PLANNING FOR EQUITY: AN EXAMINATION OF PRE-SERVICE TEACHERS' CULTURALLY RELEVANT MATHEMATICS LESSON PLANS

A Dissertation

by

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ABSTRACT

This scholarship is based on research conducted by members of the Knowledge for Algebra Teaching for Equity (KATE) Project, a 5-year National Science Foundation (NSF) funded grant that employed strategies in the context of a mathematics problem-solving course. The 29 participants included students enrolled in this course who were engaged in practice teaching that was set in a three-dimensional virtual middle-school classroom in Second Life.

A central purpose of this study, then, was to determine what areas of culturally relevant pedagogy (CRP) must be addressed in more detail among PSTs. I provide a rubric to assist in the analysis of mathematics problem solving lesson plans for CRP. Further, I look specifically at the PSTs' rationale for why they felt their lessons were culturally relevant, and justify why I believe the lesson does or does not align with this pedagogy, and more specifically, argue that cultural relevance exists both in the planning and delivery of a mathematics lesson.

Two instruments were utilized in this mixed-methods study, the Mathematics Rubric for Implementing Cultural Relevance (M-RICR), and the Diversity Preparedness Response Inventory (DPRI). Each of the 29 lesson plans were deconstructed to discover themes in how successful the PSTs were in implementing culturally relevant tenets into mathematics lessons designed for a virtual environment, as operationalized in the M-RICR, and the content analysis is discussed through the use of descriptive statistics. The DPRI data was useful in determining how the PSTs' diversity awareness and beliefs towards equity changed.

The findings indicated that four themes (i.e., familiarity, age group, for all, and real-life) arose from the content analysis depicting the PSTs' justification of their lessons as culturally relevant, and that the PSTs did particularly well with indicators within the tenet of academic

excellence and critical consciousness. Though most of the lesson plans were placed in the superficial category, there were noteworthy trends in how the PSTs implemented individual M-RICR indicators. Lastly, the DPRI data showed that diversity awareness and knowledge about teaching algebra for diversity were impacted most profoundly by one of the guest lectures and the presentation of the lesson within Second Life.

DEDICATION

I would like to dedicate this intellectual artifact and all the work that it required, to both my mother, Debbie Lorraine Warfield (Ms. Lady) and my grandmother, Rosa Bell McQueen-Sutton (Nana). Without their words of encouragement, their prayers, their emotional and physical support, I am not sure I would have finished. I am thankful for their examples of strength and understand that every word captured here is a reflection of the life lessons that I have experienced with them. But most of all, I am most grateful for their willingness to show me what obedience to God looks like. I believe that this dissertation embodies the substance of things hoped for and the evidence of things not yet seen, and for that reason, this dissertation is a result of their willingness to guide me towards Christ's love.

More generally, I dedicate this dissertation to every Black child that has at any point doubted their mathematics acumen. I know what it's like to be rendered incompetent in the mathematics class because teachers lack the ability to see your genius. This dissertation is a reflection of a story that mirrors our realities, and it sets aflame this desire to prepare teachers who are more apt at addressing your personal needs. This dissertation is a starting point and a promise that I will participate in the endeavor necessary to make yours a more meaningful mathematical enterprise, one that celebrates you and advocates for you. I will do this by speaking to your future (and past teachers), and my vow is captured in these 150+ pages, little brothers and sisters.

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process, the job search, and whether life was meant to be this way, haha. They never ceased to keep me calm and to provide superb feedback.

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Last but certainly not least thank you to my committee. Dr. Davis, you have been a crucial part of every step of this process. Thank you for the edits, for the time commitments, for the advice pertaining to my research questions and design, chapter development and discussion, as well as language choice. You have helped me to create a narrative that is well-rounded in the story that is being told but that appropriately conveys the lens through which I am analyzing these data. There were many nights and early mornings that were a part of this experience, and there were moments that made me reflect, reconsider, and celebrate. I thank you for your willingness to support me on this journey and I hope this dissertation makes you proud. Dr. Larke, you have been an incredible source of wisdom and advice. Thank you for the many holidays at your house and for providing me the family that I did not have in Texas. Thank you for answering my calls and shaping who I am as a researcher. Because of you I was able to center ideas around a research question, a title, a design, and a discussion. Dr. Slattery, I have learned so much from your classes, as you are the committee member with whom I have taken the most classes. You have introduced me to new vocabulary, new philosophers, and new ways of thinking. I appreciate your approach to the academy and your thrill for new knowledge (whatever that is). Because of you I learned to "juxtapose two ideas that have never been juxtaposed". Your influence is seen throughout my literature review and my discussion. Dr. Blake, you have been a model of mentorship that I never knew could exist at a PWI. You have shown me that mentoring is something that is learned and perfected, and you have shown me what it means to care for your students and to push them towards new heights. You have been my professional older sister with the jokes and the Black intellect. Because of you I was prompted to consider the psychometrics of this dissertation.

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CHAPTER I

INTRODUCTION

This study is situated in the Knowledge for Algebra Teaching for Equity (KATE) long-term research project to develop a problem-solving course aimed at enhancing the beliefs about and abilities of preservice mathematics teachers to address the needs of diverse students (Brown, Davis, & Kulm, 2011; Davis et al., 2015). Within the past decade, there has been a concerted effort among scholars to explore more equitable teaching practices to account for the access, achievement, culture, and identity of students who come from nondominant backgrounds (e.g., Esmonde, 2009; Gay, 2007; Strutchens et al., 2012). There has been a consensus within the research that aims to become more critical about the way content is taught and how the current system of education inadvertently sets some students up for success and further marginalizes others (Diversity in Mathematics Education Center for Learning and Teaching [DiME], 2007; Nasir & Hand, 2006; Wager, 2014). Within mathematics education specifically, the National Council of Teachers of Mathematics (NCTM) has as one of its guiding principles a commitment to access and equity (Leiwand et al., 2014). NCTM has stated that "our vision of equity required being responsive to students' backgrounds, experiences and knowledge when designing, implementing, and assessing the effectiveness of a mathematics program" (p. 60). Yet, mathematics researchers are forthright in stating that this policy is not without nuances that must be critiqued and perfected (Gutierrez, 2008; Martin, 2009; Tate, 2005), and suggest that teacher preparation programs must embody ideals of equity, cultural competence, and access.

Both researchers and practitioners are beginning to establish similar sentiments regarding equity and how an appreciation for learners' cultural, social, and linguistic contexts promote

their engagement and achievement within mathematics education (Boaler, 2011; Berry & Ellis, 2013). This contention directly translates into the teachers' understanding of their own pedagogical strategies. Aligned with this heightened notion to prepare mathematics teachers to address issues of equity, the KATE Project researchers utilized a hypothetical learning trajectory that characterized "teachers' use of strategies to engage and motivate diverse students in learning algebra" (Brown, Davis, & Kulm, 2011, p. 268). As such, the KATE Project is working to address a principle that NCTM has deemed particularly vital to future learners of mathematics.

Part of the scholarship presented here is a challenge to the deficit thinking that has plagued so many students of color (Jett, 2013), and that has contributed to a mathematics curriculum that often times fails in its potential to be truly equitable for all students. In building a research agenda, I have begun to think about sources of the problem, and to reframe the idea of the achievement gap as "a problem with the pedagogy and not a problem with the students". In this regard, the focus of this study is to analyze how teachers plan, antecedently, to make mathematics instruction more reflective of the experiences that students bring into the classroom, in ways that are advocated by the guiding principles of NCTM and that mirror what has been acknowledged as equitable teaching. It is necessary to reconceptualize the sources of access that students have to a rigorous curriculum, and, thus, the infusion of cultural competence and equity is a promising medium to help depict more diverse pedagogical strategies.

In this vein, my research focuses on how teachers plan for implementing cultural relevance and discusses how successful one group of pre-service teachers are in attending to these efforts. The major intervention that KATE pre-service teachers were exposed to came in the form of a problem-solving course that was re-designed, taught and supported by members of the funded project. As one of the members who joined the project in its later stage, the current

scholarship extends findings that were previously disseminated (e.g., Ortiz, Davis, & Kulm, 2015) and adds to a body of literature committed to mathematics teacher education that values diversity and equity.

This scholarship is based on research conducted by members of the KATE Project, a 5-year National Science Foundation (NSF) funded grant that employed strategies during a mathematics problem-solving undergraduate course to enhance preservice teachers' (PSTs') knowledge for teaching algebra for equity (Kulm et al., 2016). Participants included students enrolled in a required problem-solving undergraduate course for middle grades certification (Oner, Indiogine, Kulm, Hao, & Allen, 2014b). The overarching goal of the project was to design, develop, and test technology-enriched teacher preparation strategies to address equity in algebra teaching and learning for all students (Davis et al., 2015; Ma et al., 2016). The course that the PSTs were enrolled in consisted of four components. They were: 1) problem solving heuristics; 2) strategies for teaching diverse students which included presentations by leading scholars on diversity, equity, and algebra misconceptions (from the KATE research team); 3) opportunities to engage in teaching simulations by tutoring middle grade student avatars who had mathematics misconceptions; and 4) teaching microlessons in a simulated virtual classroom environment (Oner et al., 2014b). These components were designed to build PSTs' experience and to culminate in the presentation of their lessons in an immersive three-dimensional classroom based in a virtual environment known as Second Life.

The problem-solving course also utilized Algebra Problem-Solving Equity Challenge (APSEC) activities, exercises that were designed by the research team to increase the awareness, knowledge, and skills that PSTs possessed about teaching diverse middle-grade students (Kulm et al., 2016). APSEC activities were comprised of: a) an open-ended mathematics problem; b)

questions about mathematical misconceptions in the problem; c) a lesson planning exercise geared towards diverse students; and d) potential mathematics and culturally based questions that might be asked by students. The role of equity, affect, and diversity were all incorporated into each of the activities in the APSEC, and the lesson plan provided an opportunity for PSTs to demonstrate their ability to address these issues and ideas.

Each of the APSEC activities described above included a lesson planning component that asked the PSTs to adjust a given anchor problem in a way that appealed to diverse middle-grade students. The lesson plan instructions asked the participants to address several components. They were: 1) to reflect on how the content might be engaging; 2) why it would be interesting to diverse students; 3) other approaches to solving the problem; 4) difficulties that students might have; 5) any possible extensions or generalizations that exist; and 6) questions that might probe additional inquiry into the topic. Leading scholars from the KATE research team designed presentations focused on building thoughtful understandings of equity and culture and their role in fostering learning opportunities for the PSTs regarding equitable and excellent teaching (McKenzie, 2014), equity consciousness (McKenzie & Locke, 2009; Skria, Scheurich, Garcia, & Nolly, 2004), and culturally relevant pedagogy (Lewis, 2014).

The Conceptual Schemes

Instructional strategies were guided by a hypothetical learning trajectory (HLT) framework for learning to teach algebra for diversity (Kulm et al., 2016). The first of these two separate but overlapping HLTs targeted algebra problem-solving, and the second focused on strategies to engage and motivate diverse learners. This study focuses on the latter. Three conceptual schemes were discussed and investigated in the problem-solving course, and the PSTs were asked to apply their understanding of a self-selected scheme to create a lesson that

could be taught to the virtual student avatars in the Second Life classroom. Teaching for equity, as outlined by the second HLT, is addressed by employing a situated learning scheme, culturally relevant context scheme, or a critical pedagogy scheme (Kulm et al., 2011). These conceptual schemes (see Figure 1) are discussed in more detail in Chapter 2.

Practice Teaching in Second Life

One goal of the problem-solving course was to provide PSTs a platform for practicing the teaching of select mathematics concepts (i.e., proportion, rate and change) prior to entering physical classrooms during field-based teaching experiences (Davis, 2017). Davis noted,

> …virtual classroom simulations make it possible to provide preservice mathematics teachers orchestrated practice with diverse learners (represented by avatars or agents). During simulations avatars can exhibit a variety of mathematics misconceptions and a myriad of interests and needs, than would the more sporadic opportunities that might arise during face-to-face classroom observations or other field-based settings. (p. 2).

Additionally, KATE researchers posited that prospective teachers who are provided opportunities for orchestrated teaching practice with diverse learners are afforded additional opportunities to develop effective pedagogical strategies, and this eases PST transition into teaching algebra for equity in real classrooms (Davis et al., 2015; Ma et al., 2016).

Although the university offered other sections of the mathematics problem solving course, PSTs enrolled in this section of the mathematics problem-solving course agreed to participate in the KATE research project and engaged in practice teaching that was set in the three-dimensional virtual middle-school classroom in Second Life. They, along with the graduate student assistants and instructors, created avatars to engage in mathematics lessons in this simulated [virtual] classroom (Davis, Brown, Kulm, Chien, & Phillips, 2012).

Conceptual Schemes	Cause/Effect	Cognitive Interpretation	Bridging Steps
Situated learning scheme: Provide an instructional context that allows students to have concrete and hands-on experiences with math knowledge and skills. Build math learning on realistic, open-ended, culturally relevant problems that students solve using a variety of skills, concepts, and tools.	Traditional math instruction focuses on symbolic representations exclusively, or moves too quickly from concrete to abstract lessons. This kind of transition results in poor skill development and limited conceptual understanding. (Hollar & Norwood, 1999; Karsenty, 2002; O'Callaghan, 1998)	Students develop math understanding by constructing their own culturally relevant knowledge (Ladson-Billings, 1994), building from more concrete to abstract ideas. Activities that apply math in contexts support effective learning (Pellegrino, Chudowsky, & Glaser, 2001). Student engagement in planning and carrying out the activity builds "ownership" and understanding (Silva & Moses, 1990).	Use concrete materials such as balances, algebra tiles, and everyday objects to provide concrete (Their, 2001) and hands-on experiences, before introducing formal symbols, definitions and rules. Problem solving activities can be used that gradually are more open-ended and provide opportunities for students to devise solution strategies.
Culturally relevant context scheme: Use contexts for activities that are based in and relevant to students' cultures and lives.	Many students do not see the relevance of math and have low self-expectations for learning math. Providing interesting and relevant contexts can be motivational. (Ladson-Billings, 1997)	Learning does not take place unless students are engaged in the lesson (Their, 2001). A "zone of proximal development" is necessary in which students can learn which enhances motivation for learning math.	Adapt math activities and problems that have relevant contexts, individualized to the interests of a particular class, group, or individual student (Ladson-Billings, 1995).
Critical pedagogy scheme: Provide learning activities in which students investigate the sources of mathematical knowledge, identify social problems and plausible solutions, and react to social injustices.	Many students do not see the social relevance of math. Providing interesting and relevant social contexts can be motivational. (Ladson-Billings, 1995)	Problem-based learning engages students in using math to address and solve problems that are drawn directly from possible social or community issues. The context can motivate and engage students (Boaler, 2000).	Adapt math activities and problems that have social contexts, individualized to the interests of a particular ethnic or interest group, or individual student (McLaughlin, Shepard, & O'Day, 1995; Stinson, 2004).

Figure 1. HLT for engagement in meaningful, interesting, and culturally relevant algebra problems (Reprinted from Kulm et al. 2011, p. 5)

Along with the "experiential and situated learning approaches" (Davis et al., 2015, p. 2501), Second Life also provided a means to display and project information in audio, video, and web-based formats and utilize interactive pen displays to work out mathematics problems.

The Second Life virtual classroom environment was designed intentionally to simulate a physical middle-school classroom. Brown, Davis, and Kulm (2011) describe:

- *During the final 3 or 4 weeks of the course each PST prepared a 20-minute algebra lesson to teach to the full class of middle grade student (MGS) avatars.*
- *There were 4 to 5 "live" avatars played by math education graduate students*
- *Fifteen (15) "bot" avatars generated by advance scripting and pre-programmed with specific responses and controlled by a trained research team member*.

During the problem-solving lesson, the preservice teacher went to a remote room where she logged into Second Life® as a teacher-avatar and delivered a lesson.

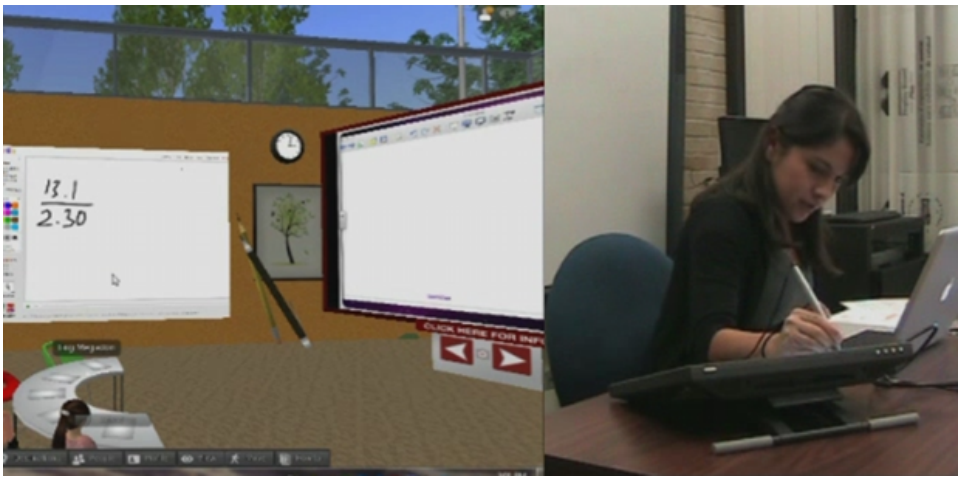


Figure 2. PST delivering SL lesson using SmartPodium

PSTs used their lesson slides that were projected on a display screen in the 3-D virtual classroom, asked questions and engaged with MGSs. They used an interactive pen display (i.e., SmartPodium tablet) to illustrate the problem-solving steps and respond to questions posed by the middle grade student avatars (Brown, Davis, & Kulm; Davis et al., 2015). The work was then

displayed on the media screen in the virtual classroom in real-time, with a few second delay (see Figure 3).

Introduction to the Problem

Educational research has advocated for the intertwining of culture and learning for decades, having developed out of the work of Lev Vygotsky to subsume many of the schools of thought that are now referred to as sociocultural theories of learning (Nasir & Hand, 2006). The purpose of this scholarship is to increase attention to identifying pedagogical strategies that seek to improve student performance among diverse learners at a time where there is substantial increase in the number of diverse students in schools. Gee (2008) emphasized the idea that students' opportunities to learn are maximized when the individual and their environment are accounted for in instructional practices, and that these environments often give rise to students' knowing and interacting with the world in ways similar to other members within their own culture.

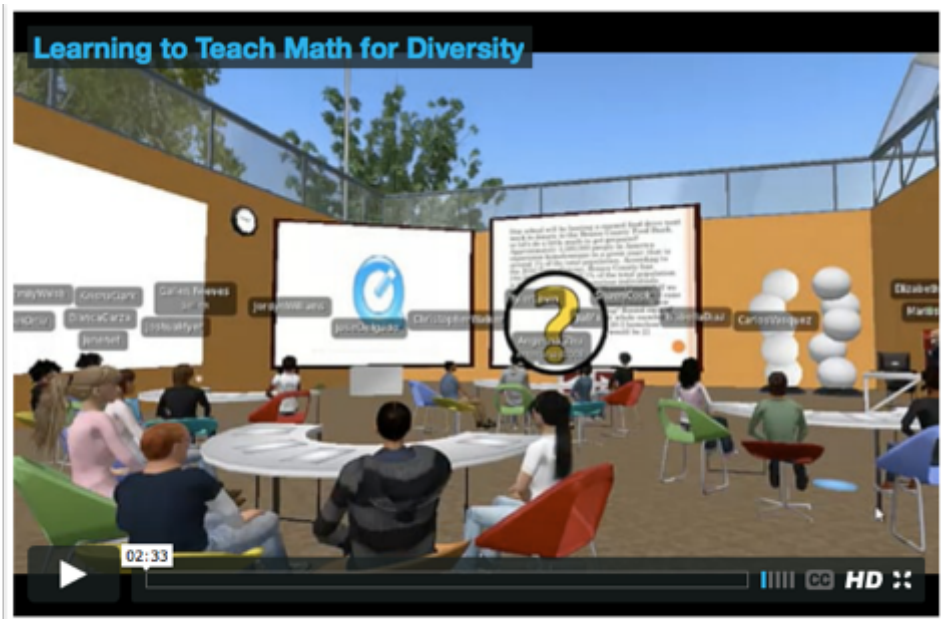


Figure 3. KATE classroom in Second Life

Within this tradition of acknowledging diversity, mathematics policies have advocated for increased attention to equity (e.g., National Council of Teachers of Mathematics [NCTM], 2000) in the teaching and learning of the subject. Generally, these ideas of equity seem nonthreatening and are accepted by those who are constituents in mathematics education, and these policies often outline ideals that teachers suggest they are already utilizing (Thomas & Williams, 2008). In this way, diversity and equity are understood as buzz-words that are over-essentialized (Guttierez, 2013) and require little attention, at least inside the domain of individual classrooms.

Learning, and more specifically mathematics learning, does not exist within a vacuum (Martin, 2009). The way students experience the world directly impact the ways in which they become socialized into certain cultures. The achievement gap is an excellent illustration of this phenomenon, and Martin (2009) asserted that just like race, the achievement gap is a social construction. The very way that students who come from diverse backgrounds are taught is a reflection of not only assimilations to achievement gap rhetoric, but a host of other conceptions about the abilities and trajectories of these students. Discussions of race are not as widely accepted as necessary and productive (Martin, 2009), especially in climates where there are beliefs that that a post-racist society exists. Furthermore, culture in mathematics instruction consists of much more than pop culture references or the use of ethnically diverse names.

Statement of the Problem

Two propositions are outlined in the previous two paragraphs, one that asserts the willingness of educators to teach for diversity and to make mathematics learning more representative of students that come from non-dominant, or diverse, backgrounds (Gee, 2008), and another that suggests that teachers address culture in superficial ways within mathematics curricula that avoid the more difficult dialogue surrounding race (Martin, 2009). Therein lies an

inherent problem and it arises from the reality that good teaching is not sufficient for counteracting the disparities that have permeated the educational experiences of students of color (Wager, 2014). There are two claims that undergird the current study: 1) Teachers must be intentional about acknowledging the role that race and racism, among other forms of hegemony, play in the lives of students of color; and 2) Teachers should begin to critique their own teaching and learning within a critical lens. Until these are done, teachers will not maximize the potential laid out within culturally relevant frameworks. Stated another way, lessons that address all tenets of culturally relevant pedagogy (Ladson-Billings, 2006) would necessarily devote attention to ideas and realities that are consistent among diverse students, and the reader will notice that some of these realities are perpetuated by structures that benefit certain groups within the society and marginalize others.

This contention does not insinuate that race has to be addressed to make lessons culturally relevant, but it does proffer a notion that culturally relevant pedagogy would be diminished if race is reduced to mere superficial and terse interpretations of culture. In her description of culturally relevant pedagogy, Ladson-Billings (1995a) insists that much of what she outlined in the tenets is just good teaching. What is also evident is that, though teachers claim that many of these ideas are not unique, the extant literature demonstrates that students of color frequently are subjected to moot and rote forms of mathematics instruction (Berry & Walkowiak, 2012); in this way, students of color are less frequently the recipients of what Ladson-Billings termed good teaching.

Additionally, KATE project researchers contended that helping teachers to address their own misconceptions in teaching mathematics helps to address equity issues that permeate the instruction of students in diverse environments (Oner et al., 2014b). Essentially, good teaching is

a motif that is easier said and theorized than it is actually implemented. Moreover, PSTs may work with student populations that are privileged enough not to be impacted negatively by the current educational structures. Understanding how these teachers still honor students' culture even in cases where the culture that teachers choose to address is not exclusively predicated upon students' racial and ethnic identities, as posited by Banks (1979), will be intriguing.

The research problem is therefore conceptual in nature and presents an undesirable consequence, one that has potential negative consequences for future students if diversity and equity are not thoughtfully interrogated by PSTs. Given inexperience to address more thorough conceptions that pervade the realities of students of color, I posit, that teachers will be less prone to provide culturally relevant lessons for these demographics. For me, realities regarding the influence of race and racism on students' lives help to honor (though not exclusively) the two progressive tenets of culturally relevant pedagogy, critical consciousness and cultural competence. Howard (2003) maintained that a crucial part of the profession is for teachers to reflect on how "race, culture, and social class shape students' thinking, learning, and various understandings of the world" (p. 197). Moreover, the intent of this study is to assert that culturally relevant pedagogy must be intentional and that when teachers are genuinely concerned about making mathematics learning more representative of their students, this truism will manifest even within their written lesson plans. The aforementioned propositions demonstrate the tension that exists between those who believe they are enacting culturally relevant pedagogy and those who operationalize and apply all three tenets, and these propositions assist in assessing the strengths of PSTs in implementing the framework. Furthermore, this research problem contends that because previous scholarship suggests that PSTs struggle with implementing

culturally relevant mathematics lesson plans (e.g., Lemons-Smith, 2013), a scaffolded solution to this finding would warrant a deeper look into the lesson plans that they design.

