and the other five have

> corresponding numerical values (one through five). The students are told to match the cards. Skylar states, "Jacobie, I am going to let Jacobie take over. [repeats in Spanish]. I am letting him be the teacher. Jacobie starts with one. He holds up the one apple and matches it to the numerical value. He moves onto two. Skylar steps in for a moment, "Jacobie, sometimes, I do this [modeling] to check in with students." Jacobie continues to lead, following her example by explicitly counting the objects in the pictures aloud and showing his match to his peers, and then, checking in with each one of them before moving on to the next number.

I witnessed similar incidences play out with many different students across all three classes. Although it looked slightly different in each moment based upon the context and the mathematics being examined, all of the teachers were encouraging students to take the lead in the mathematics instruction at various points throughout the semester. It is important to acknowledge that by allowing for students to take on such roles, the teachers were pushing against the notion that they were the ones with all of the knowledge. Additionally, these small acts were empowering the voices of youth who have historically been silenced in the classroom.

In Clay's classroom, one of the most influential moments was when this transfer of knowledge and power happened with Valentin. Valentin had immigrated to the United States two years previously and had experienced much adversity. Clay said that in his previous classes he would sit at his desk and cry in silence most of the day, every day. Thus, even when Valentin was disruptive, Clay was just ecstatic that he was present, though he discussed his own triggers in his journal prompts. On the day of discussion, Clay had received high praise from an elective teacher about his class and their dedication to their projects using Minecraft. Although the content was not connected to the current mathematics unit, Clay acknowledged that in their projects the students had to build dwellings with entrances, windows, lights, which accounted for a great deal of mathematical application and reasoning, particularly of spatial awareness and geometry. After an accomplished first part of class, Clay let the students work on their projects in the latter half.

To speak frankly, Clay had no clue how to do much of anything in Minecraft. The students all wanted to help teach him, but it was Valentin who took the lead role in being Clay's partner. He was so proud of himself as he sat patiently beside Clay, going back and forth between his own computer and Clay's, and teaching him (literally) how to build the structures. What stood out more than anything else that day was the power of knowledge that Valentin possessed and the huge smile on his face that stretched ear to ear.

All three teachers went to great depth to acknowledge their students' mathematical accomplishments. This praise happened in individual settings, like the conferences previously discussed, during small groups, and whole class discussions. The teachers each expressed wanting to celebrate their students' ideas and accomplishments and to encourage the students to have high expectations for themselves. In the following observation excerpt, Elizabeth is on the carpet working with

a small group of students. She split the group in half. She asked the first group to turn and talk with a partner about a strategy for finding the product of three times five (no cultural context was applied to the task). Meanwhile, she is speaking in Spanish with a group of four students.

> [Re-groups]
> Elizabeth: Alright, talk to me…what is a strategy for multiplication?
> Sarah: Skip counting… 5, 10, 15
> Ray: Or 3, 6, 9, 12, 15
> E: What's a different strategy? Isaac, I saw a really good strategy that you were working on.
> I: Using dots
> E: Of equal rows and columns… That's called an array
>
> Isaac walks up to the board and begins to draw his mathematical representation or strategy. He draws two rows of three dots.
> E: Keep working… how many rows of three do I need?
> [Isaac drew six rows]
> E: Think about what you could do to show 3 x 5 instead of 3 x 6
> [Isaac erases one of the rows and they continue to discuss the strategy].

Although at first, this excerpt may not demonstrate power, this teaching moment carried out throughout the weeks of observation. Every time that the class talked about arrays, Elizabeth referenced to it as Isaac's strategy. Additionally, it is noteworthy that Isaac felt comfortable within their environment to take a risk by walking up to the board to show his strategy. Although Isaac originally drew the incorrect representation for the task that did not discourage Elizabeth from empowering his ideas and his strategy, referring to him as her "brilliant mathematician." She celebrated each one of her students' successes no matter how small using powerful language. There were similar moments like this witnessed across the classrooms with many different students.

Quadrant 4: Information processing in mathematics

Quadrant 4 is the finding that varies the most from Hammond's (2015) *Ready for Rigor Framework* due to the mathematics content. While there are significant overlaps, the domains discussed in this quadrant build upon teaching practices that are specific to mathematics education research and that attend to helping students to process information and develop conceptual understanding. These standards-based practices (NCTM, 2000; Walkowiak et al., 2018) accompanied with helping students to develop growth mindsets led to students processing the mathematics. In this finding, I outline how the teachers were talking about and making meaning of how to facilitate information processing in content specifics

ways. In other words, I attend to how the teachers were observed making sense of combining Hammond's (2015) work and effective mathematics teaching practices.