Culturally relevant pedagogy is as much integral in the delivery of the material as it is in the planning component. The undesirable consequence maintains that unless PSTs understand all three tenets of culturally relevant pedagogy and are able to incorporate them into a mathematics lesson plan, most teachers will continue to resort to traditional forms of teaching that have proven futile in the experience of students of color. Further, these teachers will become convinced that the culturally relevant pedagogical strategies are not efficient and will reify deficit notions about the positions of diverse students within a racial hierarchy of mathematics learning (Martin, 2009). If culture helps to shape perspective, then culture is undeniably important to the mathematics teacher who incorporates critical thinking skills into instruction or for the teacher who promotes discourse as a means of justifying student solutions. I particularly am interested in how those who dominate the teaching profession, and likewise the class upon which this study is based, namely White women, interpret culturally relevant mathematics and subsequently implement it into their lesson plans designed for the Second Life environment as described in the aforementioned section.

Conceptual Framework

The conceptual framework provided in Figure 4 is a conceptualization of the three tenets of culturally relevant pedagogy, and describes two ways in which the pedagogy could be demonstrated or observed.

Delivery

The first of these ways involves evidence of CRP as a reflection of the teacher's strategies. I refer to as the teacher's delivery of the lesson plan and their personality. The

literature review discusses how teachers are culturally relevant in ways that they engage with their students and how they deliver instruction. For example, his was the case in Bonner and Adams (2012) and Johnson, Nyamekye, Chazan, & Rosenthal's (2013) descriptions of a culturally responsive teacher. Bonner and Adams described the teacher in their study as one who was very connected to the needs of her students, in ways that privileged the way they spoke in the classroom and that embraced their emotional and physical needs, inside and outside of the classroom. Johnson and colleagues described a teacher who utilized a consistent, empowering vernacular that motivated his students to be exceptional because they were capable. The factor that ties these cases together is that the teachers knew how to engage their students, more specifically the ones who would benefit from attention to their diversity and interests. Thus, these teachers were successful in embodying a culturally relevant ideology and implementing it within their interactions with the students.

Lesson Plan

The second manner in which culturally relevant tenets are manifested, and is the focus of the current scholarship, suggests that culturally relevant tenets should be implicit in the lesson plans. I offer, teachers must be intentional about using a liberating and empowering form of teaching. In addition, I argue in this work that these tenets should be captured within the lesson plan. As highlighted within the conceptual framework, the lesson plan informs delivery and delivery informs the lesson. Lesson plans are artifacts that allow for a more nuanced and deliberate portrayal of ideas. Thus, the contention of this study is that PSTs are more likely to honor the pedagogy when they put preconceived thoughts into the activities that will be used with students, how the concepts connect to students' lived experiences, and how they plan to assess students' work or facilitate student participation. This is an idea that is consistent in the

work of Ares (2008) who insisted that the context of the problem and nature of the interaction that were facilitated in the classroom was deliberate, and was culturally relevant. According to her study, the students were familiar with the idea of traffic in New York, and their familiarity set the stage for the mathematics that was implemented; similarly, Jett (2009) noted that collaborative efforts within the mathematics classroom are consistently interpreted to be culturally responsive. Group membership and activities are developed often before class begins; indeed, this is how teachers know how many copies to make on the school's copy machine.

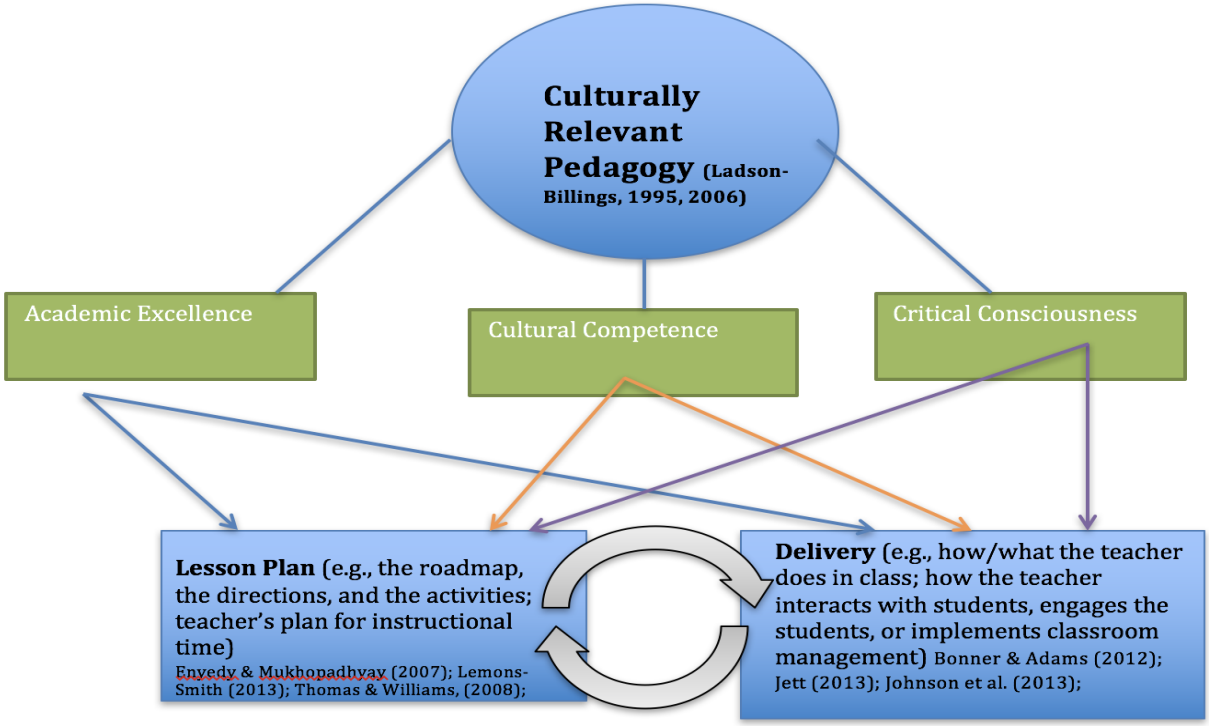


Figure 4. Culturally relevant conceptual framework

I offer, that culturally relevant experience should be a reflection of teachers' mastery of each of these pieces, the delivery of instruction and the written form of the lesson. The framework provided helps to parse out elements of CRP to make teaching more susceptible to the strategies in a variety of forms, and causes teachers to regard the lesson plan more thoroughly

as a necessary component of this strategy. Positioned at the top of this framework is culturally relevant pedagogy. It is situated at the top to convey the ultimate goal, for teachers to marry both depictions of CRP. The conceptual framework then splits into the three tenets, academic success, cultural competence, and sociopolitical consciousness. The idea communicated by this conceptual framework is that each of these has a place within the third and final level, which is referred to as the two manifestations. The two arrows above lesson plan and delivery are cyclical to show that the lesson plan can and should impact, and be impacted by, delivery. Consider how a teacher described by Bonner and Adams (2012) spent much time in reflection in an effort to improve learning for her students; this reflection was based on how her lesson translated into a tangible form when utilized with the students. Howard (2010) reminded the field that Dewey (1933) emphasized the significance of critical reflection in this manner. Lastly and intentionally, directional arrows filter from the three tenets into the lesson plan or delivery. No directional arrows are used between CRP and its tenets as this relationship is defined by Ladson-Billings (1994, 1997), and they do not necessarily impact one another in the same way that the tenets impact the lesson plan or delivery.

Culturally relevant teachers seek to embody CRP in both ways, yet attention and detail must be devoted to understanding the distinctions of each manifestation. With this goal in mind, the current research examines the lesson plans of PSTs.

Three Tenets of CRP

Teaching involves much more than collecting assignments and lecturing. Ladson-Billings (2006) made this obscenely clear in defining the practices that pervaded pedagogical strategies utilized by teachers who were successful in creating meaningful and efficient learning experiences for students of color. The work championed by Ladson-Billings led to her

identification of what she termed culturally relevant pedagogy (1994). This framework synthesizes findings discovered as she studied exceptional teachers who were successful with poor students of color, and she ultimately condensed these findings into the three tenets of culturally relevant pedagogy, nominally referred to as academic achievement, cultural competence, and sociopolitical consciousness. Much attention has been given to the use of culturally relevant pedagogy in a plethora of disciplines ranging from literature (Hefflin, 2002), history (Irvine, 2010), and science (Irvine, 2010); however, this study highlighted the role of CRP in various classifications of mathematics and emphasized the sustained relevance of Ladson-Billings' framework.

Academic Achievement

Academic achievement is better understood as student learning, not the ability to pass a standardized test (Ladson-Billings, 2006). This tenet warrants a discussion of achievement beyond that of performance on state tests to include demonstrations of reading, speaking, and problem posing skills (Ladson-Billings, 1995b). Culturally relevant teachers are those innovators who understand that students come into the classroom with knowledge that can and should be merged with the curriculum's learning objectives. Explanation for concept import and relevance subsumes student learning and academic achievement, and the objectives are made transparent. Culturally relevant teachers strive to inform their students as to why the material is pragmatic as they define the role it plays in the students' everyday life. This endeavor is accomplished by using materials that will supplement the textbook and make learning more reflective of the experiences that occur on a daily basis. Culturally relevant teaching is acknowledgement of a thought that students come into the classroom with unique skills and abilities and that the teacher builds on this knowledge to make learning more meaningful and substantive.

Cultural Competence

Ladson-Billings (2006) described cultural competence as the most difficult of the tenets to articulate for teachers. This tenet advises the teacher to help students recognize and admire their own cultural beliefs, practices, or ideas as they seek to understand the dominant one. Students' understanding of the dominant culture equates to understanding the culture that essentially oppresses their own (Ladson-Billings, 2006). The culturally relevant teacher uses the classroom as a time to incorporate these aspects of culture into learning and help students understand that their own culture should never be compromised during times of learning (Ladson-Billings, 1995b). Further, cultural competence persuades the students to maintain cultural integrity and provides the teacher insights concerning how to suppress or overcome the biases that come with misunderstanding other cultures. The students in these classrooms are encouraged to "be themselves" in all aspects of communications, dress, and learning (Ladson-Billings, 1995a).

Sociopolitical Consciousness

The final tenet of culturally relevant pedagogy demands critique of that which is accepted and familiar. Students are expected to become knowledgeable about their communities and develop ideas for how to incite change and improvement. They are taught that growth is always attainable, and settling in a world that allows inequity is unacceptable and intolerable (Ladson-Billings, 1994, 1995a, 1995b, 1997). Furthermore, Ladson-Billings contended that the role of education is to prepare students for citizenship, and that the best way to do this is to make them aware of how the society operates and what norms or values influence this operation.

This theoretical framework asserts that culture plays a substantial role in educating students, and that students of color deserve an education that caters to the ideas and ways to

which they have grown accustomed. History has shown that this happens too infrequently with these students.

Significance of the Study

While Ladson-Billings (1995b) described culturally relevant pedagogy as an interwoven product of three tenets, one important point to understand is that researchers have concluded that teachers tend to master one or two of the tenets and struggle with others (Ye, Varelas, & Guajardo, 2011). Ladson-Billings (2006) noted how cultural competence was one of the most difficult tenets to describe, and thus one of the hardest to help teachers understand. The unique aspect of this study is that it disaggregates the tenets and helps to depict them in more nuanced ways. Though the intent is not to make the pedagogy prescriptive, this study extrapolates the tenets proposed by Ladson-Billings and attempts to describe them in a more detailed manner. Other studies, though less in quantity, have reported which individual tenets teachers struggle with, yet this study conceptualizes how mastery of certain elements of a tenet help to promote a more genuine understanding of Ladson-Billings' pedagogy. While a paucity of literature exists that analyzes teacher lesson plans for evidence of cultural relevance, especially mathematics lesson plans, this study will highlighted ways in which teachers have achieved the more subtle tenets of CRP (i.e., cultural competence and critical consciousness). The study noted that mastery of these elements helps accomplish mastery of the entire pedagogy, all within the context of a virtual learning environment. I also developed a rubric to assist in the analysis of mathematics lessons plans for culturally relevant pedagogy.

In this study I also look specifically at the PSTs' rationale for why they felt their lessons were culturally relevant. Although previous studies have provided examples of culturally relevant pedagogy in mathematics (e.g., Leonard, Napp, & Adelke, 2009), teacher attitudes

towards the effectiveness and their ability to create culturally relevant lessons (e.g., Thomas & Willams, 2008), or given insight regarding student outcomes following a culturally relevant intervention (e.g., Enyedy & Mukhopadhyay, 2007), only a few studies have analyzed the rationale that PSTs provide for how CRP is embodied in their lessons or why it would be relevant for any particular student group. This study offers insight into how these PSTs understand and negotiate culture and cultural relevance as a way to reflect it in their lesson plans.

This work is significant because it further investigates the development of culturally relevant pedagogy and it does so by enriching lesson plans, components of the profession that are universal and often times mandatory. If teachers can begin to develop lesson plans that honor each tenet of culturally relevant pedagogy, then they will be more likely to let this reformed pedagogy permeate other aspects of their teaching. Significance in this work is feasible because culture and mathematics are inextricably bound fields; CRP aids in incorporating culture into learning mathematics; and those who most often teach students of color must adhere to all aspects of CRP by maintaining a fervent dedication to academic achievement, cultural competence and sociopolitical consciousness.

Purpose

A central purpose of this study, then, is to determine what areas of culturally relevant pedagogy must be addressed in more detail among PSTs after their initial introduction to the pedagogy. Thus, the current study will explore the illustrations of each of Ladson-Billings' three tenets, academic achievement, cultural competence, and critical consciousness in a manner that will provide insight for how to address each tenet and ultimately the collective framework, all within the context of understanding diversity awareness through a mathematics problem-solving course.

The results will help to indicate which aspects of the framework are thoroughly addressed among a group of PSTs, as well as provide insight into how PSTs internalized the framework and reciprocated it within a common teaching artifact, a lesson plan. This study not only will describe how cultural relevance can and should be represented within this artifact; but, will establish the development of thorough and intentional lesson plans as a necessary prerequisite for utilizing these strategies.

The study will provide a means to measure PSTs' developing propensity towards cultural relevance, and discuss how comprehension of particular indicators may influence the overall understanding of how the tenets work as a collective whole.

Research Objectives

The previous sections helped to outline the place that culture has within the learning environment, and how culture has been utilized in the teaching and learning of mathematics. This study gives credence to the argument outlined by W.E.B. DuBois (1935) in seeking to understand how teachers' actions ultimately affect the students they teach, and how these actions should be laid out clearly and intentionally with specific goals.

Objective One

This study examined the lesson plans developed by PSTs to determine their alignment with the tenets of culturally relevant scholarship. Both the accomplishments and misconceptions of the teachers will be deconstructed to provide the reader with an understanding of what elements in the PSTs' lesson plans were consistent with this scholarship, as well as what rationale they provided to support claims of their lesson plans embodying a culturally relevant teaching scheme.

Objective Two

This study discussed the PSTs' growing understanding and awareness of diversity and its presence in mathematics instruction. The relationship between PSTs' development of culturally relevant lesson plans and how their increased understandings of diversity affects the design of these lesson plans will be articulated.

Objective Three

The study described ways in which these common teaching artifacts can be impacted by the culturally relevant framework and was the focal point of the above theoretical and conceptual frameworks, explaining this manifestations of CRP. The study reflected the idea that lesson plans should incorporate tenets of the CRP, much like the lesson delivery.

Research Questions

The following research questions were used to guide the study:

1. How successful were PSTs in implementing culturally relevant tenets into mathematics lesson plans designed for a virtual classroom environment?
2. How did PSTs' diversity awareness and beliefs toward teaching for equity change?

Discussion of Terms

What follows is an identification of relevant terms that were utilized in the current study. Given that these words have different meanings in a variety of contexts, they are defined below.

Virtual world or environment: A virtual three-dimensional immersive environment that simulates complex physical spaces and allows communication and interaction between virtual objects and characters (Bainbridge, 2007).

Lesson plan: Lesson plan is defined, for the purpose of this study, as a formal, written description of the class session. It often includes such elements as what content will be taught,

the objectives that will be addressed, how it will be taught, and formative and summative assessments that will be used. A more thorough description of lesson plans is provided within the literature review.

Manifestations: Manifestation is used in this study to describe the two portions of the conceptual framework through which culturally relevant pedagogy can be demonstrated, namely the lesson plan and the delivery.

Avatar: Animated characters with human capabilities and communication tools (Ma et al., 2016). In this study, avatars represent diverse middle-grade students as well as self-designed images of the PSTs within Second Life.

Currere: Latin word from which we derive "curriculum". The Latin root has implications that the curriculum involves both the process of learning and the formalized product that is distributed among educators, and suggests that it is regressive (interrogates the past), progressive (plans for the futures), analytic (analyzes the present), and synthetic (seeks a simultaneous understanding of past, present and future) (Pinar, 2004; Slattery, 2013).

Culturally relevant pedagogy (CRP): CRP is discussed throughout but is understood and operationalized according to the three tenets (i.e., academic excellence, cultural competence, and sociopolitical consciousness) offered by Ladson-Billings (1995a).

Hypothetical learning trajectory (HLT): HLT is a vehicle for planning learning of particular mathematical concepts. The KATE research team utilized two HLTs that follow the model of Simon and Tzur (2004). The HLTs derived by the research team used the following assumptions: a) generation of the HLT is based on the current knowledge of the students involved b) mathematical tasks provide tools for promoting learning of particular mathematical tasks and are, therefore, a key part of the instructional process and c) because of the hypothetical

and inherently uncertain nature of this process, the teacher is regularly involved in modifying every aspect of the HLT (Kulm et al., 2016).

CHAPTER II

LITERATURE REVIEW

This chapter will offer a review of the culturally relevant pedagogy as it pertains to the teaching and learning of mathematics. The chapter begins with scholarship that provides a broad definition of culture and its varied conceptualizations, then discusses the presence of cultural capital that exists among all students but is often overlooked within some demographics. Culture is then discussed specifically in terms of mathematics teaching and learning, and this is addressed primarily through a critical race lens, though other forms of culture are described. The final sections in this literature review establish the similarities and delineations that exist within culturally relevant mathematics studies, and the outcomes associated with its implementation. I end the chapter by describing mathematics pedagogy as it is addressed in teacher preparation programs and justify why culture matters at all within mathematics education.

PSTs' pedagogical content knowledge for dealing with issues of equity and race are addressed by what Banks and Banks (1995) described as equity pedagogy, what Milner (2003) described as racial competence, and what Gay (2010) referred to as cultural responsiveness.

Conceptual Schemes

According to Davis et al. (2015), "a Hypothetical Learning Trajectory (HLT) (Simon & Tsur, 2004) constructed by the project team served as the theoretical framework to guide the design, development and instruction for the problem-solving course" (p. 1). Davis et al. describe:

> [We] began with the model of Lamberg and Middleton (2009) in constructing a HLT that consisted of three conceptual schemes for teaching for diversity. These schemes characterize effective research-based strategies to engage and motivate diverse students in learning algebra: (1) situated learning, (2) culturally relevant teaching, and (3) critical pedagogy. Each scheme has the following components: (a) description of the conceptual scheme, (b) cause and effect mechanisms that describe the teachers' knowledge, (c)

> cognitive interpretations of knowledge, and (d) intermediary understandings necessary for bridging to the next level (Lamberg & Middleton, 2009, p. 237).

Davis et al. continue, "the following brief summaries provide the characteristics and research bases for the HLT schemes. These schemes characterize effective research-based, [culturally relevant] strategies and engage and motivate diverse students in learning algebra (p. 1)." A more complete description is given by Brown, Davis, and Kulm (2011):

> *Situated Learning Scheme*
>
> The Situated Learning scheme requires that the teacher allows students to have concrete and hands-on experiences designed to build math learning on realistic problems that students solve using a variety of skills, concepts, and tools. Traditional lessons provide only limited development of conceptual understanding (Hollar & Norwood, 1999; Karsenty, 2002; O'Callaghan, 1998). In a situated learning context, students develop math understanding by constructing their own culturally relevant knowledge (Ladson-Billings, 2011), building from more concrete to abstract ideas (Pellegrino, Chudowsky, & Glaser, 2001). Students move from using materials such as algebra tiles and everyday objects, gradually transitioning to problems that are more open-ended, allowing students to devise solution strategies.
>
> *Culturally Relevant Teaching Scheme*
>
> The Culturally Relevant Teaching scheme relies on the teacher to identify contexts for activities that are based in and relevant to her own students' cultures and lives. Many students do not see the relevance of math and have low self-expectations for learning math (Ladson-Billings, 1997). Since learning is unlikely unless students are engaged in the lesson (Thier, 2001), a context that enhances motivation for learning math is necessary. The teacher must adapt math activities and problems to include contexts that are relevant and individualized to the interests of a particular class, group, or student (Malloy & Jones, 1998).
>
> *Critical Pedagogy Scheme*
>
> The Critical Pedagogy scheme provides learning activities in which students investigate the sources of mathematical knowledge, identify social problems and plausible solutions, and react to social injustices. Problem-based learning engages students in using math to address and solve problems that are drawn directly from possible social or community issues that are likely to motivate and engage students (Boaler, 2000; Lewis, 2009). The teacher adapts math activities and problems to include social contexts relevant to the interests of a particular ethnic or interest group, or individual student (Stinson, 2004). As students become more engaged and interested in these activities, they are more likely to build skills necessary to succeed in mathematics.

> The HLTs were presented and discussed with the PSTs, along with problem-solving activities to help the preservice teachers develop activities and lessons that address the bridging steps necessary for their own progress in the trajectories (p. 1).

These conceptual schemes were well situated to address the KATE Project's "long-term research project to develop a problem-solving course aimed at enhancing the beliefs about and abilities of preservice mathematics teachers to address the needs of diverse students" (p. 2).

Though I address briefly other facets of equity frameworks, this research utilized Ladson-Billings' (1995) conceptual framework to craft a necessary lens from which to examine lesson plans designed by PSTs. Academic success, cultural competence and socio-political consciousness are informed by an individual's culture and therefore this literature review helps to construct the complexities that pervade culture in an attempt to identify the most salient elements.

Defining Culture

Culture represents a construct that is described in a variety of nuanced definitions and operands. Gay (2010) thought it important enough to state that culture is at the heart of everything we do in education. Culture determines the way we think, believe, and behave (Gay, 2010), and this necessarily affects the way that we teach and learn. Bracey (2013) indicated that culture is one construct that is complex in its inclusion of social behaviors and skills common across ethnic backgrounds. Ladson-Billings (1997) used a broader definition of culture to suggest that it "refers to the deep structures of knowing, understanding, acting, and being" (p. 700). An identification of culture as learned ways of thinking and acting is consistent with the work of Erickson (1986), and mirrors the work of Gutierrez (2002) and Yosso (2005) by emphasizing that culture could be interpreted as patterns of beliefs, values, and practices that are learned and shared. These components of culture describe an underlying foundation for perception of the world and one's place in it (Hollis, 1996). Herein lies the complexity

mentioned by Bracey because individual people exhibit a wide variety of intricacies, and determining their shared characteristics can be tedious and subjective work.

By far, Banks (1979) provided one of the most comprehensive definitions of culture, which contended that culture "consists of the behavior patterns, symbols, institutions, values and other human-made components of society. It is the unique achievement of a human group which distinguishes it from other human groups" (p. 238). Banks established a valid point that suggested culture can be more inclusive than racial or ethnic categories. The thoughts and interests that undergird many of these definitions of culture are consistent among distinctions that extend to more macro or micro conceptions of racial groups (e.g., subculture within the Black community).

One definition of culture proffered by Guitierrez (2002) delineates the culture of the classroom and the culture of the group to which the students belong. She contended that the classroom culture (e.g., routines of the class and normative modes of interaction) is correlated with those students who populate the classroom, and thus the classroom culture is reflective of the students' racial, ethnic, and linguistic cultures. Stated more clearly, the atmosphere of the classroom does not differ significantly from the students' culture because they bring into the classroom the same means of communication, perspective, and traditions that are learned at home. Cultures overwhelmingly are associated with conceptions of race and ethnicity (Howard, 2008), though not limited to them; the culture of the classroom often will mirror the culture exhibited by the dominant ethnic group in the class. However, understanding race as a sociopolitical and historically contingent construct, as Martin (2009) asserted, demands an understanding of race and racism as necessary considerations of addressing classroom and societal culture.

Studying culture equates to studying the cultural practices and activities that are manifested in the classroom (Gutierrez, 2002; Nasir, Hand, & Taylor, 2008), and the forms of capital that together create what Yosso (2005) defined as community cultural wealth. These practices are the routines and artifacts that comprise the learning environment and dictate such elements of the classroom as interaction, participation, and support. The work of Nasir and colleagues compliments this description by establishing a consensus that culture and activity are inseparable, and that teaching and learning therefore must be shaped by culture. Milner asserted that diversity and homogeneity both exist within urban schools, but that students who come from nondominant backgrounds are immersed in a school system that does not privilege the cultures, beliefs systems, and values of their home culture. As salient elements of culture, these all must be considered to promote more congruous opportunities within education.

Cultural Capital

Traditionally, cultural capital has referred to the knowledge that is possessed and valued by the high and middle class (Bourdieu & Passeron, 1977). Lamont and Lareau (1988) extended the concept of cultural capital by stating that students from lower and working class families have social and cultural cues that differ from dominant groups, and that they often have to acquire additional skills and knowledge to compete with their peers. The cues that exist among high and middle class students are in many cases distinct from the forms that become most familiar to students of color that they bring with them from their home environments. Moreover, Howard (2010) argued that this discrepancy between those who know and embody aspects of dominant cultural capital allow for the perpetuation of privilege.

The characteristic that links these researchers' desires to include culture in learning environments stems from an American educational system that has devalued the knowledge of

various communities of color (Yosso, 2005). The collective thought is that culture and cultural capital are present in the lives of a variety of students of color, but unfortunately, many scholars have attempted to paint a picture of communities of color being culturally deficient in accordance to what Eglash, Gilbert, Taylor, and Geier (2013) described as a myth of cultural determinism. Clearly, a major function of culturally relevant pedagogy requires that the instructional strategies make use of different forms of capital, and that teachers are forthright in their attempts to fulfill this ideal in each aspect of the teaching and learning of mathematics.

Yosso (2005) described community wealth in terms of six forms of capital: aspirational, familial, social, navigational, linguistic and resistant. They are described here because they offer potential routes through which teachers could address cultural relevance. African Americans have as a part of their culture the desire to aspire past situations that oftentimes are limiting in nature; they exhibit aspirational capital. Examples of this desire to overcome low expectations and disempowering stereotypes, in many cases through education, is a common theme in the work of scholars like Harper and Davis (2011) and Berry, Thunder, and McClain (2011). Aspirational capital says that no situation or circumstance has the power to handicap an individual entirely or indefinitely.

In more popular venues of communication, a common theme among rap artists is the prevalence of a "rags to riches" ideology that suggests a triumph over past circumstances to a point of financial success. Woodson (1933) emphasized that African Americans, or as Woodson referred to them Negroes, had an obligation to help uplift other African Americans once they reached a certain level of educational or financial security. Such capital is described as social capital and has been common-place since the institution of slavery. This capital is explicit in such forms as community funds of knowledge, as described by Foley (1997) and Ares (2008),

and Yosso contends that the presence of communalism runs rampant within Hispanic, Black, and other communities of color. Community funds of knowledge are nurtured in familial capital, a capital that invests in children and welcomes participation from immediate and extended family members.

Navigational capital is understood as the ability to maneuver in systems and structures that have not always welcomed participation from people of color. Carter (2003) stated that this becomes evident in such places as job interviews where nondominant groups may have to embody more normative protocols to achieve desirable outcomes in these settings. Further, this idea may capture, in addition to the physical normative protocol, linguistic capital that includes what Greene and Walker (2004) described as code switching. Code switching, or the presence of linguistic varieties, occurs because there is a standard that these scholars described as normative and White (Delpit, 2012), and one that permeates education.

Lastly, the work in which these scholars engage collectively serves to tarnish a presupposed depiction of inferiority in America. The resistant capital combines efforts of those who paint a more representative picture of the knowledge and contributions of African Americans, Native Americans, Hispanics and other people groups. The culture thrives and in doing so resists the detrimental, deleterious, and often times hindering assumptions of the dominant culture. A thorough discussion of cultural capital is important because these are the ways in which culture may be addressed in the teaching and learning of mathematics.

Culture in Mathematics Learning

The necessity to address ideas of culture are tacit because culturally relevant pedagogy aims at embracing diversity and achieving equity in education generally, and in mathematics education more specifically. KATE Project researchers posit preparing teachers for teaching for

equity requires mathematical knowledge for teaching algebra (Kulm, 2008) and knowledge that is representative of teachers' understanding of working with all students. Davis and colleagues (2016) found that the KATE Project activities implemented in the problem-solving course moderately improved preservice teachers' knowledge and beliefs about teaching for equity. According to Skrla, McKenzie, and Scheurich (2009), equity consciousness involves four beliefs: 1) all children can excel academically, *all* children refers to *all* with diverse innate, cognitive, linguistic, sociodemographic, socioeconomic, and cultural characteristics 3), adults in school should take accountability for student learning and 4) practices in school should be changed to meet all children's needs (p. 82-83). Gutierrez (2013) posited that the field of mathematics education has grown more accepting of research that articulates the need for equity and sociocultural frameworks, and that the benefits of the sociocultural turn in the field allows, among other factors, the ability to challenge a racial hierarchy in mathematics learning (Martin, 2009) and common notions of teacher quality.

This sociopolitical turn, as described by Gutierrez (2010) and made practical by scholars such as Skrla and colleagues (2009) and Ladson-Billings (1994, 2006), is supported in the positions offered by the National Council of Teachers of Mathematics (NCTM, 2000), the governing professional organization for mathematics educators. In this position, NCTM identified diversity and equity as central components to any mathematics curriculum. Regarding mathematics education policy, Martin (2009) contended that the racialized nature of students' mathematics experiences must be accounted for. Though this policy tends to take more neutral stances, such as those devoted to equity and diversity, race and racism are realities that affect White and non-White students very differently. Student experiences in the world are extremely significant and prior research has suggested that a lack of connection between mathematics

content and connections to the world is one route to student disengagement (Atwater, 1990; Enyedy & Mukhopadhyay, 2007; Rosser, 1990).

A sociopolitical stance suggests that mathematics learning occurs within the capacity of student understanding of the world (Ladson-Billings, 1997; Nasir et al., 2008). Tate (1995) concluded that African American students need to have mathematics instruction, curriculum, and assessment techniques that reflect their culture and experiences as palpable traditions and perspectives; similar claims have been made about Latino/a students (Gutierrez, 2008). Mathematics is assumed culture-free by some practitioners (Gay, 2010; Tate, 1995), but if the cultural activities, as Gutierrez (2002) argued, that define culture are given credence, then the subject of mathematics will not escape proclivity to culture.

This same idea is communicated in the work of scholars like Glaser and Silver (1994) who presented a seemingly straightforward mathematics problem about purchasing a bus pass, one in which the African American students did not answer in a manner consistent with context-free arithmetic. These students who came from an urban background used reasoning that was most efficient with their way of life to determine the best option for purchasing the bus pass. These experiences dictate what I consider to be critical thinking and what Tate (1995) emphasized as a non-White frame of reference. Critical thinking, then, may not be a skill that warrants identical answers among those who identify with a variety of cultures. Consequently, because critical thinking is significant in these contexts, problem solving in mathematics teaching and learning often include pedagogical skills that are complex in nature (Cobb, Yackel, & Wood, 1993; Schoenfeld, 1993). Moreover, Ezeife (2002) contended that culture helps to shape learning styles and determines what, or how, mathematics is important in ones' life and what contexts would be most appropriate in mathematics teaching involving problem solving.

Ezeife solidified this point by showing that Aboriginal students were more successful and engaged with mathematical concepts that were taught within the context of their lived experiences. Kulm and colleagues (2016) found that even after allowing PSTs practice in responding to mathematical content and cultural issues that may occur within a middle-grade classroom, they had naïve notions about culture due to limited experience with different cultures.

Ortiz (2015) argued that culture resides inherently in mathematics as a) students are provided opportunities to learn, b) pedagogical strategies are evaluated, and c) teacher and parent motivational factors become involved in learning the subject. To this list, Wager (2014) adds, "attending to children's participation and identity is critical if we are to interrupt existing inequities in children's access to opportunities to learn" (p. 314). These considerations structure the mathematics classroom but will weaken the potential to learn mathematics for students of color if they are not given access to more advanced courses, or if they are not allowed to participate in mathematics learning in ways similar to their White counterparts. Ortiz and Wager argued that opportunities to learn oftentimes are in these advanced classes, courses that have a paucity of African American, Hispanic, and Native American enrollment.

The role of culture not only is evident in access to mathematics content (Spielhagen, 2008; Tate, 2005), but it becomes relevant in how students make sense of the content, and therefore how teachers choose to highlight a variety of strengths and weaknesses that are critical to math learning (Stigler & Baranes, 1989). We see the veracity of this statement in such work as Capraro (2001) who attributed African American students' success with spatial visualization to homes and cultures where they were taught to make their beds every morning. The work that Moses and Cobb (2001) did with the Algebra Project also articulated the ways in which familiarity with mathematized spaces served the purpose of drawing on cultural knowledge to

make sense of mathematical concepts. They found success in engaging students through their understanding of the transit system. Additionally, the presence of culture is mentioned by Nasir and colleagues (2008) in the way sports knowledge can help in the learning of statistics or potentially in how students are taught to provide and justify their solutions, particularly in the spirit of hip hop (Emdin, 2012). These points of connection do not deviate from those offered by Leonard, Moore, and Brooks (2013), namely such places and issues as students' livelihood, their communities, or popular trends.

Outcomes of CRP

Researchers have made practical the admonitions outlined in Ladson-Billings' (1995a) work. This work extends the findings of some of the salient CRP literature such as Enyedy and Mukhopadhyay (2007) and Leonard and Moore (2014) who found that teachers did not implement all three tenets with ease. Teachers in both of these studies found it difficult to utilize all three tenets in their lessons and many times excelled in only one or two of the tenets. In these cases, sociopolitical consciousness and cultural competence warranted further research on the part of the researcher to ensure that tensions between the student, the pedagogy, and the teacher were mitigated. Adefope (2014) asserted that the group of African American males he taught was able to demonstrate mastery of geometrical concepts. His contention was that this success was a result of a pedagogy that was more receptive of the learning styles and preferences that were familiar to these students. A variety of scholars were able to help underrepresented students realize that statistics (Enyedy & Mukhopadhyay, 2007), slope and algebra (Eglash, Gilbert, Taylor, & Geier, 2013), or measurement (Arreguin-Anderson & Ruiz, 2013) all compliment real world phenomena. The students in these studies were motivated, engaged, and were more successful in learning mathematics. Culturally relevant lessons are gaining traction in the extant

literature and researchers have found that lessons grounded in this pedagogy make for exciting lessons in fractions, counting, budgeting, and a slew of other topics (Gutstein, Lipman, Hernandez, & de los Reyes, 1997; Kisker et al., 2012; Matthews, 2008). This same competence is mirrored in instances where students are inspired to create geometric patterns within hairstyles and in using familiar and celebrated communications styles (Eglash, Gilbert, Taylor, & Geier, 2013). Though these connections are myriad, in-service and preservice teachers must become aware and likewise proficient in designing lessons that are age and culturally appropriate.

Gerdes (1988) claimed that "mathematics does not come from outside our African, Asian, and American-Indian cultures" (p. 140). He articulated an argument much like D'Ambrosio (1985) that celebrated cultural activities that informally utilized advanced levels of mathematical thinking, from building houses to creating number and barter systems. These realities too often are neglected and students are easily convinced that mathematics is a Euro-American subject, one that possesses few or no influences from people of color (Moses-Snipes, 2005; Nasir et al., 2008; Tate, 1997). These students will echo the familiar words of Lisa Delpit (2012) and proclaim that multiplication, and essentially all mathematics, is for White people. Storytelling and literature have been fundamental to the culture of people of color for centuries (Tate, 1997), and Leonard and colleagues (2013) demonstrated how mathematics concepts such as enumeration could be developed in connection with a variety of multicultural literatures that serve to challenge biased portrayals of the subject; these studies convey innovative conventions for mathematics lesson plans.

One aspect that is consistent in the literature regarding the influence of culturally relevant pedagogy is that it promotes participation among traditionally marginalized student groups. Black, Hispanic, and many other students of color were found to be more engaged in the learning

of mathematics when it was grounded in culturally relevant strategies, and they were engaged in learning a subject that is often regarded as unnecessarily difficult (Ares, 2008; Brenner, 1998; Enyedy & Mukhopadhyay, 2007; Sheppard, 2011). Culturally relevant lessons have been vital in helping students who may not be fond of mathematics to see how the subject can be valid in their everyday lives (Gutstein, 2003). This change of orientation about the subject has potential to foster more pleasantly assiduous encounters, and it is a reality that McKenzie and Locke (2004) described as equity consciousness. Another aspect of this participation is that pedagogy grounded in culturally relevant frames prepares students, particularly those of color, to critique their local environments and the use of its resources (Esposito, Davis, & Swain, 2012; Morrison, Robbins, & Rose, 2008). Engagement, motivation, and even excitement (Davis, Phillips, & Kulm, 2018) are byproducts of mathematics that are valued and relevant to students' lived experiences, and culturally relevant pedagogy ensures that these experiences are characteristic of the class make-up.

Despite the ability to empower a wide range of cultures, the research is transparent in acknowledging that the implementation of all three tenets of culturally relevant pedagogy is not easily accomplished; outcomes of CRP often lack one or more components of the framework. Cultural competence tends to be the tenet that requires a bit more patience and practice (Leonard, Brooks, Barnes-Johnson, & Berry, 2010; Young, 2010). The reality is that cultural competence can be interpreted in multiple ways and teachers may have to become familiar with a culture that is unlike the one they have mastered and proliferated for a lifetime (Ladson-Billings, 2006). As Smith (2014) stated, a necessary part of implementing this pedagogy is that teachers learn the culture of their student community. Additionally, some teachers may just be unwilling to admit that particular cultures do in fact express dominance over other minority groups (Gay & Howard,

2000). In some cases, this lack of implementation is simply a matter of comfort. Teachers may gravitate towards particular tenets of this framework because they find that some tenets occur more naturally and are just a reflection of "good teaching" (Ladson-Billings, 1995; Ye et al., 2011). Though this may be a reality among many teachers, culturally relevant pedagogy is a manifestation of all three tenets working simultaneously.

Culturally relevant teaching is not easily accomplished. Good teaching does not occur by chance, but it is developed through a desire to see students who have been underserved succeed in learning mathematics content (Enyedy & Mukhopadhyay, 2007; Raygoza, 2015), and showing these students that mathematics is relevant even in their own lives and able to help them interpret the realities that they experience. Culturally relevant pedagogy will not be implemented successfully in environments like the one described by Wager (2014), where teachers are content with classifying mathematics as a culture free subject, or where Jett (2013) faced a group of teachers who thought he should focus on math and not race.

Participants influence professional development environments like the ones described above substantially, and CRP is too extensive to be understood and likewise implemented in a day's work. Fortunately, researchers contend that teachers who are committed to teaching for equity and have every intention of empowering their students through education do exist, despite the demands to focus on passing state mandated tests and benchmarks (Davis et al., 2015; Jackson, 2013; Leonard & Moore, 2014; Young, 2010). Cultural relevance is one way to achieve what McKenzie and Locke (2004) described as equity consciousness, and quality teaching is in one way addressed through responding to students' varying cultures. Researchers are challenged by the obligation of extending the culturally relevant knowledge base and preparing those who are willing to engage in the time and effort it takes (Gay, 2010; Young, 2010). Students of color,

female students, students with disabilities, indeed all students, benefit only when their teachers are efficient in using learner empowering teaching frameworks, a difficult but possible task.

The Manifestations of CRP

A major idea that seems to be evident in the literature is that culturally relevant pedagogy is not just a reflection of the curriculum. Many components of the curriculum are influenced by this pedagogy and framework, and the articles here articulate ways in which cultural relevance is manifested through both the lesson plan and delivery. What this means is that not only is the *assignment or task* culturally relevant, but the teacher engages with students in ways that honor their brilliance and culture and mathematizes their lived experiences. This realization is imperative, and it is essentially one of the ways that Boykin (1983) suggested teachers cater to African American students' needs or how Lipka and colleagues (2005) discussed the needs of American Indian/Alaskan Native students.

This attention towards culture and its strengths is essentially why the students described by Terry and McGhee (2013) are high achieving; their teachers and school influences helped to establish their perceptions of self. These beliefs are the premise upon which Ms. Finnley (Bonner & Adams, 2011), Mr. Lee (Johnson et al., 2013), and Mrs. Arieto (Cahnmann & Remillard, 2002) based their pedagogical strategies. Mr. Lee was described by Johnson and colleagues as a person who used speeches to convey important messages about ability and expectation to his students. His words embodied what it meant by having high standards for their academic achievement. Ye and colleagues (2011) described two teacher interns who were grasping their culturally relevant identities. Though some of these distinctions they listed were debatable, Ye and colleagues described how one teacher exhibited sociopolitical consciousness in the way that she critiqued the school's willingness to provide lockers for the students. The other teacher in

this study was described as culturally competent because of the relationships she built around student's afterschool activities and interests. This scholarship helps to paint a picture that culturally relevant teachers extend their concern for students even outside of the content or classroom. They, like Ms. Finnley or like Mrs. Arieto, work to meet the emotional and physical needs as a way to affect student performance inside of the classroom.

The literature also contains many examples of lessons that were perceived to be relevant or of interest to certain populations of students. Gonzalez and colleagues (1995) approached culture and mathematics from a funds-of-knowledge perspective that envisions the home knowledge that parents and family members provide to Latino/a students. They described lessons where ecology units were based on common resources in the home as well as how sounds and absorbency operate. Lipka and colleagues (2005) worked with children in rural Hawaiian communities to design a puppet test. This test mimicked a familiar enterprise in their community, going to one of the local stores and making purchases. These students were able to show knowledge of one-to-one correspondence and knowledge about the different values of coins. Additionally, Leonard, Moore, and Brookes (2013) suggested that multicultural texts such as *Aunt Harriet's Underground Railroad in the Sky* necessarily highlighted culture and did so in the spirit of mathematics. They found that pre-service teachers are capable of addressing the tenets of CRP by incorporating these texts into their lessons, even though the effort must be taken by the teacher to do this most effectively.

Interestingly, ideas of culture for Black students typically are illustrated within pop culture referents (Jackson & Williams, 2008; Leonard et al., 2013), but Ma and colleagues (2016) found that additional and more representative conceptions of these students may be necessary in order to avoid preconceived stereotypes. One very apparent strategy for connecting

mathematics to Black students' culture is articulated through what Marshall (2013) described as U. S. dialects, or as some call it, African American Vernacular English (AAVE). When teachers honor AAVE (e.g., Ares, 2008; Eglash et al., 2013), they are using culturally relevant pedagogy. Teachers honor this language by allowing students to participate in mathematics conversations in ways that do not degrade their home vernacular. For non-native English speakers this is accomplished through the use of their own language (Cahmann & Remillard, 2002; Leonard, Napp, & Adeleke, 2009) and in honoring their community knowledge (Gutstein et al., 1997).

Lastly, few studies have attempted to rate culturally relevant lesson plans, but have done so in rather broad conceptions of the framework. Lemons-Smith (2013) used a questionnaire, teacher lesson plans, and observations to discuss the PSTs' conformity towards culturally relevant pedagogy. Concerning the lesson plans, she coded each one as substantive, cursory, or no attempt at incorporating students' background, families, communities, and lived or out-of-school experiences. She contended that only three of the 21 lessons from the seven teachers were considered to be substantive, and that these results mirrored what Gay (2010) suggested about how PSTs do not always tend to value their students, specifically regarding their realities in accordance with race or culture. Leonard and Moore (2014) borrowed from this framework outlined by Lemons-Smith but did so through a lens of social justice pedagogy. Though similar to learning that is culturally relevant, social justice has a bit more focus on the critical consciousness tenet of CRP. In their study, Leonard and Moore found that PSTs' lesson plans aligned well with three out of four of the principles for social justice pedagogy, where the tenet on which PSTs did not perform as well involved students' family and cultural values. These studies offer some insight into how to improve the review of the lesson plans in the current study.

Research Paradigms and Methodologies

A postmodern perspective regarding the curriculum asserts that we often forget that dominant groups within a society do not lack culture (Slattery, 2013). Both men and women have gender, both heterosexual and homosexuals have a sexual orientation, and both Black and White citizens are racialized. Further, postmodernism problematizes these bifurcations of categories to realize there are other subcultures and options among these spectrums. This is important to the current work because it establishes ways in which teachers can focus on different aspects of culture or interests (i.e., youth culture, gay culture, White culture, and Feminist culture). Whichever choice teachers make, this should be apparent to both the teacher and her/his students in such a way that it still empowers and liberates them (Gay, 2010).

One perspective about culturally congruent work is that it allows the participants to be humanized. We see this in such work like Thomas and Williams (2008) or Jackson (2013) where the teachers are not just identified as culturally relevant or lacking cultural relevance, but an explanation exists of how, and this explanation is built on subjectivity of the researchers. Nevertheless, it is interesting that some researchers offered quantitative support for their studies. This is demonstrated in the work of Enyedy and Mukhopadhyay (2007) and Eglash and colleagues (2013) where students improved on some researcher-designed mathematics assessment after receiving a culturally relevant intervention. Johnson and colleagues (2013) and Bonner and Adams (2012) mentioned how student achievement on standardized tests was favorable as a result of having teachers who exhibited culturally relevant pedagogical styles.

Lesson Plans

Given the acknowledgement of a post-modern perception of the curriculum, it seems appropriate to discuss lesson plans within both a historical and philosophical context. Part of the rationale for the inclusion of this portion of the literature review is that there are different perceptions of what a lesson plan entails, as well as what items or artifacts constitute the curriculum. For the purpose of this study, a lesson plan will be defined as the formal, written outline of the preservice teacher's strategy for teaching a mathematics concept within a 15-20 minute time frame. Further, this section helps to outline components that are consistent in lesson plans and the ones that are most practical for addressing and implementing culture while engaging students in mathematics problem solving.

With this understanding, I build on the notion of curriculum as presented by Pinar (2004) and argue that elements of both the curriculum and lesson plan are reflections of different moments that build on the regressive (the past), the progressive (the present), the analytic (the future), and the synthetic (the overlap of all three) moments. Pinar's description of the curriculum is noteworthy here because cultural relevance, I believe, is consistent with how the society helps to shape education and this is a process that is both fluid and gradual. Further, a philosophy of mathematics education provokes researchers, educators, and students to all consider such questions that challenge the need for a mathematics curriculum and the components that should be encapsulated in such a lesson plan design. Scholars such as Gutstein (2003), Frakenstein (2007), and Powell & Brantlinger (2008) offer ideas regarding critical perspectives in mathematics education, and impress upon prospective and practicing teachers the emancipatory process that Freire (1970) articulated, restructuring the teacher's role from just *the one who teaches* to one who is also taught alongside the students through a dialogical process.

This necessarily influences the teachers' ideas about designing lesson plans in regard to pedagogy, and helps to respond to questions that a philosophy of mathematics education should answer, such as what is it that my students need to know and how best should I teach it to them (Gutierrez, 2010; Martin, 2009; Stinson, 2016).

A Brief History

The unique quality of post-modernism suggests that many ideas about the curriculum are limited. Within the American model of schooling, we follow a Tylerian Rationale that lends itself to a very mundane set of activities that have pre-determined roles for the teacher and his students. According to Slattery (2013), the questions proffered by the Tylerian Rationale concern ideas of goals, objectives, lesson plans, and testing. Much of the extant literature defines the lesson plan as an artifact that encompasses most if not all or more of these elements, and evidence is seen in such places as the Universal Design for Learning (UDL) literature (Spooner, Baker, Harris, Ahlgrim-Delzell, & Browder, 2007). Although UDL scholarship is specifically geared towards lesson plans that increase differentiation within general education classrooms, this scholarship mentions how a basic lesson plan format might include materials, objectives, procedures, guided and independent practice, and some form of assessment.