Growth mindset. Hammond (2015) states that a component of information processing includes, "providing appropriate challenge in order to stimulate brain growth to increase intellective capacity" (p. 17). While I witnessed the ways in which the teachers were giving their students tasks that required problem solving, using mathematical representations, and creating communities of discourse, the practice that stood out across all three teachers was the attention towards developing growth mindsets (Boaler, 2016) and mathematical identities so that students felt more confident in tackling such tasks without experiencing frustration. Thus, developing growth mindsets was a primary priority with all three teachers and acted as an umbrella for the other practices witnessed. The following observation except models what this process looked like in Clay's classroom.

> Clay has given the students a set of problems that each build upon one another and that all address finding the sum of cookies in a bakery on given days. Clay has been very explicit about how they are incorporating Cognitively Guided Instruction (CGI) and how he wants the students to model the problems using different strategies, tools, and mathematical representations. Clay gives the students time to work independently but he begins to notice that when the students cannot find the answers immediately or determine appropriate representations, they begin checking out mentally. Clay looks a little agitated and at one point, I hear him say, "this is driving me bonkers." About 15 minutes in, he calls a whole-group meeting on the carpet. He talked about how the problems made them feel a little uncomfortable because they didn't know what to do right away but that this was a feeling that they were going to have to get used to because when you are challenged that's when you are learning. They proceeded by talking about what it means to do math and to be "doers of mathematics."

In the previous vignette, Clay is seen trying to teach his students about what it means to learn mathematics and how grappling stimulates brain growth. In particular, he is emphasizing how they need to confront challenges with a growth mindset. It is also worth noting that these whole-group meetings to discuss the expectations and norms surrounding "doing mathematics" happened quite regularly across all three classes. In the domains that follow, practices, both specific to standards-based mathematics and CRT strategies, are discussed that assisted students in processing information.

Relevance. Relevance is being defined such that the mathematical tasks made connections to daily lived experiences and/or were made relevant by literature and/or media discussed within the class. I want it to be explicitly stated, that the mathematical tasks witnessed were rarely 'culturally relevant," such that the meaningfulness for students was not always clear.

Skylar in particular began nearly every lesson with a children's story or a video. She claimed that these sources ignited learning when following Hammond's

(2015) Ignite/Chunk/Chew/Review four macro level instructional strategies. Furthermore, these sources built upon oral storytelling traditions and/or music, provided that many of the video clips incorporated signing, rhythmic movements, and rhyme. These ignite activities were often used to help students to make connections to themselves and/or their environment. For instance, after watching videos about patterns, the students started to discover patterns on their shirts and on the tile floor. Additionally, Skylar took care to make sure that these ignites translated directly into mathematical lessons.

Elizabeth utilized a great deal of word problems (not culturally specific) within her instruction to unpack multiplication and division and to make it more relevant to the students. These word problems often focused on frogs in lakes, school bake sales, and skyscrapers (windows as arrays). For instance, one of the problems stated: "If there are four frogs in the lake, how many frog legs are there?". On a few occasions, she incorporated video clips like Brain Pop which disguised a multiplication lesson in a story about bank robbers. The students found the video humorous and entertaining.

Similar to Elizabeth, Clay also drew upon word problems to make connections. In the context of comparing numbers, he sparked student interest by talking about monetary values and racing competition on the playground. One of the more cultural examples that he incorporated had the students hypothesize over which musical artist, between Taylor Swift, Lil Nas X, and Panic at the Disco, was most popular. He then pulled up data from YouTube to have the students compare the values. When looking at addition and subtraction problems, most of the word problems related to cooking and class recycling competitions. Clay also incorporated numerous mathematical games into his instruction. For example, in one of the partner games, students each rolled dice (three) to create three-digit numbers and to compare their values with those of their partner. The person who created the largest number each round, received a point toward the score. As students advanced, he also let them add more dice. Clay claimed that in these games, the students were learning (comparing numerical values and discussing place values) through play and that they drew upon knowledge from games that many of the students played at home with their siblings and other family members.

Mathematics representations. Hammond (2015) discusses the importance of utilizing teaching practices that help students process and make connections to new content. In the mathematics classrooms observed, the teachers were all using multiple mathematics representations to help students build such connections to new materials. In addition to the presence of representations, the teachers were also modeling and translating from one representation to another (as illustrated in the following excerpt). These acts accompanied with time to "chew" on the information, were beneficial to students as students were able to engage in information processing.

To model this use of representations and the role of representations in information processing, I have drawn upon a teaching vignette in Clay's classroom.