Post-modernism allows for alternative interpretations of how teachers might develop and enact their daily instruction. Pinar (2004) envisioned the curriculum, and thus the lesson plan, in much more of a natural and spontaneous form. If the curriculum is truly the racecourse of life, as Pinar asserted, then the lesson plan has the potential to evoke ideas, discussions, and endeavors that are not necessarily constrained to one content or subject. In this notion, the lesson is not bounded by a certain discipline or standard, but by the interests and needs of the students; therefore, I contend that a more diverse understanding of curriculum welcomes ideas of cultural

relevance and equity. This is the same idea communicated by Wallin and Graham (2002) in their discussion of the superficiality of "canned" lessons that lack any connection to authentic student experience or inquiry. Wallin and Graham went as far to relate this prepackaged approach to education to Marx's (1977) theory of alienation where work, or in the current case, education, is disconnected from student life and renders them powerless. Lesson plans and more generally, the curriculum, have the potential to "awaken the intelligence of the students, [and] to invite them into a dialogue with the curriculum in a way that does not regard them as merely a participant" (Wallin & Graham, 2002, p. 343). The reality for this study is that the lesson plan interpretation is situated on a spectrum that has post-modernism at one side of the spectrum and the Tylerian Rationale on the other.

Exemplary Models of Lesson Plans

Lesson planning is typically a year-long process where teachers map out the content that they will cover in class. Ding and Carlson (2013) referred to this as intended curriculum. Yinger (1980) asserted that teachers tend to devote at least part of their time to yearly, term, unit, weekly, and daily lesson planning. Farrell (2002) described a daily lesson plan as a "written description of how students will move toward attaining a specific objective" (p. 30), and defined a lesson plan as the daily decisions made by the teacher to ensure a successful outcome of the lesson. Farrell begins the article by describing why lesson plans exist, and posits that they tend to help the lessons run more smoothly in regard to timing and sequencing, and can help to maintain a log of what has already been taught in previous classes. Additionally, lessons plans can be used as evidence that quality teaching is occurring within the classroom as a part of teacher evaluations (Darling-Hammond & Baratz-Snowden, 2007).

Farrell then discussed a few models of lesson planning, including Tyler's model as described above, and Yinger's model in which lesson planning takes place in different stages. These stages consist of: *problem conception*, which is influenced by the teacher's knowledge and goals, *seeing the problem formulated and the solution achieved*, and finally the *implementation of the plan and its evaluation*. Farrell offered an adaptation of scholarship from Shrum and Gilsan (1994) and produced a generic lesson plan. This lesson plan included five phases: a) perspective or opening, b) stimulation, c) instruction/participation, d) closure, and e) follow-up. In discussing the implementation of the lesson plan, Farrell stated that teachers should monitor pacing and lesson variety. When the implementation of the lesson plan is not going well, teachers are able to modify the lesson plan in these two areas in a way that will still allow the objectives to be covered, but that allow the lesson to be more effective and engaging for the students (Ball, 1996). Pashler and colleagues (2007) offered seven recommendations for helping teachers improve lesson plans as a part of Institute of Education Science, and Ding and Carlson (2007) utilized three of these within a conceptual framework. These recommendations included a) worked examples, b) connecting concrete and abstract representations, and c) asking thoughtful questions with a goal of eliciting student self-explanations. These recommendations are based on research that has interrogated best practices in education and lesson planning within mathematics, such as Boaler and Staples (2008) conception that teachers who write out possible questions before creating their lesson plans are generally more successful in addressing key mathematical ideas, or in Chi and colleagues (1989) notion that explaining worked examples allow students to ascertain the general principles in determining why the examples follow specific protocols.

Overall, what seems to be a major focus in much of the literature on lesson planning is consistent attention to objectives, engagement, and assessment. Ferrell (1992) and Fruden (1984) suggested that a major assumption in education embodies a belief that the lesson plan is an accurate depiction of what is going to occur in the classroom and that these plans are linked to student outcomes. Jacobs, Martin, and Otieno (2007) described that lesson plans required by teachers are typically outlines of the procedural aspects of the lesson, such as page numbers in a book, problems to be assigned for homework, and the standards to be covered. McCutcheon (1980) referred to this as planbook planning. I share an understanding with Jacobs and colleagues that the lesson plan is focused on "the pedagogical knowledge and decisions of the teacher as embodied in lesson planning documents that are more fully developed by teachers for their day-to-day teaching practice" (p. 1100). Research on teacher planning can, and in some cases does, devote attention to content goals, the knowledge of the teacher, and sequencing of the lessons, as well as how activities will proceed, be implemented, and assessed (e.g., Brown, 1993; Kagan & Tippins, 1992). Lastly, Shulman (1986) made it clear that effective teaching causes teachers to consider "what to teach, how to represent it, how to question students about it and how to deal with problems or misunderstanding" (p. 8). As stated by Ding and Carlson (2013), this typically demands the construction of more thorough lesson plans.

Teacher Preparation Programs and Lesson Plans

Lessons plans are incredibly important artifacts associated with teaching and thus are often times addressed in methods courses and/or certification programs. They have a variety of qualities, one of which is to help plan for ways to address the misconceptions that typically accompany the study of certain concepts (Darling-Hammond & Baratz-Snowden, 2007). Misconceptions occur in a wide assortment of content areas, and they are particularly common in

mathematics (Ma et al., 2016; Shulman, 1986). Lesson plans are also useful in that they help to ensure that the teacher follows predetermined methods, curriculum, and procedures, and likewise helps the class operate as normal in the teacher's absence (Doak & King, 1999).

The literature indicates that there is room for improving lessons plans as a goal of teacher preparation programs (Ding & Carlson, 2013), claiming that "the quality and style of many U. S. teachers' mathematics plans are discouraging" (p. 359). Prior research has indicated that teacher education programs have inadequately prepared PSTs in mathematical knowledge for teaching, and this raises concerns regarding their problem-solving skills and strategies (Kulm et al., 2016; Ponte, 2009). Ding and Carlson attributed this to a bevy of ideas, one being that teacher beliefs might affect how they teach and plan. For example, Burns and Lash (1988) described how some teachers were reluctant to show students how to solve problems, emphasizing the need for students to take on this task themselves as a way to promote problem-based learning. Anderson, Reder, and Simon (2000) considered this to be a misunderstanding of constructivism and Ding and Carlson (2013) indicated that even in this type of discovery learning, teachers must plan for their students to be exposed to what Hmelo-Silver, Duncan, and Chin (2007) termed "expert guidance". Ozogul, Olina, and Sullivan (2006) found that pre-service teachers were able to improve the lesson plans they designed, and perceived to do this most effectively when their professor evaluated these lesson plans.

Darling-Hammond (2006) contended that one of the characteristics that proved beneficial in international school settings was that teachers had ample time to plan their lessons. This statement speaks to the fact that lesson plans are critical components of teaching and suggests that it is worth taking the time to develop them meticulously, and that teacher programs should use sufficient time to support pre-service teachers' construction of lesson plans. Ding and

Carlson (2013), however, reported that elementary teachers and more experienced teachers felt that detailed lesson plans were not necessary to promote productive class sessions.

Much like PSTs are trained to plan to address common mathematics misconceptions, lesson plans play a vital part in helping teachers plan to teach for cultural relevance. The National Council for the Accreditation of Teacher Education (NCATE) regarded the importance of diversity, so much so that it included diversity as a unit standard (Ma, Brown, Kulm, Davis, Lewis, & Allen, 2016; NCATE, 2008). The council suggested that PSTs must be able to operationalize the belief that all students can learn and that fairness in the education settings must be met in a non-discriminatory and equitable manner. These ideas are an articulation of Gay's (2002) admonition that academic achievement would increase as a result of teacher preparation programs who prepare PSTs to be culturally responsive to diversity. However, as Watson, Charner-Lind, Kilpatrick, Szczesiul, & Gordon (2006) and Sleeter (2001) articulated, many PSTs lack experience with confronting diversity issues and are failing to meet the needs of diverse students. Martin (2009) contended that mathematics teacher development efforts "should not only focus on content knowledge and pedagogical content knowledge, but also include developing teachers' awareness that classroom practices influence the construction of academic and mathematics identities and that these identities are co-constructed with students' racial identities" (p. 299). I argue in this paper that one way for teacher preparation programs to meet this goal, and to simultaneously help PSTs improve their ability to design lesson plans, is to devote greater attention to achieving the tenets of culturally relevant pedagogy in lesson plans. The suggestion I provide here compliments the work of Banks (1993) where he identified four approaches to the integration of multicultural content into the curriculum. The contention is that

these ideas are planned for and executed, even within lesson plans, and that teacher preparation programs have the obligation to target these goals as a part of their agendas.

Why it Matters

In following this research, practitioners would be remiss to deny the significance of attending to culture during the process of teaching. Culture becomes associated with the financial, social, and educational characteristics of groups within the American society (Gutierrez, 2002). The implication therefore is that to know the culture of students in the classroom is to help understand the child as a whole (Ortiz, Capraro, & Caprao, in-press; Stinson, 2006). Students' experiences in the classroom are merely a fraction of the reality which they encounter daily, and experience, in the school, in the world, and in life, is in fact essential to the learning process. This being true, culture, as Yosso (2005) explained, serves to empower and nurture students of color in particular. She defends the commitment that teachers should have concerning culture because it creates, as Freire (1970) would suggest, the ability for school and education to become a liberating factor in the lives of all students. Anything less would legitimize what Blaisdell (2016) described as whiteness as property and its role in eradicating any real access Black students, as well as other students of color, have to equal access in education.

African American students have not been benefactors of such a reality because, as Woodson (1933) argued, these students have been educated away from their own culture and made to believe that their brilliance is lacking in comparison to their White peers. Mason (2016) conceded similar sentiments by describing cultures as different, but that these differences should not be communicated as problematic or deficient. An acknowledgement of cultural capital achieves the goal that critical race theory was intended to combat: the idea that White capital is

normative and thus is viewed as a standard (Guttierez, 2013; Tate, 1997). Challenging the idea of what is considered normative is at the heart of the work of critical race theorists and advocates for a culturally sensitive curriculum and environment (e.g., Bell, 1992; Howard, 2008; Krenshaw, 1989; Ladson-Billings, 1998; Rogoff, 1990; Tate, 1995). Though a discussion of race is not the only way to challenge these ideas, it cannot be treated as irrelevant; race still matters in education (West, 1992), and because of its pervasive nature in American society, stands as one access point to address ideas of academic excellence, cultural competences, and critical consciousness.

The revelation of culture as significant welcomes a claim that race and racism are inherent in America's history, and that current assessment strategies and pedagogies reify the inequity existent in American schools (Ladson-Billings, 2004). If teachers do not acknowledge the presence of culture and instead pretend it to be nonexistent, these inequities will continue to harm the beneficial potential of education. Race and racism, especially in the lives of people of color, are relevant focal points in mathematics. Further, these inequities may be a reflection of misunderstanding about a culture that is not identical to that of White middle class teachers. This idea is incredibly important in helping PSTs understand how to develop culturally relevant lesson plans and to teach for diversity (Oner et al., 2014b), because White values and norms are often times privileged in schools as well as the American society as a whole (Ye et al., 2011). Stinson (2006) offered an example of the cool pose exhibited by Black male students in which teachers may have the tendency to interpret style and posture as defiant and rude. The bigger picture suggests that a difference in culture should not be defined as a fault, but that these differences should be celebrated and that anything less extends the life of the historic detriments to diverse student learning.

Interestingly, teachers who "do not see color" are at times inadvertently operating out of a sociocultural lens (Guttierez, 2013; Nasir & Hand, 2006), albeit one that stops short of discussions of race or privilege (Martin, 2009; Tate, 1997). Research suggests that these teachers try to claim some sense of color-blind ideology as a way to approach equity. The reality is that this ideology often does more harm than it does good for students of color, particularly Black students in mathematics. As Martin proffered, this ideology operates as an unwillingness to address issues of race and racism and thereafter lead to the color-blind rhetoric. Nevertheless, the sociocultural lens articulates that meaning, thinking, and reasoning all are developed within social activity. It stands to reason that multiculturalism has lost its focus on race and racism as intricate parts of teaching and learning (Ladson-Billings, 1996; Ladson-Billings & Tate, 1995), and has been recast as a perspective that is more reflective of difference in general (Schlesinger, 1991). While all differences are important, race stands to be a salient and overarching theme in addressing culture and diversity. In this vein, cultural relevance would warrant some discussion of the influence of race on mathematics teaching and learning, policy, and research.

The ineffectiveness of PSTs, or teachers in general, in addressing cultural competence will allow capitalization of stereotypes, misappropriations concerning behavior, and perceived incompetence to truncate the success of underrepresented students (Howard, 2008; Ladson-Billings, 1994). These stereotypes are a result of a lack of understanding of what non-dominant culture is, and ignorance of this entity will maintain low performance from the myriad students of color in K-12 settings. The veracity of this statement was articulated by Ares (2008) by saying that little hope for improving the underrepresented students' participation and preparation for STEM disciplines exists if issues directly connected to culture are ignored, and Ortiz and colleagues (in-press) echoed this sentiment by demonstrating the impact that a misalignment

between student culture and mathematics content had on student learning; these issues then, must become explicit even within lesson plans.

On one hand, teachers do not see the significance of addressing culture and race in the mathematics classroom. They may see the content, in particular mathematics, as inexorable and thus free from personal reservations. Conversely, these teachers may view their perception of culture as well-informed and thus see no need to question what they deem as factual. Necessarily, one must understand that culture plays an important role in access to education in this country, prior to entering the classroom as well as during instruction. As such, pedagogical suggestions involving culture must be highlighted in teacher education programs. Though I spend much of this discussion on how culture might be addressed, and in particular in the way that it is a reflection of students' realities as racialized human beings, there are no limitations to how culture can be addressed or how teachers might conceptualize student's lived experiences. This presents an interesting mode of inquiry as discussed in the next chapter and throughout this study.

CHAPTER III

METHODS

This chapter describes the research method by detailing the essential elements of the study: variables, analytic techniques, and the rationale behind the selected procedures. The research questions for the study were: 1) how successful were PSTs in implementing culturally relevant tenets into mathematics lesson plans designed for a virtual classroom environment and 2) how did PSTs' diversity awareness and beliefs towards teaching for equity change? These questions were the catalyst for the inquiry and helped to articulate the methods most appropriate to address issues of understanding manifestation of CRP in mathematics problem-solving lesson plans.

Participants

The archival data used in this study were collected by KATE Project members at a large southwestern research university. All participants were middle-grade mathematics pre-service teachers (PSTs) enrolled in a required mathematics problem-solving course in the school year 2013-2014. The participants were composed of 29 PSTs from the Fall 2013 class, and thus 29 total lesson plans were submitted by the PSTs as a required assignment. Of the 29 PSTs whose lessons were reviewed, three identified as Hispanic, one identified as White and Hispanic, and the remainder (i.e., 25 PSTs) identified as White. There was one male PST within this sample and 28 females.

Lesson Planning and Teaching Exercises

Preservice teachers enrolled in the problem-solving course each semester and developed personal teacher avatars in Second Life® (SL). The KATE virtual classroom and learning spaces in Second Life were designed specifically for preservice teachers to engage in tutoring and

practice teaching exercises with middle grade student (MGS) avatars. Multiple Second Life® classroom simulation sessions were integrated in the *Problem-Solving in Mathematics* course throughout the semester. Students in the course (i.e., PSTs) completed three activities in Second Life® along with lesson preparation activities throughout the fifteen-week course. Key activities included 1) Meet Your Middle Grade Students 2) Tutoring Middle Grade Students, and 3) a Problem-solving Lesson Teaching Experience. Opportunities to observe, critique, and later discuss their peers' teaching in SL were also an integral component of the course design.

Problem-solving Lessons

PSTs prepared a problem-solving lesson to teach to the full class of middle grade student avatars. Instruction for diversity was guided by a Hypothetical Learning Trajectory (HLT) for teaching for equity developed by the research team (Brown, Davis, & Kulm, 2011). The PSTs chose one of three conceptual schemes from the HLT to guide the design of their problem-solving lessons in SL and described in Chapter 2. Upon selecting a conceptual scheme to use in their problem-solving lessons, PSTs were instructed to create virtual avatars inside of Second Life where they would interact with diverse student avatars controlled remotely by graduate research assistants, or operated by programming. Additional components of the problem-solving course are described below:

- Mathematics problem-solving and problem posing: This included instruction and practice with problem-solving heuristics and homework assignments where the participants had to complete problem sets, apply the heuristic methods, and demonstrate and articulate complete solutions (Kulm et. Al, 2016; Oner et al., 2014).

- Math equity problem challenges: The course involved three equity problems that were each framed around one of the conceptual schemes. Four components were included in these challenges and consisted of a culturally relevant problem to solve and to adapt, addressing any student misconceptions, planning a problem-solving lesson, and responding to the both mathematics and equity questions that students might ask (Ma et al., 2016).

- Readings and discussions on diversity: Readings were assigned to the students that addressed equity and leading scholars who were part of the KATE research team gave presentations (Davis et al., 2015;).

- Second Life: the PSTs met middle grade student avatars, tutored them individually, and later taught a lesson to the full class of middle grade student avatars using one of the conceptual schemes within this virtual environment (Davis et al., 2015; Ma et al., 2016).

Data Sources

Lesson plans designed by the PSTs and their Diversity Preparedness Response Inventory (DPRI) responses served as the data sources in this study. PSTs created their lesson plans prior to teaching in the simulated virtual middle grades classroom in Second Life. The following eight components were to be addressed:

- Name of the scheme
- Key mathematical concepts and procedures
- Rationale for the context used
- Statement of the problem
- Solution
- Alternative approaches
- Questions to probe student understanding and
- Extensions or generalizations of the problem

The final version of the lesson plans was used as the main source of data in this study. Additionally, the PSTs were required to include the slides that would be used in their Second Life problem-solving lessons in the virtual classroom. The lesson plans were examined for evidence of the three tenets of CRP. Lesson plans from each scheme were utilized in the current study because of their attention towards the work of Dr. Gloria Ladson-Billings, and the connections that each of the schemes had to the HLTs outlined by the KATE research team.

Instrumentation

Two instruments were utilized in this study. The Mathematics Rubric for Implementing Cultural Relevance (M-RICR) was developed to examine mathematics problem-solving lesson

plans. The Diversity Preparedness Response Inventory (DPRI), developed by the KATE research team, was used to examine the impact that key course activities had on PSTs' diversity awareness, and knowledge about teaching for equity. Applying these instruments allowed me to use both quantitative and qualitative methods to guide the research.

The M-RICR

The Mathematics Rubric for Implementing Cultural Relevance (M-RICR) was created to examine PSTs' ability to implement culturally relevant tenets into mathematics lesson plans (see Figure 5). The M-RICR included three strands that were based on the three tenets of CRP as described by Ladson-Billings (2006): students should experience a) academic excellence or success b) cultural competence and c) socio-political or critical consciousness. These three strands were operationalized by listing specific ways for PSTs to demonstrate each strand. Items subsumed by the strands are referred to as indicators. Academic excellence (AE) and sociopolitical consciousness (SC) both have four indicators and cultural competence (CC) has three indicators. Based on the work of Ladson-Billings, I position: teachers who promote academic excellence and success (AE) 1) draw on issues that are meaningful to the student; 2) indicate a purpose for students learning the content; 3) utilize the students' skills and/or acknowledges and builds on their prior knowledge; and 4) supplement learning by using resources in addition to a textbook or the word problem. Similarly, those teachers who value the benefits of cultural competence: 1) draw on or use cultural artifacts as learning tools; 2) include the role of family as a knowledgeable source for support and learning; and 3) integrate or allow recognition of the students' culture and embraces the culture. Finally, teachers who are

Observer	(Last, First)
Preservice Teacher's Name	(Last, First)
Lesson Semester, Year	
Lesson Title	

Mathematics–Rubric for Implementing Cultural Relevance

		Indicators within Culturally Relevant Pedagogy (CRP)	No Attempt to Implement Indicator	Partial Attempt to Implement Indicator	Fully Implemented Indicator
			1	2	3
Tenets of Culturally Relevant Pedagogy	Academic Excellence	**AE1: Teacher draws on issues or contexts that are meaningful to the student.** *Possible source of evidence: Rationale for context selected*			
		AE2: Teacher indicates the purpose for students learning present content. *Possible source of evidence: Teacher introduction of the problem and the rationale for context*			
		AE3: Teacher utilizes students' skills and/or acknowledges and builds on their initial knowledge. *Possible source of evidence: Devision of plan and looking back.*			
		AE4: Teacher uses appropriate mathematical discourse. *Possible source of evidence: Understanding the probem and extension*			
	Cultural Competence	**CC1: Teacher draws on or uses cultural artifacts as learning tools.** *Possible source of evidence: Questions to probe*			
		CC2: Teacher includes the role of family as a knowledgeable and capable source for support and learning. *Possible source of evidence: Questions to probe and extension*			
		CC3: Teacher integrates or allows recognition of students' culture and embraces it. Possible source of evidence: Understanding the problem			
	Socio-Political Consciousness	**SC1: Teacher encourages the students to engage in the world critically to better understand their social position, as well as others.** *Possible source of evidence: Extension, rationale for context, looking back*			
		SC2: Teacher highlights multiple mathematics perspectives or approaches. *Possible source of evidence: Looking back*			
		SC3: Teacher encourages critical reflection and inquisitive or open-ended thinking. *Possible sources of evidence: Extension*			
		SC4: Teacher engages students in mathematics problem solving, where they identify and investigate social problems, and plausible solutions. *Possible sources of evidence:*			

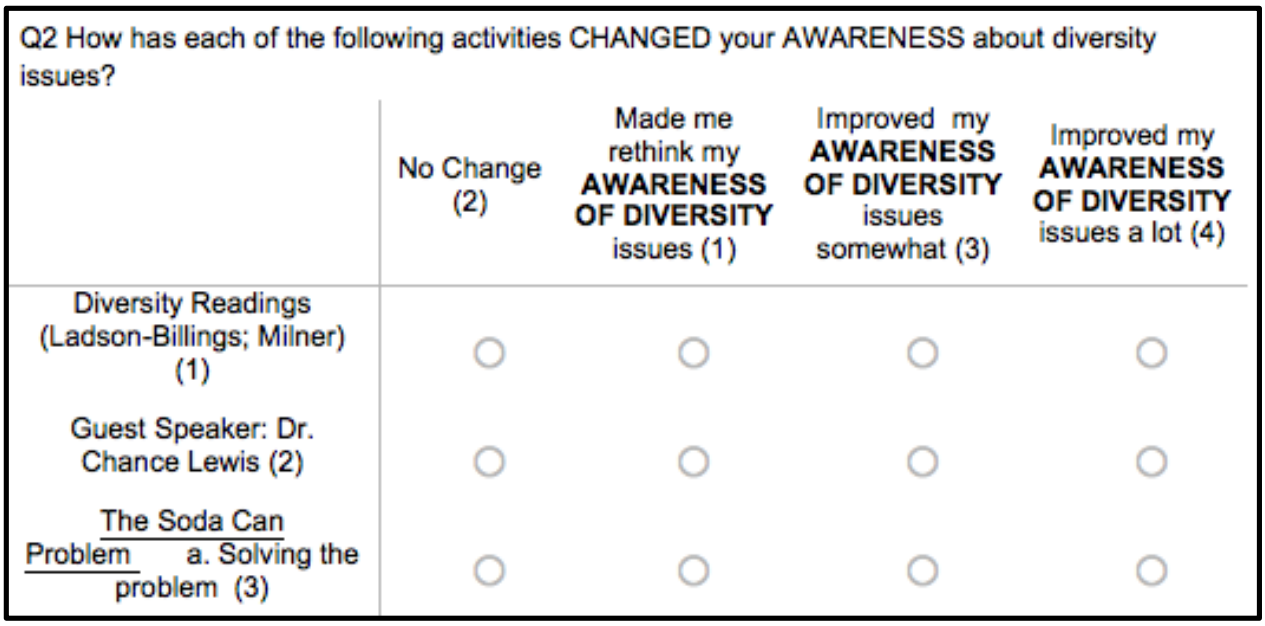
Figure 5. Mathematics- Rubric for Implementing Cultural Relevance

committed to increasing the sociopolitical consciousness of their students: 1) encourage students to engage in the world critically to better understand their social position as well as others; 2) highlight multiple perspectives or approaches to problems; 3) encourage critical reflection and inquisitive or open-ended thinking; and 4) engage students in mathematics problem-solving, where they identify and investigate social problems and plausible solutions.

The DPRI

Additionally, all participants completed a 13-question Diversity Preparedness Response Inventory (DPRI) that asked the PSTs about the impact that key course activities had on their diversity awareness, and knowledge about teaching for equity. These Likert Scale items allowed for responses ranging from *no change at all* to *improved my awareness of diversity issues a lot (or knowledge about teaching for diversity) a lot*. One of the main purposes of this instrument was to capture the PSTs' perceptions about the impact of a wide array of course activities (e.g., course readings on diversity or equity, speaker presentations on mathematics misconceptions or equity consciousness, designing problem-solving lessons).

The DPRI investigates more specifically PSTs' diversity awareness and beliefs toward teaching for equity. Section one of the DPRI focused on how the key course activities changed the PSTs' *awareness* about diversity issues. Figure 6 helps to illustrate one section of the DPRI.

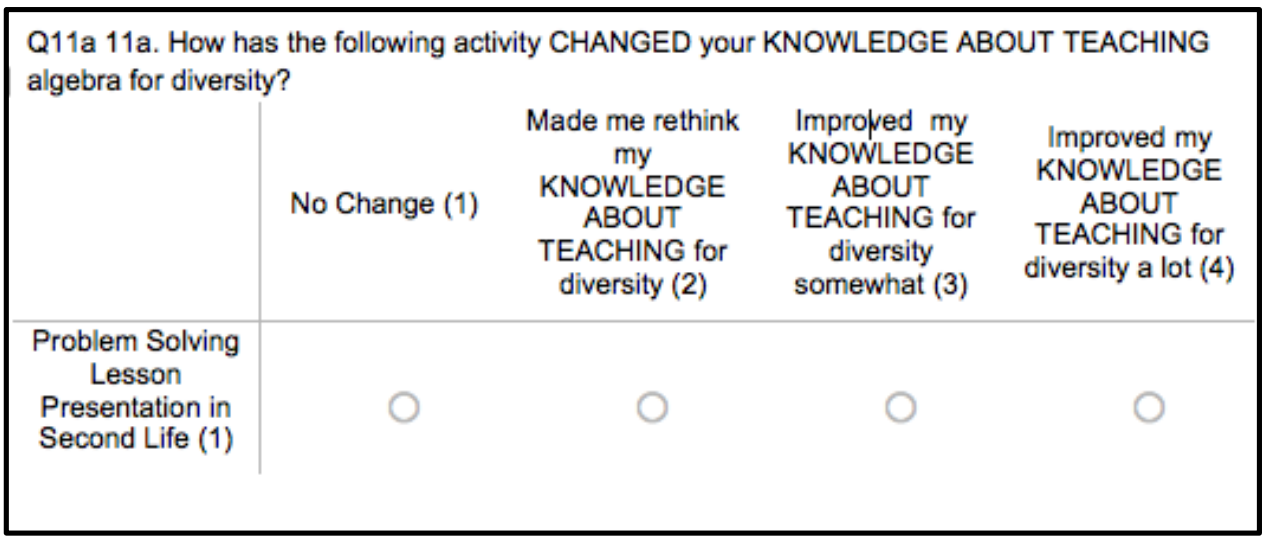


Q2 How has each of the following activities CHANGED your AWARENESS about diversity issues?

	No Change (2)	Made me rethink my **AWARENESS OF DIVERSITY** issues (1)	Improved my **AWARENESS OF DIVERSITY** issues somewhat (3)	Improved my **AWARENESS OF DIVERSITY** issues a lot (4)
Diversity Readings (Ladson-Billings; Milner) (1)	○	○	○	○
Guest Speaker: Dr. Chance Lewis (2)	○	○	○	○
The Soda Can Problem a. Solving the problem (3)	○	○	○	○

Figure 6. DPRI excerpt addressing awareness of diversity issues

Similarly, section two of the DPRI focused on how the course activities changed PSTs' *knowledge* about teaching algebra for diversity.



Q11a 11a. How has the following activity CHANGED your KNOWLEDGE ABOUT TEACHING algebra for diversity?

	No Change (1)	Made me rethink my KNOWLEDGE ABOUT TEACHING for diversity (2)	Improved my KNOWLEDGE ABOUT TEACHING for diversity somewhat (3)	Improved my KNOWLEDGE ABOUT TEACHING for diversity a lot (4)
Problem Solving Lesson Presentation in Second Life (1)	○	○	○	○

Figure 7. DPRI excerpt addressing the knowledge about teaching for diversity

Activities referenced on the DPRI included the course readings (e.g., Ladson-Billings (2006) and Polya (2006), presentations from leading scholars (e.g., Chance Lewis and Kathryn McKenzie), algebra problem-solving equity challenge (APSEC) activities (e.g., the Dinner Problem Activity and the Soda Can Problem), and the problem-solving lesson planning and presentation in Second Life.

Though all of the items on the DPRI will be considered in their impact on the PSTs' diversity awareness, some items are particularly relevant for the current inquiry. For example, one item examines the role that the reading of Ladson-Billings (2006) chapter had on the PSTs' diversity awareness and knowledge about teaching for equity. What makes this question particularly noteworthy is that the M-M-RICR was designed based on the scholarship of Ladson-Billings and more significantly, this particular manuscript. Another item in the DPRI asked the PSTs about the impact that planning a lesson based on one of the APSEC activities (e.g., the Dinner Problem) had on their diversity awareness and knowledge. Similarly, one of the last items on the DPRI specifically addressed the impact that the presentation of the problem-solving lesson in Second Life had on the PSTs' diversity awareness; this is the presentation for which the lesson plans, those artifacts which were analyzed using the M-RICR, were designed. Though what I have included here is not exhaustive of all items on the DPRI, it does illustrate the parallel efforts of both of these attempts to understand and communicate the PSTs' understandings towards diversity awareness and teaching algebra for equity.

Together, information from the M-RICR and the DPRI helped to depict the PSTs' growing disposition towards diversity (cultural relevance) and its presence within their lesson plans. This data helped to validate some of the findings that came out of the content analysis and that are discussed in the subsequent chapters.

Procedure (M-RICR)

For each lesson plan, I recorded the presence of the 11 indicators by scoring each indicator with a 1, 2, or 3, establishing what Thompson (2006) described as ordinal data; the scores highlighted no attempt to implement the indicator, partial attempt to implement the indicator, or full implementation of the indicator respectively. This evidence could be in any of the 8 bulleted components of the lesson plan, and the M-RICR offered possible locations for this evidence. For example, the M-RICR suggested that evidence indicative of *the teacher encouraged the students to engage in the world critically to better understand their social position as well as others* could be found in the extension, rationale for context, or looking back components. The sum of scores on each indicator produced the overall final score of CRP implementation, hereafter referred to as CR Score, and thus can be identified as intervally scaled data (Thompson, 2006). All CR Scores had a lower-bound of 11 and an upper-bound of 33. Additionally, the last column on the M-RICR was used for including comments such as evidence to support the score on that particular indicator or suggestions on how to move from a score of 2 to a score of 3 on a particular indicator.

Once each lesson plan was analyzed according to the M-RICR, data for the participants were combined in one large MS Excel file and included scores on all indicators as well as the final CR score. Descriptive statistics and ratios were utilized to determine which indicators were the most difficult or most simple for the PSTs to implement by assessing the amount of individuals who achieved a "no attempt" rating and "fully implemented" rating respectfully.

Analysis

Qualitative analyses were utilized, and more specifically, a content analysis was completed. Content analysis, as described by Lincoln and Guba (1985), is a systematic research

method that allows the researcher to reassemble data in text form to glean definitive inferences from both its latent and manifest content. Lesson plans were coded to uncover prevalent themes (Glaser, 1978); Saldana (2009) defined a code as a word or short phrase assigned to language or an image that serves to capture the main idea. Similarly, Lodico (2010) described a theme as the big or main ideas that combine multiple codes from the data and that help to answer the question. These themes were derived from the individual units and grouped together to make the central ideas more salient. The following describes methods used to address each research question.

Research Question One

Each of the 29 lesson plans were deconstructed to discover themes in how successful the PSTs were in implementing culturally relevant tenets into mathematics lessons designed for a virtual environment, and the content analysis is discussed through the use of descriptive statistics. As stated by Lincoln (2007), a unit is not easily defined but it can be described as some idea or thought that is able to convey a complete thought. Each lesson plan was broken into units, a process known as unitizing the data. Unitizing the complete lesson plan and subsequently utilizing the indicators from the M-RICR as inclusion and exclusion criteria achieved the desired results. Lincoln (2007) described inclusion and exclusion criterion as descriptions that aid in the systematic decision of whether an item does or does not belong to a particular category. Each unit was compared to the indicators that represent a particular category, or in this case a tenet, and was then placed accordingly. Those units that did not fit into any of the categories as defined by the indicators were placed into a fourth category, a miscellaneous group. A constant comparison method helped to ensure consistent assignment within appropriate a priori categories. In this process, each of the units was forced into a category to account for the entire lesson plan.

Similarly, the lessons plans were evaluated by matching the indicators on the rubric to evidence in the lesson plan. The reader will notice that although similar to what was described in the paragraph above, the direction of the analysis has changed. In this part of the analysis, each indicator was rated as having been fully implemented, somewhat implemented, or not implemented at all. Here, each of the indicators were evaluated for any evidence from the lesson plan to support said indicator, and to determine to what extent it exists. These two processes do indeed compliment one another, but the latter allowed for every indicator to be addressed and scored while the former could potentially allow all three tenets to exist with no evidence of a particular indicator. In other words, academic excellence could be present in a lesson plan even if the lesson plan is weak in addressing just one of the indicators. Further, all lesson plans that received a 3 on a particular indicator were analyzed to determine the themes in this evidence. For example, if 20 of the lesson plans acquire a 3 on indicator AE1, evidence for this indicator were palpable across all 20 lessons plans. This process continued for each of the 11 indicators.

Content analysis was used specifically to determine the justification that PSTs provided regarding why they felt their lessons were culturally relevant. These responses, assessed under the *rationale for the context chosen* portion of the lesson plan, were open coded. Each lesson plan was then reexamined to determine themes.

A final score for cultural relevance, known as the CR Score, was calculated for each PST. This score depicts a continuum that the teachers are on and how they represent the tenets of culturally relevant pedagogy as a collective whole within their lesson plans. Borrowing from the work of Lemons-Smith (2009) and Leonard and Moore (2014), I utilized categories which subsumed each of the 29 lesson plans based on this CR Score.

Lesson plans with a score of 15 or less were categorized as absent level of cultural relevance. Similarly, superficial, moderate, and substantive levels of incorporation were based on ranges 16-21, 22-27, and greater than or equal to 28 respectively. These categories, those which I call CR categories, were based on the lower (CR Score = 11) and upper bounds (CR Score = 33) of the M-RICR. The cutoff score for the substantive level, for example, was 28 because PSTs could achieve this score by receiving a 3 on all but approximately half (i.e., 5) of the indicators, whereas the remaining scores on the other six indicators would all have to be 2; the cutoff score for the remaining categories were achieved in a similar manner and sought to provide equal score ranges across all categories. Group membership into one of the classifications described here will be reported as frequencies, establishing the quantity of PSTs who were able to develop lesson plans that represented different qualities of final products.

The results are expected to be consistent with my initial thoughts and they will be described in the following chapter. These qualitative methods were the best way to collect the data and answer the questions because they deconstructed human thought and perception (i.e., the rationale and application of cultural relevance as demonstrated by the PSTs) specifically addressed in the research questions. The quantitative approach allowed for discussion and categorization of particular elements garnered from the qualitative analyses.

Research Question Two

The DPRI data was useful in determining how the PSTs' diversity awareness and beliefs towards equity changed, and analysis of the data helped to validate the findings from the M-RICR. Results from the M-RICR aided in quantifying the number of teachers in each CR category and the DPRI aided in identifying the components of the course which PSTs, specifically those whose lesson plans were identified as moderate and substantive lessons plans,

felt impacted their diversity awareness the most. Diversity awareness and beliefs towards teaching for equity were gauged through the Likert scale items presented on the DPRI where the PSTs responded to all activities throughout the problem-solving course as having either: a) made no change; b) made them rethink awareness of diversity issues (or knowledge about teaching); c) improved their awareness of diversity issues (or knowledge about teaching) somewhat; or d) improved their awareness of diversity issues (or knowledge about teaching) a lot.

DPRI profiles were created for the PSTs to report the key course activities that they felt impacted their diversity awareness the most. In other words, DPRI data for all PSTs who had lessons plans in the moderate and substantive categories were analyzed to determine which activities they found to be the most impactful, and this was operationalized by their indication of an activity that *improved my awareness of diversity issues (or knowledge about teaching for diversity) a lot.* Descriptive statistics were reported to communicate the frequency of the activities as selected by the PSTs and to establish a ranking order for impact of these activities as perceived by the PSTs. Similar reporting was conducted for the tasks that were reported by these PSTs to have no change in their awareness of diversity issues or knowledge about teaching algebra for diversity.

Earlier I explained that some DPRI items were particularly relevant to the current inquiry. For these items, I reported the descriptive statistics across all PSTs and not solely those in the substantive and moderate categories. For example, I wanted to know specifically how many PSTs felt that the Ladson-Billings (2006) article impacted their diversity awareness, and reported the number of teachers who selected each option in the Likert scale ratings for this item. This process was repeated for the other two items that I interpreted to be most salient among the DPRI items.

Further, I address how particular PSTs indicated change (or no change) among the DPRI items and how I perceived it to be demonstrated in their lessons. In other words, for the PST who scored high on the M-RICR, I analyzed the lesson plan units for evidence of where he or she said that their diversity awareness was improved, and how I either confirm or contest this based on evidence from the lesson plan. The thematic analysis described above will help to convey which ways the DPRI items manifested in the lesson plans.

Quality

Qualitative paradigms afford the researcher some measure of freedom from quantitative paradigms. Lincoln and Guba (1985) contended that there exist no direct equivalents to measures of reliability and validity within a post-positivist paradigm because no intent for objectivity exists. The M-RICR is a human created instrument and does possess the bias of the researcher as is common in this line of research. Qualitative and constructivist work does not pretend to bypass these realities, but this work embraces them. Nevertheless, to reduce bias, I performed interrater reliability to ensure that the M-RICR was a quality instrument and helped to produce quality results in analysis and coding. The full process of this attention to reliability is described in the following pilot study.

Pilot Study

A pilot study can be understood as a small-scale study that precedes a larger, more comprehensive study. Simon (2011) and Polit, Beck and Hunger (2001) described the pilot study as a trial run or a pre-test for the main study, and Baker (1994) maintained that this process allows the researcher to try out an instrument. The purpose of the current pilot study was to gauge the effectiveness of the researcher-created instrument in terms of validity and reliability. The pilot study helped to determine whether the indicators on the instrument would be salient in

the lesson plans that the pre-service teachers created and whether I was being consistent in my analysis and scoring of these lesson plans. An earlier version of the instrument was used on all the lesson plans from which the pilot study sample was drawn. The indicators on the first version of the instrument did not capture the true essence of a virtual learning environment (i.e., Second Life), and thus warranted substantive improvements. The pilot study assisted in the validation and reliability of the instrument, and foreshadowed the effectiveness of an improved version of the instrument and its ability to capture noteworthy results. Further, it helped to solidify consensus among myself and another researcher about what represented evidence in regard to specific indicators.

Reliability was established through rater training, scoring, and post-evaluation rater debriefing to achieve consensus. To minimize bias, the expertise of a second researcher was solicited to analyze the lesson plans using the M-RICR. This study used inter-rater reliability (IRR) as a way to assess the reproducibility of the findings (Stemler, 2001). Percent agreement was selected as the viable method because the other rater was trained in how to use the rubric and it was expected that she would not guess on any of these items. McHugh (2012) asserted that when these conditions are met, the researcher may rely safely on percent agreement to gauge IRR. Content validity is the measurement property that assesses whether the items on a particular rubric are comprehensive enough to represent some conceptual framework and adequately represent the population (Brod & Tesler, 2009; Nunally & Bernstein, 1994). Content validity was established in the current study through operationalizing the tenets of culturally relevant pedagogy, review by content experts, and revision among the KATE team members.

Rater Training

The second rater was another graduate student in urban education. She was considered to be a viable candidate for assessing the lesson plans because she holds a Texas Generalist Certification and has experience teaching STEM content (both mathematics and science) at the middle school level. Further, her research agenda is grounded in teacher education and sociocultural influences on education, and thus she is particularly well-versed in the theoretical framework that informed the creation of the M-RICR. The second rater was trained in how to use the rubric during a 60-minute workshop. We began with a discussion of each of the tenets of culturally relevant pedagogy, and discussed our interpretations of Ladson-Billings' framework. This discussion succeeded a review of an excerpt from *Yes, but how do we do it? Practicing culturally relevant pedagogy,* a reading that the pre-service teachers were given as an assignment during the problem-solving course.

In addition to operationalizing each of the indicators listed on the rubric, examples of evidence were provided and discussed, most of which came from unidentified pre-service teacher lesson plans. This was done to further establish agreement regarding what was sufficient justification for an indicator, and to avoid any bias in assigning scores to the pre-service teachers we had already discussed. Next, we analyzed one of the lesson plans independently and then scored it collaboratively. The purpose of this was two-fold: it allowed us practice in identifying the evidence for the indicators, and allowed us to discuss how much flexibility should be given in assigning a 1(no attempt to implement the indicator), a 2 (partial attempt to implement the indicator), or 3 (full implementation of indicator). This lesson plan was then taken out of the pool of 10 lesson plans that we analyzed and that are discussed in this pilot study.

The Scoring

During the pilot study, 10 lesson plans were analyzed from the spring 2014 problem-solving course. This sample size represents approximately 20% of the full sample, and is therefore a definitive sample size as described by Hertzog (2008). A description of the full sample for the pilot study can be seen in Table 1. These lesson plans comprise a purposive sample because they were selected based on whether they received a high, mid-range, or low culturally relevant (CR) score. This score represents a cumulative score across all indicators for a lesson plan. To showcase lesson plans on the extreme sides of the spectrum, I selected 4 lesson plans with a high CR score, 4 with a low CR score, and two with a mid-range score.

Table 1 *Pilot Study Sample Description*

Gender	Race/Ethnicity of PST	Title of Lesson Plan	Level Designation from Original Instrument
Female	White	Jellybeans	high
Female	White	Birthday Time	high
Female	Asian	The Train Set Problem	high
Female	White	Are Your Ready for Some Football	high
Female	White/AI	I Scream You Scream	middle
Female	White	Mr. Jones Ice Cream	middle
Female	White	Who's Taller	low
Female	White	It's Nugget Time	low
Female	Asian	Library Books	low
Female	White	Wal-Mart	low

Note. N=10

Each lesson plan was analyzed using the M-RICR independently. We scored all of the indicators for each of the 10 lesson plans described above. Each lesson took approximately 15-20 minutes to review and score. When the lesson was completed, I called the scores out loud and we both marked on hard copies of the M-RICR to record all indicators where there was disagreement.

Debriefing and Consensus

In a debriefing session, we sought to come to consensus about some the initial disagreements. This process allowed us to discuss why we gave the specific scores and to determine the rationale that was most appropriate and consistent with understanding the indicator. This process allowed me to determine what items might need more clarification in terms of wording and scope on the M-RICR, and gave me a better understanding of what I would look for in the main study. We engaged in this process by discussing all disagreements in each of the 10 lesson plans. In discussing disagreements, the other researcher and myself provided reasoning for the selection. If one of us was convinced of the logic and interpretation, then the assigned score was adjusted. This provided much clarification because of the diversity of the lesson plans and the uniqueness of the way pre-service teachers conveyed the elements of culturally relevant pedagogy.

Results of the Pilot

Table 2 captures a summary of the agreement on each of the indicators. Before consensus, there was a total percent agreement of 76.4%. This was calculated as the total agreed responses from the other rater and myself (84) divided by the overall total of scores (110). Though scores could take on a value of 1, 2, or 3, responses were coded as dichotomous and marked as either agreed or disagreed based on whether or not the scores matched. For example, if one rater marked a pre-service teacher as having a 1 on an indicator and the other marked that same pre-service teacher as a 2, this was recorded as disagreement. Similarly, if we both scored the pre-service teacher as having a 2 on an indicator, this was noted as agreement.

Table 2 *Pilot Study Sample Agreement Results*

M-RICR Indicators	Total # of Agree (BEFORE Consensus)	Total # of Agree (AFTER Consensus)
AE1	9	9
AE2	7	10
AE3	8	9
AE4	7	10
CC1	8	10
CC2	9	10
CC4	7	8
SC1	7	9
SC2	6	9
SC3	7	9
SC4	10	10
Total % Agreement	0.763636364	0.936363636

After the debriefing session, the inter-rater reliability increased to 93.64%, as can be seen in Table 2. Discrepancies between the second rater and I were noted on indicators AE4 and SC2; these were the two indicators that had the greatest amount of disagreement (i.e., 4 total). AE4 established that the pre-service teachers used appropriate mathematical discourse. My scoring was more stringent in this category because one small mistake in language or description was enough to move the pre-service teachers from a score of 3 to a score of 2. I explained that this was important to me because it could lead to misconceptions that students take into future courses, so the decision was made to score this indicator with less flexibility. SC2 established that the pre-service teachers used multiple mathematics perspectives or approaches. I tended to score a bit more leniently in this indicator and allowed for these perspectives to be situated specifically in mathematics, whereas the other rater applied it to more of a worldly view. This was a perception that we were able to address, and agreed that there was room for multiple perspectives in either or both contexts, mathematics or the world.

Overall, this pilot did not suggest any major modifications to the rubric. One interesting finding was that we achieved perfect agreement on SC4. This is the indicator that says *Teacher engages students in mathematics problem-solving, where they identify and investigate social problems, and plausible solutions.* In addition to achieving perfect agreement, it is noteworthy that no pre-service teachers received a score of 3 in this indicator. Though SC4 was not unique in this regard (CC2 and CC4 likewise had no pre-service teachers who achieved a 3), it was notable because the other rater and I needed no additional time to achieve consensus. The paucity of social problems matched my assumptions, and these depictions are expected to be more salient in the sample that will be used in the main study because some of these lessons devoted specific attention to the critical consciousness tenet of this pedagogy. On another note, many of the indicators possessed specific details that helped us to determine the difference between a score of 2 or 3. For example, on SC2, *Teacher encourages critical reflection and inquisitive or open-ended thinking,* we determined that even if there was a critical reflection component to the pre-service teachers' questions, the overabundance of questions that warranted a "yes" or "no" response with no explanation was scored as a 2. Lastly, there is a reality that culture is constructed very differently for these pre-service teachers from what the second rater and I have come to understand. I expect to expand upon this idea in further detail in the main study, but it is noteworthy here in regard to how CC4, *Teacher integrates or allows recognition of students' culture and embraces it,* will be scored in the full study sample.

This pilot study was useful in helping to achieve the two purposes described earlier in this section. We were able to find evidence of each of these indicators within the lessons plans. This claim is supported because no indicators were scored completely with a score of 1. Further, it helped to build my awareness and clarity of the indicators and to determine the magnitude of

the evidence within the lesson (e.g., delineating between a score of 2 or 3). Going forward, this will help in my review of the 29 lesson plans utilized in the full study. The scores we have are reliable according to IRR and thus the instrument is one that can be trusted with reasonable accuracy.

CHAPTER IV

FINDINGS

Chapter 4 presents the findings for the current study that indicated how the PSTs were successful in implementing culturally relevant pedagogy into their lesson plans, as well as describe their awareness and beliefs about teaching for equity. This study utilized both qualitative and quantitative methods to arrive at the following findings and is presented in three sections. Section one and two are dedicated to answering research question one. Section one reports on the distribution of the CR scores and identifies the number of lesson plans that belong to each of the CR categories as described in the methodology. The second section highlights trends in how PSTs fully implemented each indicator and/or how they addressed these indicators if they were not fully implemented. Section three, although similar to section two, discusses in depth how PSTs articulated their understanding of why their lessons were culturally relevant. Research question two is divided into two sections. The first of these sections highlights the activities that were specified by the PSTs who scored higher on the M-RICR as having changed their awareness of diversity issues and knowledge about teaching for diversity *a lot*. The final section uses descriptive statistics to report the full range of responses from all PSTs on selected key course activities, and these activities were selected because of their relevance to the process of lesson planning. More broadly, this chapter presents the findings from the data analysis as they relate to the following research questions:

1. How successful were PSTs in implementing culturally relevant tenets into mathematics lesson plans designed for a virtual classroom environment?
2. How did PSTs' diversity awareness and beliefs toward teaching for equity change?