> The students have been assigned the following four problems (written format):
>
> > 1. Kathy had 207 milliliters of water in her cup. She poured out 159 milliliters. How many milliliters of water does she have left? First, estimate. Will it be more or less that 207?
> > 2. Miles had 2,071 milliliters of water in his cup. He poured out 159 milliliters. How many milliliters of water does he have left?
> > 3. Sophia had 23,007 milliliters of water in her cup. She poured out 5,159 milliliters and then drank 150 milliliters. How many milliliters of water does she have left?
> > 4. Create your own problem [English or Spanish]
>
> Prior to letting students work independently, Clay reads the first problem aloud both in English and in Spanish (verbal representation). Additionally, they discuss what the term "millimeter" means in relation to ounces that appear on a student's water bottle. As he walks around the room, he encourages students to use the base-10 rods at their tables to model the first problem and to draw their own pictorial representations on their sheets of paper based upon the concrete representation. After the students have a representation for number one, he encourages them to connect the representation to the algorithm or the symbolic representation. During this process, Clay notices that Valentin is not actively participating. He walks over to have a conversation with him in Spanish and it becomes apparent that Valentin is not fully understanding the context of the problem. Clay and Valentine move to the back part of the classroom near a sink. Clay has the water bottle with ounces labeled on the side. He modeled what it means to "pour" water out of the bottle using water from the sink. Valentin watches the ounces on the side of the bottle. Clay and Valentine conclude by talking about how a millimeter is smaller than an ounce (looping back to the initial, whole-group conversation).

Through this vignette, it is evident not only how various mathematics representations were being utilized, but also how they were being connected in ways that helped the students to process the information. Additionally, we see Clay physically representing the situation, as he acknowledges that the language and context of the problem is presenting challenges.

Provided that the teachers were presenting and encouraging the students to use and translate between multiple mathematics representations, it should be stated that they were also encouraging the students to employ multiple strategies. In such ways, the teachers were engaging in equitable mathematics teaching practices, creating multiple access points for students.

Mathematical discourse. Hammond (2015) speaks of the importance of talking to learn or engaging in dialogic talk that is rooted in oral traditions. Hammond (2015) states, "we learn best when we are able to talk through our cognitive routines" (p. 134). Mathematical discourse was present throughout the lessons

observed. The three teachers were continually soliciting students' ideas and questions, allowing for peer-to-peer talk, and having students explain and justify their think, building their intellective capacity. In the following excerpt from Elizabeth's class, the students were thinking about the quotient of eight divided by four (non-contextual).

> Elizabeth: What strategy do you want to use? Start thinking… How am I going to work to solve this? [Students have time to work and talk with neighbors] How did you do it? Okay, so show me… we are going to do a whip around.
>
> Chase: I got eight tiles, and then, I split them into two groups of four.
>
> Elizabeth: Do we agree? Take your time. Think about your answer.
>
> Clarissa: I made four groups.
>
> Elizabeth: So, how many were in each group?
>
> Clarissa: Two.

It is also important to add that every time a student gave an explanation, Elizabeth wrote a representation on the board. In the conversation that followed, Elizabeth and the students talked about fact families and the similarities and differences between the students' methods and representations. From the discourse observed in the excerpt, it is evidenced how the teachers were asking the students questions to gauge their understanding and simultaneously doing formative assessments.

Limitations

Sampling for participants at the K-2 level was complicated by the fact that all teachers who met these sampling criteria were part of Spanish immersion programs and the mathematics instruction was only delivered in Spanish. Provided that I am not fluent in Spanish, they could not be considered as participants; therefore, I do not have a participant in the K-2 grades. However, the teachers selected each bring insight to this work based upon their unique contexts. The yield of data collected across the teachers could be considered a limitation because not all of the teachers approached the journal prompts with the same commitment. Elizabeth was by far the most reflective on the journals while Clay often wrote brief statements. Further, I note that in the interview protocols, many of the questions are broadly asking about CRT across teaching contexts due to the PD being non-content specific, but I acknowledge that this framing may have limited the specificity in mathematics.

Discussion & Implications

Based on the study's findings, it became apparent that teachers who were trained in CRT in the focal district are aligning their teaching practices with the *Ready for Rigor* framework, indicating that the PD was influential (as with Timmons-Brown & Warner, 2016). This was especially true for those experiences related to text reflections and cohort conversations and presenting at and observing peers at the CRT Equity Conference. However, there are tenets of CRT based upon the works of Gay (2010) and Ladson-Billings (1994) that are more profound in practice in these teachers' mathematics classrooms than witnessed in Hammond's (2015) framework. Thus, Hammond's framework was adapted (see Figure 2) to illustrate what was happening in practice. Note that *gaining knowledge* and using knowledge to inform practice is at the core of this model.