Research Question One

Section 1

In this section, the results from the M-RICR are stated. Also included here is a quantification of the number of lesson plans within each of the CR categories and the frequencies corresponding to how each indicator was addressed (e.g., partially or fully).

As described in Chapter 3, each lesson plan was unitized and analyzed for evidence of the M-RICR indicators. The sum score across all indicators for a lesson plan constituted the final CR score, and this CR score was used to designate the CR category to which each lesson plan was placed. As demonstrated in Figure 8, most of the PSTs' lesson plans were designated to the superficial category. This finding is consistent with what was found in the pilot study across all categories. Namely, the two end categories, the absent level of cultural relevance and substantive level of cultural relevance, were found to have the fewest number of lesson plans, each having only 1 lesson plan. There were 18 and 9 lesson plans that were identified as superficial and moderate respectively. Figure 8 depicts a graphical representation that shows most of the lesson plans had scores that gravitated towards the center of the spread.

Table 3 shows each of the CR scores that the PSTs received on their lesson plans, the CR category that was associated with that score, and the scheme upon which the lesson plan was based. The table lists the PSTs according to their CR score. The range for the CR scores was 16 points with the lowest CR score being a 15 and the highest being a 29. There were 29 total lesson plans analyzed in this study, the average CR score was a 20.4, a score that is consistent with the superficial category. CR scores for the current sample had a standard deviation of 3.27.

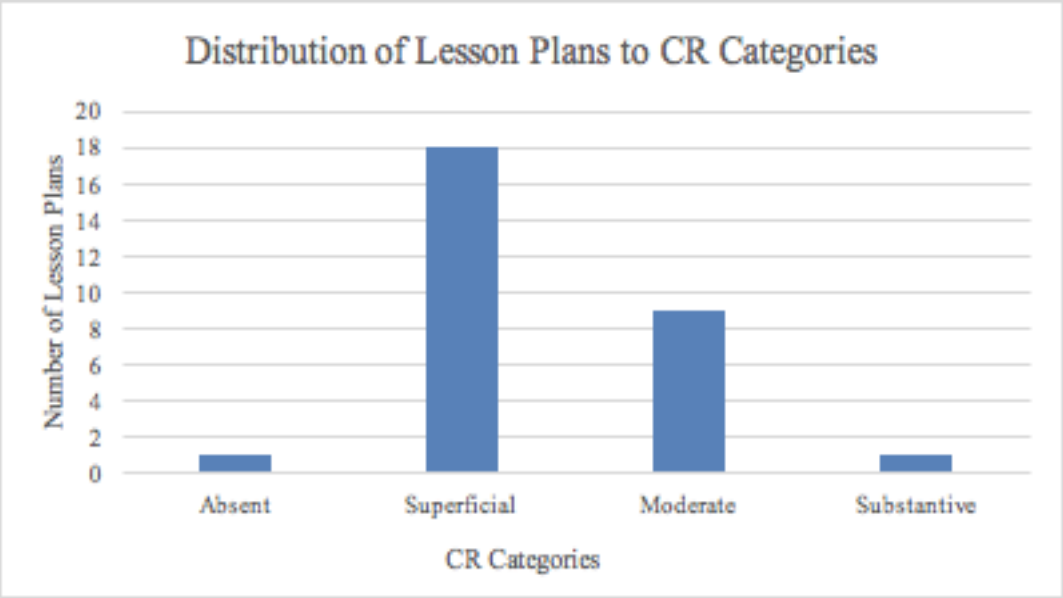


Figure 8. Distribution of lesson plans to the CR categories (n=29)

Of the three lesson plans that were developed with the situated learning scheme as the dominant scheme for the lesson plan, two were rated in the superficial category and one was rated in the moderate category. Of the eight lesson plans that followed the critical pedagogy scheme, the lessons were split in half, with four lesson plans being identified as superficial and four of them being identified as moderate. Lastly, the only lesson plan that ended up in the absent level of cultural relevance was from the culturally relevant scheme, and similarly the only lesson plan to be identified as a substantive level of cultural relevance was from this scheme as well. Twelve of the problem-solving lessons following the culturally relevant scheme were identified as superficial and the remaining four were identified as moderate. Another way to interpret these results is that there was a culturally relevant lesson in each of the CR categories, yet the situated learning and critical pedagogy schemes were all contained within the superficial and moderate categories.

There were also interesting trends that occurred within and among the tenets. Table 4 shows the percentage of implementation for each of the 11 indicators across all of the PSTs. The percentages of full implementation were noteworthy for many of the indicators within the academic excellence and sociopolitical consciousness tenets, as can be gleaned from the indicators with full implementation at or above 20% on five of the indicators.

Contrastingly, cultural competence possessed the smallest percentages overall for full implementation, the highest rating that an indicator could receive on the M-RICR. None of these indicators (i.e., CC1, CC2, or CC3) had full implementation over 10% within the PSTs' lesson plans, and none of the indicators within this tenet, unlike the other two, had relatively small percentages of *no attempt to implement indicator,* (i.e., the percentages of *no attempt to implement the indicator* were greater than or equal to 28% for CC). The frequency for *no attempt to implement the indicator* for CC1, CC2, and CC3 were 41%, 76%, and 28% respectively. However, the other two tenets, academic excellence and sociopolitical consciousness, had at least one indicator where the frequency for *no attempt to implement the indicator* was relatively small (i.e., less than 10%), suggesting that most of the PSTs were at least attempting to implement the indicators within the AE and SC tenets. Figure 9 summarizes frequency data for each of the cultural competence indicators, and the smallest portion of the pie in each diagram represents full implementation. Thus, findings suggest that cultural competence was the tenet that was not as easily represented within these PSTs' mathematics lesson plans.

Table 3 *PST Final CR Scores and Categories*

PST (Pseudonym)	CR Score	CR category	Lesson Plan Scheme
Diana	15	Absent	CR
Kim	16	Superficial	CR
Jazmine	16	Superficial	Critical Pedagogy
Donny	17	Superficial	CR
Beyonce	17	Superficial	CR
Aretha	17	Superficial	CR
Dionne	18	Superficial	CR
Tiny	18	Superficial	Situated Learning
Coko	19	Superficial	CR
Rihanna	19	Superficial	CR
Deborah	19	Superficial	CR
Lauryn	19	Superficial	Critical Pedagogy
Mavis	20	Superficial	CR
Keyshia	20	Superficial	Critical Pedagogy
Tasha	20	Superficial	Situated Learning
Stephanie	21	Superficial	CR
Brandy	21	Superficial	CR
Kelly	21	Superficial	CR
Mariah	21	Superficial	Critical Pedagogy
Monica	22	Moderate	CR
Tamia	22	Moderate	CR
Lisa	22	Moderate	Critical Pedagogy
Candi	22	Moderate	Situated Learning
Aaliyah	23	Moderate	CR
Faith	23	Moderate	Critical Pedagogy
Patti	24	Moderate	Critical Pedagogy
Whitney	25	Moderate	CR
Phyllis	27	Moderate	Critical Pedagogy
Gladys	29	Substantive	CR
Average	*20.44827586*		
SD	*3.268750383*		

Note: CR is an abbreviation for the culturally relevant teaching scheme

Table 4 *Percentages of Implementation for Each of the M-RICR Indicators*

Indicators	Percentage of PSTs with No Attempt to Implement Indicator	Percentage of PSTs who Partially Attempt to Implement Indicator	Percentage of PSTs who Fully Implemented Indicator
AE1	21%	59%	21%
AE2	72%	21%	7%
AE3	7%	59%	34%
AE4	14%	59%	28%
CC1	41%	48%	10%
CC2	76%	17%	7%
CC3	28%	66%	7%
SC1	28%	62%	10%
SC2	10%	48%	41%
SC3	3%	45%	52%
SC4	76%	21%	3%

Similarly, frequencies within the tenets showed that each tenet had an indicator that was represented most consistently and effectively within the PSTs' lesson plans. Representation was interpreted by identifying which indicators had the highest rate of full implementation based on a positive skew of the scores (i.e., most PSTs either fully implemented or partially implemented the indicator), and thus suggested that most PSTs were actively implementing the indicator, at

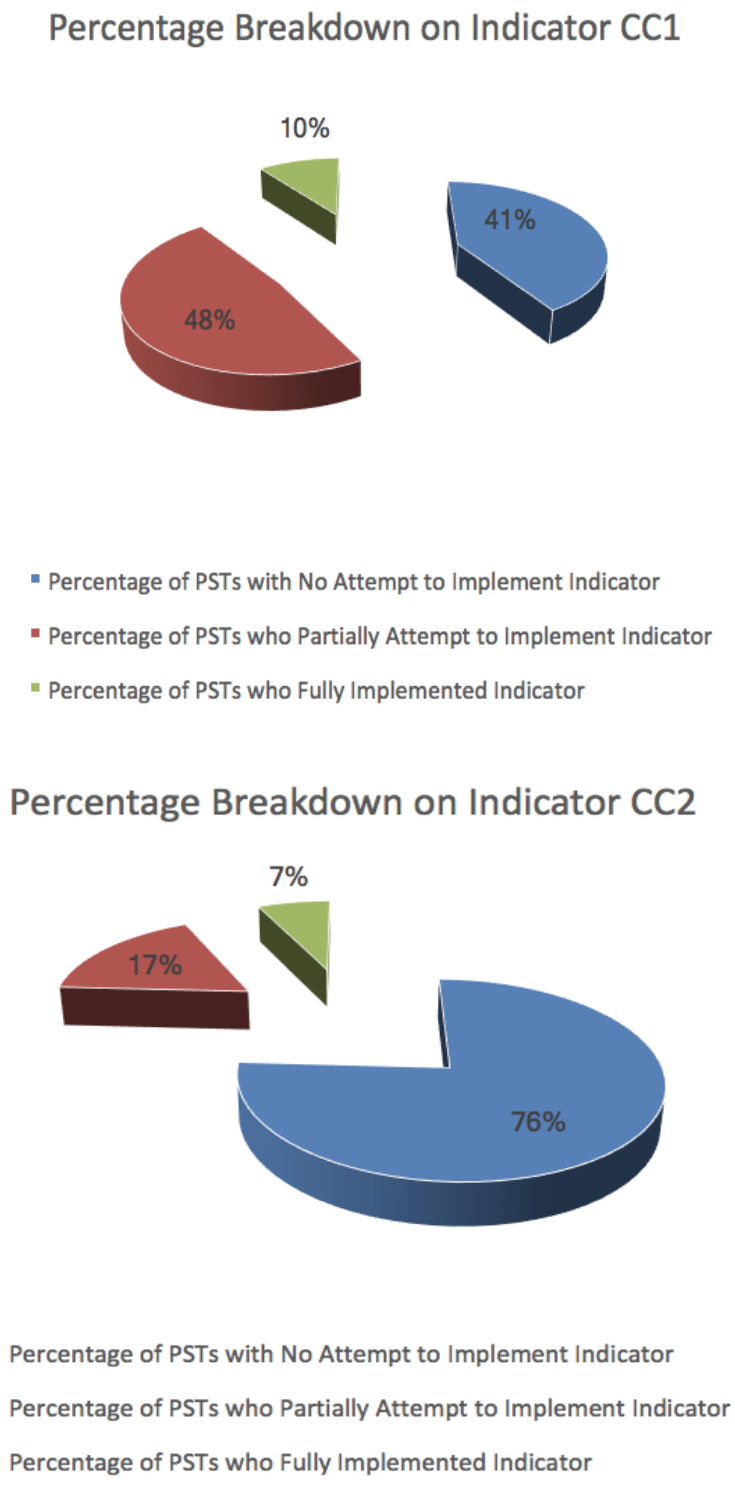


Figure 9. Percentage breakdown on three indicators of cultural competence

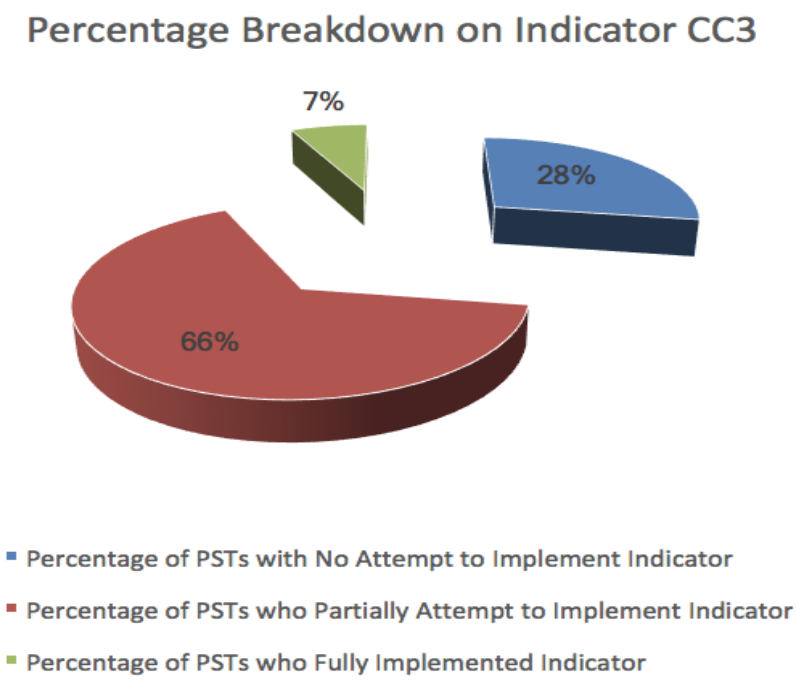


Figure 9. Continued

least partially, into their lesson plans. For academic excellence, AE3 was most implemented. This was the indicator that stated the PSTs utilize and acknowledge the prior knowledge that students bring into the classroom. For cultural competence, the PSTs fully implemented CC1 the most. Though only 10% of the lesson plans demonstrated this, CC1 indicated that the PSTs were using cultural artifacts as learning tools. Lastly, for the sociopolitical consciousness tenet, the indicator that was fully implemented the most was SC3. This indicator stated that the PST encouraged critical and open-ended thinking.

Regarding indicator SC3, it was not only the indicator that was ***fully implemented*** the most within the sociopolitical consciousness tenet, it was the one that was fully implemented the most among all the tenets. This was evident because 52% of the PSTs fully implemented this tenet into their lessons plans. The top three most implemented indicators were composed of SC3, SC2, and AE3. SC2 indicated that the PST highlighted multiple mathematics perspectives or

approaches to solving the problem, and 41% of the PSTs were noted as having fully implemented this indicator. The AE3 indicator stated that the PSTs built on the students' prior knowledge. The percentage of the PSTs who fully implemented this indicator was 34%. The information presented here is summarized in Table 5.

Table 5 *Highest Ranking Indicators*

Top 3 Most and Least Implemented Indicators Within the Lesson Plans		
	Indicator	*% of PSTs Who Fully Implemented Indicator*
Top 3 Most Implemented	SC3: Teacher encourages critical reflection and inquisitive or open-ended thinking.	52%
	SC2: Teacher highlights multiple mathematics perspectives or approaches.	41%
	AE3: Teacher utilizes students' skills and/or acknowledges and builds on their initial knowledge.	34%
	Indicator	*% of PSTs With No Attempt to Implement Indicator*
Top 3 Least Implemented	SC4: Teacher engages students in mathematics problem solving, where they identify and investigate social problems, and plausible solutions.	76%
	CC2: Teacher includes the role of family as a knowledgeable and capable source for support and learning.	76%
	AE2: Teacher indicates the purpose for students learning present content.	72%

Similarly, the three indicators that seemed to be least represented in the PSTs' lesson plans were identified by analyzing those indicators with the highest rates of *no attempt to implement the indicator.* These indicators each came from a different tenet, and two of them, SC4 and CC2, tied as the highest at 76%. This means that more than three quarters of the PSTs' lesson plans showed no signs of attempt to implement both indicators, and have thus been identified as those indicators which were least represented across the lesson plans in this study. The first of these indicators, SC4, suggested that the PSTs engaged the students in identifying and investigating social problems. CC2 was focused on whether the PSTs included the role of family as a knowledge source of learning. Though very close to the rate of no implementation among SC4 and CC2, AE2, the indicator that suggested the PSTs indicated the purpose of the content, was identified to be 72%.

Themes in Cultural Relevance

One section in the PSTs' lesson plans referenced the rationale for the context that they selected. In this section, PSTs were able to justify why they felt their lesson plans represented one of the conceptual schemes targeted by the KATE Project's hypothetical learning trajectories. Here, themes that developed across the lesson plans are provided, the majority of which followed the culturally relevant scheme. Though the culturally relevant schemes were greater equipped to address why the lesson was culturally relevant, what was clear in all of the lessons was a pervasive idea that even critical pedagogy lessons and situated learning lessons had the potential to be culturally relevant. The PSTs were reflective about why their lessons, including those following the different schemes, were culturally relevant and thus are included here in the reporting of the themes. What also became very apparent was that the rationale that PSTs provided for why their lessons were culturally relevant set a precedent for how I would look for

evidence of the indicators, particularly those addressing cultural competence. To be clear, this rationale played a major role in helping to score the indicators within this tenet.

Explanations provided by the PSTs helped me understand exactly how they would address the nuanced forms of cultural competence and indicated places that I should look within the mathematics problem, specifically, and throughout the lesson more generally, for why and how culture and/or cultural competence might be implemented. For example, based on the rationale for context, I could determine if there was some cultural artifact that was mentioned in the problem that culturally, students would appreciate. The themes presented in this section helped to address the first research question because they provided a collective understanding of exactly how the PSTs understood cultural relevance and how it was addressed in their lesson plans from their own perspectives. Additionally, these themes provided some insight for what to look for when providing scores on the M-RICR.

Theme 1: Familiarity

Perhaps the most prevalent theme (occurring in 23 of the PSTs' lesson plans) that developed in the rationale for why the PSTs felt that their lessons were culturally relevant was based on a theme identified as familiarity. It was common for the PSTs to suggest that their students would be familiar with the context or the items that were referenced in the problem, and thus they would have no problem being able to learn the associated mathematics. Familiarity could be among school activities, sports, national issues, nature, or even resources and activities within school. For the PSTs, it was enough that students had at some point in their lives, heard of the tools, resources, or items that were used in the problem, or had at one point or another been in the exact same situation as the individual upon whom the problem is based. Familiarity was chosen as the theme because this had a connotation that even if the students were not that

interested or astute in their knowledge about this event or context, they would not be limited because of some lack of knowledge of the scenario.

Diana demonstrated this idea of familiarity, though somewhat vaguely, when she provided her rationale for her lesson plan. In it, she implied that a problem that dealt with pizza and a contest demonstrated elements of the problem that should be culturally relevant for her students. However, what was unique about Diana's rationale is that it was not much of a rationale at all. She simply stated that pizza and a contest were used in this problem. As shown earlier in Table 3, Diana was the only PST to be placed in the absent level of cultural relevance, and this is part of the reason why. This background information is relevant here because the anecdote provided by Diana was interpreted as a summary rather than a rationale, and thus it is somewhat of a conjecture on my behalf to propose that she believed her students would be familiar with the idea of pizza and contests. Familiarity with other food items was also common in other lesson plans as a way to make them culturally relevant, and this is seen in the lesson plans developed by Monica and Stephanie. These two PSTs suggested that including cake and pizza into their lessons would be relevant because students were familiar with these treats.

Kim, one of the PSTs whose lesson plan was identified as superficial, provided a more explicit rationale that was common among the PSTs. Kim wrote:

> The context deals with fruit, which is something everybody has seen, eaten, and heard about. Even if the students do not like that particular fruit, they still know what an apple and orange look like so they are able to visualize it. By using an example of fruit, the problem will be relatable to all students, no matter how diverse.

This statement still embodies the idea that the lesson plan was culturally relevant because the students would be familiar with food items, and in particular, one that was known as fruit. Fruit was something that Kim felt that all her students would be able to relate to and visualize, and something that would not hinder their comprehension towards the mathematical concepts.

Brandy and Beyonce echoed a similar sentiment in both of their respective lesson plans because they felt that no student would be hindered from the mathematics concepts being taught simply as a result of the context in which the problem was set. Further, Kim believed that fruit is something that students from any culture would be familiar with, though there may be some differences in which ones they liked, she was attempting to pick a fruit that was common enough to most students in the United States and around the world. Analogously, Brandy said that all students have experienced the fall season and Beyonce wrote that most students have used crayons to work on some project in school. The theme of familiarity is important here because it was one that they felt every student has encountered and equally important, would not serve as an obstacle to what many felt was the primary focus, the mathematics.

Another typical quote that was associated with this theme of familiarity was demonstrated by Faith, one of the PSTs whose lesson plan was identified in the moderate category. Though she followed the critical pedagogy scheme for her lesson plan, she commented that the problem she used was "reasonable and relevant to middle grade students because as students in a public school they are bound to encounter a Food-Drive Project". In this way, Faith posited that her students would be familiar with a Food-Drive Project because they were common enough in a public school, and that poverty was a national issue that most of the country was grappling with. This school activity, much like a contest or fruit, was something that the PSTs felt the students would have encountered at some point throughout their lives and thus be able to approach with experience.

Familiarity with national issues was also evident in Lauryn's lesson where she identified increasing gas prices as a national issue. Gladys, the only PST with a lesson plan to be in the substantive category, stated that her lesson was culturally relevant because background research

she conducted to determine both the access and experience that students had with technology devices such as iPhones. What was unique about the rationale here was that even though it was related to how familiar her students would be with operating and using the apps on an iPhone, it was not based on mere assumptions. She planned this instruction with references to specific and credible resources, and justified why she expected her students to be familiar with the context of the mathematics problem, and included it in her lesson plan.

Theme 2: Age Group

The second, extremely common theme that arose in this study was one that I identified as age group. Many of the PSTs said that their lessons were culturally relevant for a group of middle school students, and that what inundated these students' experiences at this age were: a) activities such as football games and food drives; b) places, such as the lunch room or the gym; c) food items, such as cake, pizza or fruit; and d) contexts, such as having to do chores. Clearly, the age and maturity of the students were foundations for designing the corresponding mathematics instruction. Tiny provided a depiction of why her lesson was relevant for middle grade students:

> This problem is culturally relevant because most middle school students either still have recess or just recently stopped having recess during school. Most students were required to do specific exercises during recess or gym class. This should make the problem culturally relevant to most, if not all, of the students.

For Tiny, recess and/or gym was something that all middle school students had encountered and only as of recently may no longer experience. Mavis provided a rationale that was similar along this mode of thinking:

> The context is about a carnival, which is something middle grade students like to participate in. It also has to do with students taking a break from school and getting to play, which will relate to middle grade students. The problem is also about friendly competition and winning a prize.

The PSTs in this study contended that by targeting issues or contexts that may occur within and among middle school students, they were developing lessons that were culturally relevant for this group. Some of the other PSTs in this sample made other claims of middle grade students' experience with superhero movies, eating in the cafeteria, and conducting chores and participating in sports or academic contests. This theme is somewhat connected to that of familiarity because the PSTs communicated that most, if not all, of middle school students should be familiar with the ideas presented here. In other words, middle grades students should be familiar with the ideas presented here. In other words, middle grades students should be familiar with recess, as Tiny articulated, or with the carnival, as Mavis suggested.

Theme 3: For All

Another theme that echoed in many of the lesson plans submitted by these PSTs was that their lessons would be applicable to most, if not all, of their students. It was common for the PSTs to state that everyone in their class would have some knowledge or familiarity with the context that was used in the problem, and thus the lessons they created were culturally relevant for ALL of their students. This theme is one in which the PSTs felt that any student that was to be taught while using their lesson would be able to connect with the context. The goal, it seemed, was for the PSTs to make sure everyone in the class could participate in the learning and to design a lesson that most or all of the students would be able to relate. A typical statement is one that comes directly from Deborah who stated "superhero movies are very popular in middle schools. The problem will be relatable to a multitude of students, because they have all heard of the superheroes by watching the movies or seeing the commercials". Similarly, Aretha noted that

> The context is about middle school students and is definitely one to be used in a real-life situation. Many people can connect to this example because after checking the student profiles, all of the students have a mother, and while some don't make as much as the other families, they can save up money for an inexpensive bike, making this problem relatable to many students.

Aretha implied that she would expect for all of her students to have mothers, and also stated that all of her students (or perhaps many) had the means to save money in order to purchase a cheap bike.

There are traces of this this theme of *all* students as it is presented in the examples above. Tiny, for example, wrote that recess and gym class were some activities that all students had experienced and participate in often, and Beyonce echoed this implication when she said that they should be familiar with crayons and school projects. Another PST, Brandy, posited that

> The context of this problem relates to seasons that we have all experienced. During fall, we all recognize the changing color of the leave. This is relevant to all students because they have all been able to see this change and look and find the different color leaves before.

For Brandy, the seasons, and in particular fall, were relevant and familiar to all students and thus could be viewed as the specific component that made the lesson plan culturally relevant. Similar notions of relevance for *all* or most students were palpable in lessons such as Mariah who stated that since most students love animals, they would be particularly engaged in the lesson that she had designed. This seemed to be the same idea that Tamia provided in her rationale because she justified the cultural relevance of her lesson plan by saying that most students were either involved with or watched sports, and thus would know what sports equipment may be used in different activities. Likewise, Keyshia suggested that her lesson was culturally relevant and relatable by a multitude of students because many students have done chores and gone to the movies.

Theme 4: Real-life

Lastly, one of the recurring statements provided in these rationales is that the problem or context was something that could happen in real-life. It was very common, within about ten of the lesson plans, for the PSTs to say that the lesson was culturally relevant because it was a problem that was related to a real-life scenario, one that could actually or has occurred in

students' lives. To see this, one can revisit the rationale provided by Aretha who suggested that students living with their mothers and saving up for something like a bike was a real-life scenario. Connection to a real-life scenario is also salient in Stephanie's lesson plan when she stated that middle school students could go to a restaurant and split a pizza. Dionne asserted this connection to real-life by saying that students enter the school lunchroom daily in real-life, and Patti's lesson mirrored this theme when she stated that there are students who actually have free and reduced lunch. Patti's was an example that started to articulate the more nuanced ways that contexts connect to real-life, alluding to the realities that students face as it pertains to finance and class. Whitney provided an example of how she saw her lesson relate to real-life scenarios that dealt with weather and vacation:

> The context is about a 6th grade boy whose mom is taking him and two of his friends to Colorado over the winter break. Although not all kids have been in snow, they still know what snow is. This is a possible real-life situation within any age group that many students can relate to. By using an example during the holiday season and including snowballs which most kids will find intriguing, the problem will be appropriate to a plethora of students.

Phyllis provided another example which highlighted the way her lesson could connect to real-life examples, though hers did not necessarily use the term real-life.

> This problem fits the critical pedagogy scheme because it informs students of the homeless problem that is infesting the United States as well brings it to a local scale in the Brazos County. Students are not only learning social problems at the national level, but they are also using proportions and percentages to apply it to their own local environment. Problems such as these help make students aware of the social injustices that are nationwide in addition to realizing that the same circumstances exist within their own backyard, per say. In this problem students are learning how to solve for variables in a proportion and utilize percentages in order to derive the amount of people within a population that fit a certain category.

She goes on to say that poverty and homelessness are conditions that can and do affect students, even if they do not notice its presence in their own backyards. This connects to their real lives because it is something that can and does happen to those in communities around them. For these

PSTs, real-life connections were ones that could be within the school, within families, or even within the country.

The themes presented within this section were at times directly related to the wording of the mathematics problem within the PSTs' lesson plans. However, the context for the mathematics problems were developed with much more detail in lesson plans of the PSTs who were using a critical pedagogy as the guiding scheme. This was evident even in the wording of the problem because the critical pedagogy lessons were consistent in presenting localized knowledge about statistics or contemporary issues within and around the local school districts. Whereas the critical pedagogy lessons gave some background and connection to real data or scenarios, the culturally relevant lessons possessed multiple lessons that referenced "culture" in ways that are commonly seen in standard mathematics problems.

In other words, there was no stark difference between what was presented in many of these culturally relevant rationales than what one would expect to see in a traditional mathematics problem, even if the teacher had no intentions of making the lesson culturally relevant. I also mentioned in the analysis that the appeals to culture were many times circumstantial. By this I mean that they were connections that appeared in the problem but were not explicit in tying in conceptions of culture. Whitney's lesson plan helps to illustrate this point. Her rationale for this problem being culturally relevant was that students know what snow looks like. No specific or significant ties to the idea of snow are developed for the students in this problem, it just happens to appear in the problem. In other words, it was not explored as a cultural connection, merely referenced incidentally in the problem. What was typical was that the connections to culture seemed to be afterthoughts or convenient connections to what the student might be familiar with. The biggest takeaway from looking at the problems is that the rationale

Table 6 *Analysis of the PSTs Word Problems as Compared to Their Rationale*

PST	CR category	Scheme	Problem	Analysis
Kim	Superficial	Culturally Relevant	You have a huge craving for some fruit salad but you are out of some of your favorite fruits at home, so you take a trip to the grocery store. You see that there is a deal on your favorite fruits! With the sale, you see that 5 apples and 3 oranges cost $23 and that 5 apples and 1 orange cost $20. You are curious as to how much does 1 apple cost. How do you solve the problem?	Connections to culture are brief and circumstantial, not explicit (e.g., familiarity with apples and oranges)
Jazmine	Superficial	Critical Pedagogy	Research shows that 29.7% of the population of the Brazos county is in poverty. To help the county out, students from Texas A&M are hosing [*sic*] a 3 day fundraiser to raise money to buy Christmas presents for the under privileged families living in Brazos county. On the first day, the students collected $2065.60. On the second day, the students collected 20% more than they did on the first day. On the third day, the students collected 7% more than they did on the first day. How much money did the students collect on day 2 and day 3?	Localized knowledge confirmed by statistics is shared; issues that draw on students' understanding of local issues and solutions is referenced
Whitney	Moderate	Culturally Relevant	Mrs. Laney has a son in the 6^{th} grade. She is taking her son, Luke, and 2 of his friends to Colorado over the winter break. The boys can make 15 snowballs each every 10 minutes although the snowball on the top of the stack every 10 minutes is melted by the time they restack the new set of snowballs on top. How long will it take the boys to make 252 snowballs (in minutes)?	Connections to culture are brief and circumstantial, not explicit (e.g., familiarity with winter break and snowballs)

Table 6 *Continued*

PST	CR category	Scheme	Problem	Analysis
Phyllis	Moderate	Critical Pedagogy	Our school will be hosting a canned food drive next week to donate to the Brazos County Food Bank, so let's do a little math to get prepared! Approximately 3,500,000 people in America experience homelessness in a given year; that is around 1% of the total population. According to the 2010 Texas Census, Brazos County has 194,851 total people. If 1% of the total population is homeless, how many homeless individuals would you expect to have in Brazos County? If we donate an initial amount of 5 cans and then 2 cans per homeless person in the Brazos County, how many total cans are we donating? Round each of your numbers up to the nearest whole number; for example, if you solved and got 20.3 homeless people then your final answer would be 21 homeless people.	Localized and national knowledge confirmed by statistics is shared; issues that draw on students' understanding of local issues and solutions is referenced

was supported by the construction of the mathematics problem. In Table 6, I showed that there are themes of familiarity (with fruit and snow) that were present and consistent in many of the culturally relevant problems, and themes of real-life that were addressed in the context of many of the critical pedagogy problems.

Themes and Trends Among the Indicators

After using the M-RICR to analyze the lesson plans, it was clear that most of the indicators had at least one PST who scored a 3 on it, though there were a few instances where this did not occur. What I provide in this section is a deeper look into how PSTs achieved a 3 on (i.e., fully implemented) an indicator, as well as information about the trends that existed among

how the PSTs implemented the indicators, as evidenced from the content analysis. In keeping with the research question, this allowed me to decipher exactly how PSTs were successful in implementing the various indicators into their lesson plans.

Academic Excellence

Evidence for academic excellence was reflected mostly in how the PSTs devised a plan to solve the mathematics problem and in carrying it out. This was the part of the lesson plan where the PSTs explained what the problem was asking and how to go about solving it. The academic excellence was often times reflected in how the PSTs described the mathematics to their potential students and how thoroughly and accurately they conveyed the concepts.

AE1. Teacher draws on issues or contexts that are meaningful to the students.

There was a total of 21% of the PSTs who fully implemented this indicator. To achieve a score of full implementation here, PSTs were typically making plans to involve their students' experiences or desires into the instructional time. This was apparent in how they built questions that connected to the lesson. For example, Mariah's problem dealt with students volunteering at an animal shelter, yet she set aside time in her lesson to ask students where they might like to volunteer in the future. In this way, she was aiming to make the lesson and conversation more reflective of student interests and what counts as meaningful to them. Similarly, Aaliyah had a lesson centered around the amount of text messages that a student might send and inquired about whether this amount reflected how many they sent monthly. Gladys inquired about what kind of apps that the students would purchase if they had the option. The overarching theme among these PSTs was that they were giving room for their students to be able to interact with them in a way that connected to the problem that was discussed. This brought in ideas or contexts that may be

meaningful to them in particularly. This was evident in the apps that they would choose, the shelters where they would volunteer, or the total amount of text messages they sent each month.

Lisa went a bit further to say that students were inspired by writing letters to veterans that were fighting for the freedom of those in America. If students can be inspired by something that is a part of the lesson, then it has potential to be that much more meaningful to them. Patti asserted the importance of her students not feeling alienated by the conditions that they experienced, and thus created her lesson to mirror some components of students' realities within her local community by discussing statistics regarding free or reduced lunch. For Patti, this made the lesson meaningful. Here, and in some of the other lessons, it was clear that the context did not overshadow the mathematics. The PSTs were able to mathematize contexts that would bring meaning to both the mathematics and experiences of their students.

AE2. Teacher indicates the purpose for students learning the present content.

A total of 7% of the PSTs fully implemented this indicator. The main idea in this indicator targeted whether the PSTs addressed why the students would need to learn the *math* concept. Some PSTs were able to group this justification in with why their lesson fit a certain conceptual scheme, but most did not do this quite concretely. Many of the lessons did not address the age-old question proposed by students of all ages asking, "Why are we learning this and when will we ever use it in life?".

Donny, however, did well in conveying the purpose of learning how to take discounts and explore percentages by explaining that discounts and sales happen globally, so students must be able to make these calculations when seeking to make purchases whenever and wherever they travel. Percentages were also the main concept in Phyllis's lesson plan. She stated that this concept was important in finding totals and parts, and situated this discussion within the

percentages of people in the community who were living in poverty. Many of the PSTs, however, did address why or how their lesson was rooted in a real-life scenario, but not necessarily why the particular concepts, such as solving linear equations or finding and calculating central tendency concepts, would be very beneficial to students. Thus, the mathematics concept could still be seen as one that was not very applicable in students' everyday lives.

AE3. Teacher utilizes students' skills and/or acknowledges and builds on their initial knowledge.

AE3 was one of the top 3 most fully implemented indicators with 34% of the PSTs receiving this score. This indicator was focused on whether the PSTs communicated an expectation of prior knowledge and if they connected it to what they wanted their students to learn. Additionally, it was reflected in how PSTs mentioned that they would not have to spend much time on a certain step of the problem or if they developed questions that students might have about certain steps. Those who received a score of three on this indicator often used and justified some mathematics vocabulary that students should be familiar with, and some even used brief reminders to bring this up in discussion. Candi expected that her students would know about foundational concepts in probability and stated that this would not be the first time that they heard about independent events. This was demonstrated also in Monica's lesson where she expected students to be familiar with the term denominator or in Lauryn's lesson where she expected her students to know that average and mean were synonymous terms.

One way that the PSTs accounted for what students already knew was in finding alternative methods. It was common for the PSTs to suggest that one step could be skipped or done as mental math because students would be expected to know how to solve the step in the

process. The guiding questions that were developed in the lesson plan helped to communicate some of the evidence used for this indicator. For example, one of the questions that Faith was prepared to ask her students dealt with them understanding what a variable was and specifically, what it stood for in the current problem. This was seen as tapping into their prior knowledge because the lesson was not devoted to teaching or defining variables for a student, but she used it as a way to interrogate information that they should already know and to build connections that helped them remember some very important terms.

Similarly, Phyllis and Tamia were noted because they expressed certain mathematics procedures or facts that they thought should be points of proficiency for students. Phyllis, for example, discussed percentages but reviewed with her students the role of considering the proportion of 1/100 in calculating percentages, as opposed to telling students to simply move the decimal to the left. This brief review was not the main concept she was teaching, but one that she briefly addressed because students should have already come to an understanding of these conversions. Tamia felt that most of her students would know that 50% was equivalent to ½ and thus used this to advance the lesson. The point here is that many of these decisions to adapt to students' perceived proficiency are intentional, whether the PST decides to skip a step or to remind students of the conceptual nature of the procedure.

AE4. Teacher uses appropriate mathematical discourse.

There were a total of 28% of the PSTs who fully implemented this indicator. The main idea behind this indicator was whether the PSTs were using appropriate language to describe the concept being taught or were using the mathematics vocabulary appropriately. Though there was potential overlap here with the indicator addressing prior knowledge, what made this indicator

unique was that it was analyzing whether some other, more rigorous or accurate language would have best suited the scenario or concept being portrayed in the lesson plan.

Gladys was one of the PSTs who fully implemented this indicator. Her lesson was one that thoroughly addressed the concept that she was trying to teach, and left no gaps in the sequence from question to the solution. One component that was articulated very clearly in her lesson plan was how she explained that the solution they found must be a whole number, because one could not purchase half of an app. She planned to clarify this for her students, and her definition of a whole number and why it was relevant to the current problem was found to be accurate. Similarly, Tiny was effective in highlighting the definition of circumference and comparing it to how we think about perimeter in other objects. What was clear here was that the discourse she provided was not something that was problematic or just a shortcut for helping students to understand this solitary lesson, she provided a connection that was well-planned and consistent with the meaning and reality of why perimeter makes sense in some objects but not in ones that are circular in nature.

The other PSTs in this group were noted because they described the process or steps to the solutions accurately and there were no glaring mistakes in their steps. Mavis highlighted in her lesson the way that students should understand the difference between mean, median, and mode and exactly how these terms were distinct and how to calculate them in datasets. Candi and Stephanie scored high on this indicator by addressing terms such as unknowns, solutions, and equations in their individual lesson plans. Lastly, Whitney correctly made the connection between how snowballs were melting in the problem that she described and how this could be translated to the concept of subtraction and why.

There were many PSTs who scored in the partially implemented category on this indicator, and it simply was because they made some simple mistake in describing a mathematics term or process. In other instances, there was a term that PSTs would describe but would never use the appropriate word to identify the convention or symbol (e.g., describing the bottom of a fraction without saying denominator). This was seen in the use of colloquialisms that were exhibited in the PST's language or some shortcuts that could lead to a misconception for students. For example, this was the case in Diana's lesson where she says that some of the language she used was an attempt to make the lesson easier for the students. She also goes on to describe that she wants her students to predict some part of the problem in finding solutions. She describes a process that is more aligned with estimation and not prediction because she has them base their estimates on some understandings of how the equations work. Though not big mistakes, there was potential for more accurate depictions and language in some of the lessons.

Cultural Competence

As stated, the rationale for context was often a crucial point for addressing cultural competence. This rationale had the potential to address all of the indicators among this tenet, and could be supported within the lesson plan. Cultural competence was operationalized most prominently within this section of the lesson plan, as well as the parts where students were told to check their solutions. Important here was how teachers described culture and if it was pervasive and relevant in the rest of the mathematics instructional lesson.

CC1. Teacher draws on or uses cultural artifacts as learning tools.

10% of the PSTs implemented this indicator fully. This indicator was meant to be a broad conception of tools or artifacts that could be related to and/or introduce culture. Depending on how the PSTs justified cultural relevance in their lesson plans, I looked for ways that the lesson

was supported by these artifacts or how the contexts allowed these items to be mathematized. In other words, I was looking for the PSTs to use some objects that helped to make ties to cultural knowledge and to operate or make calculations based on those objects. In designing the M-RICR, I had a wide range of ideas that could be used as cultural artifacts, yet what I was looking for in particular was for the PSTs to relate their interpretations of culture to something that was used to mathematize the students' world. In analyzing what the PST mentioned about why the lesson was culturally relevant or critical pedagogy, I sought to determine whether there was some tool, artifact, article, or reference that could be used to develop and guide the process of calculation and mathematics inquiry.

Given that there were some very cursory interpretations of culture, the artifacts are debatable. Nevertheless, I think it is important to consider that these items were important in helping articulate the PSTs' understanding of culture, and that the main focus in this indicator was whether some artifact at least existed in the problem. The rationale or transparent tie to culture helped in distinguishing between a full or partial implementation, and these artifacts could be in the form of newspaper articles, cultural tools such as instruments or souvenirs, or items that helped secure ideas of cultural activities such as how a coupon is used at a specific store.

Deborah offered a noteworthy example to address this indicator in her lesson plan. She suggested that her lesson plan was culturally relevant because of middle school students' infatuation with superheroes and more specifically in this problem, Captain America. For Deborah, autographed copies of the picture of Captain America were items that tied to the students' interests and cultures, and that mathematized these conceptions of culture. The picture which served as the artifact is the central focus of the calculations that follow. This artifact

connects both the rationale of culture to some physical or tangible object, and more importantly it serves as a basis for the mathematics that was thoughtful and thoroughly explained. Gladys not only highlighted statistics, but she shared an article that conveyed meaningful statistics regarding the access that students had to technology tools. This artifact was directly related to the culture and reality that the students faced in the classroom and helped to build a rich and meaningful foundation that was genuine for her and her students. It was interpreted as an artifact in this sense because it was something that was pulled into the lesson in addition to just the routine worksheet or lecture notes; it was a tool that help to supplement instruction and did so by addressing the culture and climate in which her students were entrenched. Lastly, Aaliyah provided a similar notion dealing with phones and text messages, a context that has a more convincing connection to how students utilize resources such as text messaging, as opposed to something like snowballs that Whitney mentioned. The difference here is that the connections to culture were more genuine to the targeted student group than something like crayons or snowballs, and thus earned Aaliyah a score of full implementation.

CC2. Teacher includes the role of family as a knowledgeable and capable source for support and learning.

The results from the M-RICR showed that 7% of the PSTs included references to family that were noteworthy to helping build a meaningful and relevant context around the mathematics concept. There were many lessons that included some mention of a family member, but the ones who fully implemented this indicator were those who showed the family members in the problem as those who possessed some insightful message or fluency with and about mathematics.

One example that existed in this sample of lesson plans comes from Monica. What was noteworthy about the problem that she provided is that it was delivered or narrated by the

grandfather. He is positioned as someone with a distinguishable amount of mathematical proficiency, and he challenges the other family members to figure out a riddle. This is drastically different from a lesson plan like Keyshia where the mother is only referenced as the person who says that the child must complete chores before going to the movies, or Rihanna's where she makes no mention of family at all. For Keyshia, the mother was easily a person who could have been overlooked in the problem or treated as extraneous information. This was also consistent in Coko's plan where merely mentioning the parents on a drive to school earned the PST a score of partial implementation on the M-RICR. In Monica's problem, the grandfather was central to the construction of the context and delivery of the mathematics. Similarly, in the lesson plan developed by Gladys, the parents were central figures to the context because they were the ones who provided the resources for the child in the problem to make purchases that she wanted, and they were also connected to some of the questions that Gladys developed in the lesson plan. One of the questions, for example, was based on why some students were offered a weekly allowance from their parents. These were questions that she felt her students would ask during the lesson and ones for which she prepared to have an answer, and they included ideas and thoughts about the parents position even within the context of mathematics.

CC3. Teacher integrates or allows recognition of the students' culture and embraces it.

This indicator was one of in which only 7% of the PSTs implemented it fully into their lesson plans. In designing the M-RICR, I was looking for a way the PSTs would highlight some explicit and definitive connection to culture, one that students would readily identify with and appreciate even without commentary from a teacher. The reality, it seemed, in most of these lesson plans was that the connections to culture were so broad that they did not make much

connection to any specific student groups. The representation was hard to identify as far as whose culture was being affirmed or was being investigated further in regard to mathematics and the relevant concepts.

Even within some of the lesson plans that received a 3 for this indicator, there were examples that attested to the PSTs' developing propensity to involve culture into their lesson plans. This was the case in Whitney's lesson plan. As mentioned earlier, she justified the relevance of her lesson plan based on the idea that her students would all know what snow was and be familiar with it. Though this is a somewhat shallow conception of culture, she was given a 3 here because she explored this idea in more depth when it came to her guiding questions. Whitney included questions that focused on when students had ever experienced snow and the activities that they liked to do in snow. These inquiries helped to make the lesson include more of the students' input and allowed for them to inundate the lesson with realities that they construct in regard to their own familiarity with snow. The biggest point here is that this was the connection that Whitney had for how the lesson could be culturally relevant, specifically in how snow might be in the students' lives, and she created room for further inquiry and discussion that planned for and welcomed additional discourse from the students. Similarly, for Faith, she explained that her lesson was critical and relevant because of students having seen a food drive at some point in their life. She explains that within middle school this is typical, and especially in a community where they have poverty rates such as those presented in the problem. For this reason, her lesson plan was rated a 3 on this indicator.

There was a fine line between those who received a score of 2 and those who received a three on this indicator, and it was very much connected to their rationale. Ideas of culture were moreso explicit and convincing in lesson plans submitted by Whitney and Faith, and less

intentional in lessons such as those by Mavis. Though Mavis felt that her lesson was culturally relevant because she mentioned a carnival, it was not anything that had to be recognized or embraced for the problem to proceed. It was information that could have easily been excluded from the problem without loss of generality to the mathematics or concepts.

Sociopolitical Consciousness

Lastly, sociopolitical consciousness tended to be evident in the looking back, extension, and guiding questions. This section allowed the PSTs a chance to engage in conversation that was not necessarily mathematical in and of itself, but it did allow students some autonomy over the context of the situation. I think what was important in this section was that there were no limits to how one chose to steer the conversation. As overarching themes, critique and reflection found way in some of these mathematics lessons in many unique ways.

SC1.Teacher encourages the students to engage in the real world critically to better understand their social position, as well as others.

This was an indicator which only 10% of the PSTs in the sample fully implemented. Though many of the PSTs were getting the students to think about the world critically, the difference between those who were fully implementing it and those who were partially was that the ones who fully implemented the indicator helped focus the critique of the world on specifically how the students fit into this reality. In other words, the critique had to involve how the students were positioned in this world as well.

Phyllis demonstrates a critical reflection of the world when she developed a question that asked students about whether the homeless rates that are presented in the problem are what they expect. This question leaves a lot of room for there to be discourse about what causes homelessness rates to become amplified and how individuals end up in these unfortunate

predicaments. There is a sense of deconstructing what could be reality for some people that students may have encountered. One of the questions that Gladys provided in her lesson plan also accomplishes a similar goal. Again, her lesson plan is focused on a child who may get to spend their allowance on apps for their phone or wireless enabled device. She stated in her lesson plan that one of the questions she may have to answer in the class is why some students are given allowance and others are not. For Gladys, she saw this as an argument that may arise out of the context she is using and this is a question and conversation that critiques that access and resources that some families may have at their disposal. It presents a noteworthy segue into how one might critique the availability of resources that some students take for granted and those that may be seen as luxuries.

Lastly, though Kelly did not provide much commentary on students' position in the world, she provided many examples of helping students critique the real world in multiple genuine and authentic ways. For example, she considered asking her students why they felt that the diamond shape was the best shape for a kickball field, and how they might go about finding the perimeter if they were limited to such resources as just string. Because of her many examples of critical thinking and the potential that some of these questions had to promote deeper conversations, such as who would be the one to paint the lines on the field and the role that the perimeter and shape had in the purchase of the paint, she was given a three.

SC2.Teacher highlights multiple mathematics perspectives or approaches.

The PSTs who were given a score of three on this indicator, approximately 41% of the sample, were those who not only highlighted an alternative method to solving the problem, they included this other method in the lesson plan. This was a quick explanation that often only hinted at first steps to solving the problem. There were some of the PSTs who merely suggested or

discussed an approach that students could take to solve the problem discussed. Some of the approaches highlighted in the lesson plans, however, were not much different from the original method, having perhaps left out or condensed one step to shorten the amount of work shown. These lessons were given a rating of partially implementing the indicator. On the other hand, there were those who created tables, worked out the various steps, and solved the problem in a way that was necessarily different.

Coko demonstrated an alternative approach by describing how a picture, something she did not use in the original description of the solution, could be used to arrive at the same answer. This was common in many of the PSTs' lesson plans who felt that a visual solution to the problem would aid the students who needed additional ways to conceptualize the mathematics. Tamia did this by creating fractional bars to represent equivalent fractions and Brandy did this by showing how proportions could be equivalent given how we construct quantities within a table and this example is given in Figure 10.