Quadrant 1 on awareness aligns closely with Hammond's (2015) first quadrant. Quadrant 2 aligns broadly with Hammond's (2015) perception of partnerships, but in practice, Thomas and colleague's (2019) finding of *care* and Ladson-Billing's (1994) framework for *high expectations* are more pronounced. Quadrant 3 also aligns broadly with Hammond's (2015) conceptualization of community of learners but the domains for *cultural competence* and *power* align with the work of Ladson-Billings (1994) and Bonner (2014) respectively. Last, although the ways that the teachers thought through providing opportunities for information processing align with Hammond (2015), the practices that they were enacting are evidenced in standards-based teaching (NCTM, 2000). However, it should be explicitly stated that the teachers within this study rarely made the context of the mathematical tasks culturally relevant. The mathematical practices would be strengthened by making the tasks more culturally relevant to the lived experiences of their students.

When considering these findings, one can expand upon the literature (e.g., Bonner, 2011; Bonner; 2014; Thomas & Berry, 2019) and continue to inform understanding of how to operationalize CRT in elementary mathematics classrooms in different contexts. However, more work is needed to expand upon this relationship between CRT practices and standards-based mathematics teaching practices (Thomas et al., 2024). Furthermore, more work is needed to examine how teachers' mathematics knowledge for teaching or mathematics content knowledge impacts CRT practices in elementary mathematics classrooms.

Given that this research was conducted in a district that has implemented a CRT PD certification program and has delineated support structures for CRT enactment, the findings may be used to contribute to literature regarding district-level structures that have the potential to influence CRT practices (Thomas & Sebastian, 2023). However, more work needs to be done to examine what specific elements are impacting the teachers' CRT instruction on a daily basis and how they perceive

the influence of such elements. Furthermore, the scope of the impact of the CRT certification on the teachers' instruction is not clear without a comparison of the teachers' instruction before certification. Lastly, more work needs to be done to examine how mathematics instruction might further support CRT with content-specific PD.

As outlined by Thomas and colleague (2019), although developing critical consciousness with students is a central tenet of CRT, it is often excluded in practice. Thus, a question raised from this study includes the role of culturally responsive elementary teachers to develop consciousness with parents. This is an area that has not been fully developed in the literature. Although, this study contributes to bridging the gap between research and practice with CRT (Cai et al., 2017), it also raises a significant number of questions that call for further dedication to CRT.

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Appendix A

First Interview Protocol

1. What were your educational experiences?
2. What is your teaching background?
3. What were your experiences with receiving Culturally Responsive Teaching (CRT) Certification?
    a. When?
    b. Micro-certification or full-day professional development (PD)?
    c. Who led the PD?
    d. Describe portfolio development and presentation.
4. How do you practice CRT with students?
    a. Gain knowledge and use it to inform practice?
    b. Develop relationships? Build bridges between school and home?
    c. Empower students?
    d. Hold students to high expectations?
    e. What is specific to mathematics?
5. What factors influence your CRT practices?
    a. Mathematics content knowledge/Mathematics Knowledge for Teaching/Pedagogical Content Knowledge?
    b. Resources?
    c. Are there structures in place that support your implementation of CRT? In mathematics?
    d. Challenges?

Appendix B

Second Interview Protocol

1. The first interview took place before school started, therefore, please describe the demographic breakdown of the students in your class.

2. Can you describe how your mathematics instruction supports CRT? In particular, is there anything that you feel like you are doing differently this year compared to last year, since you spoke about last year in the first interview.

3. How do you make decisions about communication patterns?

4. Have you attended an PD related to CRT this semester? Please describe.

5. Have you given any PD related to CRT this semester? Please describe.

6. What supports are in place to help you enact CRT?

7. Show them the Equity Model, Figure 1. From your perspective does this accurately illustrate division structures. From your perception, how does this play out? Discuss each tier in the model.

8. Are you continuing to apply the process of CRT certification this year?
   Looking at student achievement data

Appendix C

Observation Protocol

Culturally Responsive Teaching
Awareness (Teacher): -Reflection (personal reflection) -Revisions
Knowledge: -Knowledge of Learners -culture and cultural practices -home/community -funds of knowledge -mathematical identity -Mathematics Knowledge for Teaching -Mathematics Content Knowledge -Pedagogical Content Knowledge
Teaching Practices: -How do teachers learn about their students? -How do they incorporate such knowledge (about learners) into their instruction? -How is the mathematics communicated to students in culturally connected ways? -Does the teacher display cultural competency? -What does the mathematics instruction look like?
Learning Partnerships: -Relationships -Caring -Classroom management/Warm demander
High Expectations for Students: -Self-determination
Power: -Critical consciousness -Agency
Community Partnerships: -Efforts to bridge school and home -Reaching out to parents/families