It gives students a better visualization of the information they need in order to solve the problem. So, it could have looked something like this:

Boy	**# of leaves found**	**Percentage of Red leave**	**# of red leaves (% times total # they individually found)**
Matthew	30	70%	21
Mark	44	25%	11
Luke	28	x	14
Total	**102**		**46**

Figure 10. Example of one PST's highlighting another approach to the mathematics problem

For many of the PSTs, the diagrams were a way to summarize the steps and present them more concisely. This was evident in how Donny created a table to formalize the steps to finding percentages or how Deborah was able to add an extension to the problem and the concepts by using a table. One unique approach that Candi provided was showing how students might be able to act out probability solutions. She felt that students would benefit from seeing how probability works, even if it solutions were approximate and not exact. The description of this approach in her lesson plan was noteworthy because it was one that was not utilized in the other lesson plans and it was one that demonstrated the calculations efficiently.

SC3. Teacher encourages critical reflection and inquisitive or open-ended thinking.

The PSTs who scored 3s in this category did so because they prompted students to reflect on a host of ideas, such as why conditions or phenomena were in place. Those successful in this category also planned to encourage their students to engage in conversation that was open-ended and did not have a unique or exact response. The reflection allowed students a much less stringent model in which to approach either the mathematics or their world. One question was used consistently in most of the lesson plans, and evidence is seen in Aretha's where she asked her students to find another way to solve the problem. Though this question was open ended, it did not receive a score of full implementation because there was not much guidance in this prompt. This question alone was not seen to be sufficient to promote and sustain critical thinking because students could, based on this question alone, respond that there is not another approach and proceed to another question. In other words, it offers a good start but it seems incomplete in what the indicator was trying to accomplish.

One of the underlying similarities in how these PSTs approached this was that they were asking students more than just another question. Comparison was an integral part of responding

to these questions, and that allowed PSTs to score a 3 on this tenet. This is seen in Keyshia's lesson plan when she asked her students how the addition of a fourth chore would affect the calculations that they previously obtained. Also, Brandy planned to ask her students about how the results would change had one of the conditions differed, in her problem this was related to how many leaves were counted in one of the percentages. Whereas Brandy could have asked her students a brand new question, and to calculate a new percentage, she asked for how the results would change and this required much more thought than a simple recalculation, thought the mandates the use of critical thinking and reflection on a previous answer. Phyllis demonstrated a similar element in her lesson plan, asking the students how an increase in the overall population of Brazos County would affect the percent of the homeless population.

Other questions simply asked an additional question, but this was not seen to be as effective in engaging students in critical reflection and open-ended thinking, components of the lesson that were salient in lesson plans such as those submitted by Dionne who asked:

> If you increase Brazos County's total population, the amount of homeless people also increase. Would the percentage of homeless people in Brazos County increase, decrease, or remain the same as the original 1% stated in the problem.

These lesson plans evoked a sense of wonder and thought that could come out of an already well-developed mathematics lesson. Additionally, the critical thinking and inquisitiveness prompted by the teachers led to discussions regarding mathematics and finance and what rationale went into these decisions. For example, Dionne asked in her lesson plan, "Would you prefer any other cupcakes besides vanilla and chocolate? If so, what price do you think would be appropriate for it's sizes?". Lastly, Gladys and Monica approached this indicator by helping students with what I see to be metacognition. In here problem, Gladys plans to ask students whether the final numbers and answers that they got make sense for the context that they are using, and to ask how the tax affects the problem. Monica planned to ask students if there were

any parts that confused them specifically. This type of thinking and reflecting is powerful, especially within mathematics.

SC4. Teacher engages students in mathematics problem solving, where they identify and investigate social problems, and plausible solutions.

As one of the least fully implemented indicators, SC4 was recorded as being fully implemented by only one of the PSTs in the sample. Though many of the eight lessons plans following the critical pedagogy scheme discussed a prevalent social issue such as homelessness and poverty, prompting students to begin thinking about a solution was not always emphasized in the lesson plan. Indeed, this was often times the characteristic distinguishing the partial implementation from the fully implemented.

Patti's lesson plan provides a way to at least begin a discussion of what students can do to impact their communities. One of the questions that she charges the students with is to come up with a way to lower the poverty statistics within their community. This question has implications for a future project or research, but most importantly it challenges students to understand their community and their role in inciting change in it. She also suggested that students may question the need for them to learn any of this information if they do not receive free or reduced lunch. Though not necessarily mathematical in and of itself, it provides a segue into deeper conversations about how communities are impacted by economic investments and how a better understanding of their peer group may foster insight into other solutions.

There were other lesson plans submitted by the PSTs which imitated similar potential as the question posed within Patti's lesson plan, but action towards a solution was what set her lesson apart. Phyllis and Lauryn began to discuss ways in which students were presented with different problems within national and local contexts. This indicator could have been addressed

by Lauryn in her discussion of gas prices by discussing alternative modes of transportation, and with Phyllis in ways that may have not only asked what would happen if the total population in the country increased but how current members could help provide resources for those in poverty. Similarly, in the culturally relevant lesson submitted by Beyonce, there was potential for more authentic connections to how to gather resources, such as crayons and other project supplies, for the students. However, in these lessons, the solution was not readily perceivable or identified by the PST.

Research Question Two

The second research question exists to support and validate results from the M-RICR, and to provide connections to course influences experienced by the PSTs as they designed their problem-solving lessons. In this section I focus primarily on how the PSTs with substantive (n=1) or moderate (n=9) lesson plans responded to the impact of some of the key course activities, and then report on how several of the activities which were projected to have some substantial influence on their diversity awareness either met or failed this expectation. The reason for concentrating on the PSTs who ended up in the moderate and substantive categories is because there is evidence that these PSTs acknowledged their change and/or growth and there is evidence of such growth manifesting within their lesson plans. These findings allowed me to make claims about how cultural relevance was manifested in the lesson plans, specifically in how PSTs established the contexts for their lesson and developed extensions or guiding questions. In presenting these findings, I am arguing that the activities that were perceived to have the most impact on PSTs' diversity awareness and/or knowledge about teaching algebra for equity (i.e., awareness and knowledge; these phrases are used here interchangeably) are the ones that have residual effects that are demonstrated within the lesson plans. Though one cannot

explicate the findings to suggest that any specific activity caused the PSTs to design a substantive or moderate lesson plan, these data do suggest a notion that some activities were identified by the PSTs to be more efficient in promoting a change in their awareness and knowledge, and these claims are conspicuous primarily within the M-RICR results. Nevertheless, I do include the trends that occurred among the full set of PSTs in this section as well.

The High Scoring PSTs

As mentioned, the PSTs who designed lesson plans that were identified as substantive and moderate comprise the focus of the first look into the DPRI data. It must be noted that for the DPRI data, only responses from nine of the PSTs were utilized because one PST had not completed the survey. Nevertheless, analysis of DPRI data showed that there were seven items out of the total 28 Likert-scale items on the instrument that two or more of the PSTs found to impact their awareness or knowledge *a lot*, and Table 4 captures, among the PSTs who designed substantive and moderate lesson plans, the number of PSTs who found any particular course activity to change either their awareness or knowledge *a lot*. This was the highest rating that PSTs could record for an activity, as the complete list of options were that the activity a) caused no change, b) helped them to rethink their diversity awareness (or knowledge), c) improved their awareness (or knowledge) somewhat, or d) improved their diversity awareness (or knowledge) a lot.

As evident in Table 7, PSTs in these two CR categories indicated that the most impactful activity throughout the course was the presentation from Kathryn McKenzie, with seven of the PSTs noting that this changed their awareness of diversity issues. In it, she focused on establishing both equity consciousness and high-quality teaching skills with the PSTs. For at least two of the PSTs, planning a lesson that was based off one of the course's equity challenges,

a problem known as the Soda Problem, was able to change their awareness about diversity *a lot*, though it did not seem to have the same impact on their knowledge about teaching algebra for diversity. Equity challenges were described in the course as central activities that included problem solving, student thinking, planning for teaching, and student questions. It is also worth noting that no more than one of the PSTs who scored in the moderate or substantive groups reported that the reading of Ladson-Billings had any effect on their diversity awareness or knowledge about teaching algebra for equity.

Table 7 *Frequencies of Responses Indicating a lot of Change*

DPRI Item	Frequency of PSTs who Reported "a lot"	PST Name
Changed your awareness about diversity issues: Guest Speaker- Dr. Chance Lewis	2	Lisa, Monica
Changed your awareness about diversity issues: Soda Problem- Planning a lesson	2	Lisa, Phyllis
Changed your awareness about diversity issues: Analysis of Language Moves from your tutoring	2	Phyllis, Patti
Changed your awareness about diversity issues: Guest Speaker- Dr. Kathryn McKenzie	7	Aaliyah, Patti, Monica, Lisa, Tamia, Phyllis, Candi
Changed your knowledge about teaching algebra diversity: Guest Speaker- Dr. Chance Lewis	2	Lisa, Monica
Changed your knowledge about teaching algebra diversity: Analysis of Language Moves from your tutoring	2	Phyllis, Patti
Changed your knowledge about teaching algebra diversity: Guest Speaker: Dr. Kathryn McKenzie	5	Tamia, Aaliyah, Phyllis, Patti, Monica

Table 7 shows a few additional activities which PSTs determined to be helpful in causing a change in their awareness and knowledge. These activities included the lecture from Chance Lewis and the Analysis of Teaching Language Moves. The lecture from Chance Lewis consisted of an introduction to culturally relevant teaching, and the language moves activity was the PSTs' reflection and analysis of their lesson after the presentation and tutoring experiences in Second Life. Nevertheless, each of these activities (exclusive of the Kathryn McKenzie presentation) only had a maximum of two PSTs who agreed that it had a lot of change on their awareness or knowledge. Interestingly, it can also be garnered from these results that Gladys, the PST who had the highest CR score, did not indicate that any of the activities caused a lot of change in her awareness or knowledge about teaching for equity. She is not represented at all within Table 7.

It is also worth noting that there was one of the PSTs, Phyllis, who felt that there were many activities that impacted her diversity awareness *a lot*. With the responses from Phyllis, there were a total of 24 items on the instrument that were seen to impact at least one of the PSTs a lot. Phyllis was an outlier in this data in the sense that many of the items which the PSTs did not indicate as having changed their diversity awareness or knowledge for teaching algebra *a lot* were gauged by her as having accomplished this goal. Without including the results from Phyllis among the high scoring PSTs, there would have only been eight items on the instrument that were seen to impact at least one of the PSTs a lot. These eight items included all seven of the items mentioned in Table 4, and the one additional course activity that had a significant impact on at least one of the PSTs, indicated as such by Candi, was one of the diversity readings from Ladson-Billings or Milner.

In summarizing this portion of the findings, what is captured in Table 7 is all of the items where at least two PSTs said that the activity changed their diversity awareness or knowledge

about teaching algebra for diversity *a lot*. There were no items reported singularly (i.e., by one PST) as having a lot of change on the PSTs' awareness or knowledge, except those that were reported by Phyllis and the one activity as reported by Candi. For this reason, I focus on the activities referenced in Table 7. Nevertheless, the findings here are noteworthy because Phyllis's lesson plan followed the critical pedagogy scheme and was the second highest rated lesson plan according to the M-RICR, and thus her identification of these activities as important to her change is not taken lightly.

Distributions on the Activities

Multiple items on the DPRI were directly connected to how PSTs might lesson plan, and how the corresponding activities might contribute to the PSTs' understanding and implementation of culturally relevant tenets. For these items, I have provided not only the PSTs who rated the item as having changed their diversity awareness or knowledge about teaching algebra for equity *a lot*, but the complete breakdown across all the Likert-scale options for these specific activities (i.e., from *no change* to changed *a lot*).

Table 8 shows the distribution as it occurred on a subset of the key course activities. Seven of the activities were included within this reporting, and all were chosen because of their direct connection to helping construct notions of cultural relevance and/or equity. The first part of the table addressed the change that the PSTs had in their awareness about diversity issues, and provides the percentages of PSTs who selected each Likert-scale option on all indicators. The second part of the table addresses how PSTs' knowledge about teaching algebra for diversity changed. Percentages are used here as well to communicate the PSTs' selections.

Information in Table 8 is significant because it demonstrates the distribution of responses, even within the course activities that were expected to be the most influential in

helping develop awareness and knowledge among the PSTs, and utilizing that knowledge for designing culturally relevant lesson plans. Partly consistent with what was found among the high-achieving PSTs, the presentations from Katherine McKkenzine and Chance Lewis had an enormous impact on all PSTs. However, this data also shows that the presentation of their lesson plans within Second Life were instrumental in helping to cause change in the PSTs' awareness and knowledge. This is evident because out of all the DPRI items, these three activities had at least 50% of the distribution in the *somewhat* or *a lot* response categories.

For example, for the problem-solving lesson presentation in Second Life, 55% of the PSTs responded that it improved their knowledge about teaching algebra diversity *somewhat* and 10% responded that it improved it *a lot*. Collectively, this totaled 66% of the PSTs, and accounts for over half of the sample. Similarly, the presentations from Chance Lewis and Katherine McKenzie were the only other activities to have over half of the sample to respond in the affirmative (i.e., *somewhat* or *a lot* of change).

The diversity readings and equity challenges (i.e., planning the lesson for the Food Drive and Soda problems) did not have over 50% of the sample to respond that these activities improved their diversity awareness or the knowledge about teaching algebra for diversity *somewha*t and/or *a lot*. The mode among the diversity readings activity, both for awareness and knowledge, was "made me rethink my awareness of diversity issues". In other words, this is the option that most of the PSTs selected in regard to this activity and its impact on their awareness and knowledge, with 55.56% and 39% of the PSTs respectively responding in this manner. For the diversity awareness portion of the question, this represents over half of the PSTs saying that reading Ladson-Billings made them rethink their awareness of diversity issues.

Table 8 *DPRI Results from Selected Items*

Selected Items from the DPRI	No	Made Me	Improved it	Improved it
How has each of the following activities CHANGED your AWARENESS about diversity issues?				
Diversity Readings (Ladson-Billings; Milner)	18.52%	55.56%	22.22%	3.70%
Guest Speaker: Dr. Chance Lewis	14.81%	25.93%	37.04%	22.22%
Soda Problem- Responding to student misconceptions	22.22%	40.74%	33.33%	3.70%
Soda Problem- Planning a lesson	25.93%	33.33%	33.33%	7.41%
Guest Speaker: Dr. Kathryn McKenzie	3.70%	7.41%	33.33%	55.56%
Food Drive Problem- Responding to student	22.22%	44.44%	29.63%	3.70%
Food Drive Problem- Planning a lesson	25.93%	40.74%	29.63%	3.70%
Problem Solving Lesson Presentation in Second Life	17%	21%	52%	10%
How has each of the following activities CHANGED your KNOWLEDGE ABOUT TEACHING algebra diversity?				
Diversity Readings (Ladson-Billings; Milner)	30%	39%	26%	4%
Guest Speaker: Dr. Chance Lewis	13%	39%	30%	17%
Soda Problem- Responding to student misconceptions	39%	26%	26%	9%
Soda Problem- Planning a lesson	30%	26%	35%	9%
Guest Speaker: Dr. Kathryn McKenzie	4%	13%	39%	43%
Food Drive Problem- Responding to student	30%	35%	26%	9%
Food Drive Problem- Planning a lesson	26%	30%	35%	9%
Problem Solving Lesson Presentation in Second Life	10%	24%	55%	10%

Note: n=27 for the first set of questions and n=23 for the second set of questions

Additionally, it was interesting to see that the mode switched for the Food Drive equity challenge, a task where the PSTs had to plan a lesson. Whereas the mode for how the activity changed the PSTs' awareness about diversity issues was that it helped them *rethink* their awareness, the mode for how it changed the PSTs' knowledge about teaching algebra for diversity was that it improved this knowledge *somewhat*. Typically, the two responses stuck together in that the mode would be the same, but for this activity, it is clear that there was a higher ranking regarding the knowledge. PSTs also had to develop a lesson around the Soda Problem equity challenge. This was the only activity that had a bimodal response, indicating an equal amount of PSTs who felt that this activity made them *rethink* their awareness of diversity issues and those who felt it improved their awareness *somewhat*. When asked about the change on their knowledge for algebra teaching for equity, the largest response group among the PSTs said that the Soda Problem improved this for them *somewhat*.

One of the only activities (the other was the lecture from Chance Lewis) where the mode decreased from awareness to knowledge was for the PSTs' activity in which they had to respond to student misconceptions within Second Life. This was interesting because most of the PSTs said that this activity made them *rethink* their awareness about diversity issues, but that it had *no change* in their knowledge about teaching algebra for diversity. This activity was unique in that it was the only one where there was a decrease in the mode that resulted in a response of a no change.

Lastly, the largest modes in this data set were always in a range of 50-60%, and this occurred among the reading of Ladson-Billings, the lecture from Katherine McKenzie, and the problem-solving lesson presentation in Second Life. What stands out here is that the problem-solving lesson presentation had a mode of 52% in regard to the change in awareness experienced

by the PSTs and a mode of 55% in their knowledge about teaching algebra for diversity. Further, this mode was consistent in that it improved both the PSTs' awareness and knowledge *somewhat*, which suggests that this activity was significant in their journey towards equity. This will be further discussed in the next chapter but it is important here because of its connection to the lesson plan that was analyzed according to the M-RICR.

The findings in Chapter 4 indicated that four themes arose from the content analysis and that the PSTs did particularly well with indicators SC3, SC2, and AE3. Though most of the lesson plans were placed in the superficial category, there were noteworthy trends in how the PSTs implemented individual indicators. Lastly, the DPRI data showed that diversity awareness and knowledge about teaching algebra for diversity were impacted most profoundly by one of the guest presenters (i.e., Kathryn McKenzie) who focused on equitable and excellent teaching, as well as the PSTs' presentation of the problem-solving lessons within Second Life. To continue the efforts of the current study to make meaning from the literature as outlined in Chapter 2 and the findings presented here, the following chapter offers an interpretation and discussion of this scholarship. Implications for PSTs, teacher educators, researchers, and all those involved in education are discussed, along with limitations of the study and overarching conclusions.

CHAPTER V

DISCUSSION/CONCLUSION

This final chapter is organized in three parts that discuss the conclusions, limitations to the study, and implications for future research. Three conclusions were derived from this study and they include: 1) how the PSTs understood and justified their lessons as culturally relevant; 2) the elements of CRP which were most salient in the PSTs' lesson plans; and 3) how the PSTs' diversity awareness changed and how it related to the lesson plans they designed. This study was designed to explore the ways in which PSTs implemented the tenets of culturally relevant pedagogy specifically within their lesson plans. As such, this study reports on findings from the M-RICR as a tool to analyze the implementation of culturally relevant pedagogy into mathematics lesson plans designed by preservice teachers for a virtual classroom. Through analysis of these lesson plans and the DPRI data, themes and trends emerged regarding how PSTs grew in their diversity awareness and knowledge and how they incorporated culturally relevant tenets into their lessons. The review of these lesson plans reveals both successes and challenges related to teacher education, particularly in how PSTs problem-solving lessons reflect this framework, specifically, and the course activities which help to accomplish their culturally relevant prowess. Lastly, this study offers insight for future approaches to helping pre-service teachers realize the complexity of culturally relevant pedagogy. A content analysis and descriptive statistics were used to investigate the following research questions:

1. How successful were PSTs in implementing culturally relevant tenets into mathematics lesson plans designed for a virtual classroom environment?
2. How did PSTs' diversity awareness and beliefs toward teaching for equity change?

Research Question 1

The response to research question 1 involves a discussion of how and to what extent the PSTs addressed the M-RICR indicators and how they understood and justified their lessons as culturally relevant.

Distribution among CR Categories

The distribution of the lesson plans across the CR categories was somewhat consistent with my expectations. What is very heartening about these results is that there is evidence that there are PSTs who are at least working towards making sure they are using lesson plans that are representative of diverse students (a primary goal of culturally relevant pedagogy), and those who are aiming to design equitable learning opportunities for students. The reality is that most of these lesson plans are in a category where there exists some foundation for culturally specific connections, the category which I have described as superficial. For these teachers, they represent a teaching workforce that, through additional training or perhaps a more explicit directive to address each tenet of CRP, will be able to master the implementation within their lesson plans.

The findings presented in this study mirror the finding presented by Lemons-Smith (2013) in that most of the PSTs' lesson plans fell into the mid-range categories. Though the categories created by Lemons-Smith have descriptors by which group membership was determined, and my CR categories are numeric based cut-off scores, there are some overlaps in what we have described as substantive lesson plans. The one lesson plan identified in the current study as substantive was a model lesson plan for addressing cultural relevance. There was attention to each of the tenets and they were demonstrated across multiple indicators. For Lemons-Smith, a substantive lesson plan was one in which PSTs were able to anchor the

mathematics. She operationalized this by saying that the PSTs used a variety of methods, such as using students' backgrounds, their families, communities, and both lived and out-of-school experiences, to draw upon their informal knowledge and to make connections, all for the purpose of helping them to understand the concept being taught. Gladys demonstrated much of this in her lesson plan. The anchor, as described in her rationale, reflected the informal knowledge that students brought into the classroom about how to use the technology she referenced in the problem, as well as the reality that some of them may not be afforded the same access to these items or even the privilege of having allowance. The point here is that the rationale and questions to probe student thinking that Gladys provided in her lesson plan were grounded in much more than engaging interest, a characteristic that Lemons-Smith used to describe the cursory lessons in her study.

It is interesting that one of the articles written by Ladson-Billings describes much of her pedagogy as just good teaching (1995a). What she highlights as a conceptual framework, and more practically as a set of pedagogical strategies, is a collection of teaching practices that should be occurring in the classroom if good teaching is occurring. This is vastly different from what Haberman (1991) described as a pedagogy of poverty, one that is characterized by monotonous forms of lecture, practice, and assessment. From the lesson plans, it appears that the PSTs did particularly well with the M-RICR items that are characteristic of good teaching, or more specifically, good mathematics teaching. This consisted of such tasks as making sure the students were introduced to some *alternate solution in the problem* (SC2) or *activating prior knowledge* (AE3). We see evidence of these innovations specifically in the chart Brandy created in her lesson as a way to show a solution that was more intuitive for visual learners, or in how Faith catered to and built on students' prior knowledge by asking them what a variable was and

what it represented in the current problem. Herein lies an overlap with what is proffered in culturally relevant pedagogy and what entities like NCTM deem as good mathematics teaching, and these were the indicators that separated the PST in the substantive group from those in the moderate and superficial groups. Evidence of this claim can be garnered from the descriptive statistics addressed in the aforementioned tables that show higher frequencies on these particular items than those within the tenet of cultural competence.

However, the indicators that were a bit more nuanced and specific to cultural relevance, for example the connection to cultural competence, were not as consistently represented within the lesson plans. This is the tenet that Ladson-Billings (2006) said was the more difficult one to explain and to help teachers to achieve, and this was consistent with what was found in the results. As Delpit (1995) implied, this is often times a trend of teaching other people's children. The PSTs in this study did particularly well with addressing academic excellence and were fairly consistent in demonstrating sociopolitical consciousness, because the indicators here are addressed in other frameworks outside of cultural relevance. Whereas some of the indicators within the cultural competence tenet would require that one operate out of a sociocultural lens, this lens is not often deemed necessary in other schools of thought that promote efficient mathematics learning. Guttierez (2013) reminds us that the sociopolitical turn in mathematics is relatively recent. Nevertheless, cultural competence, as the data suggested, provided instances where the PSTs did not demonstrate full incorporation of the indicators as readily. I acknowledge that Ladson-Billings (2006) and Enyedy and Mukhopadhyay (2007) stated that teaching and learning cultural competence may be easier said than done, especially considering tensions that may arise in seeking to address cultural competence in meaningful and thoughtful ways.

Despite the paucity of examples of cultural competence within these lesson plans, there was potential to address all the indicators within this tenet. In particular, I would like to address the cultural artifacts. I interpreted this evidence very loosely to allow the PSTs to earn points on this indicator towards their CR score. Before assessing each of the lesson plans, I created a master rubric in which I offered some examples of the evidence that I was looking for. For this indicator, I envisioned seeing cultural artifacts in the sense that PSTs referenced a familiar menu or receipt as a way to begin discussions. These artifacts are cultural in the sense that they are based on and give legitimacy to the mathematics that is embedded in the problem. It would seem that Lemons-Smith (2013) might classify this connection as a cursory one. She elaborated on this category by saying that using or referencing a Chuck E. Cheese in the problem because there is one in the neighborhood is merely helping to engage students. However, I do not believe we disagree here, but I see more potential for there being artifacts that exist within a familiar store or location, one that may be prominent or unique to the student's community, as a way to further contextualize the mathematics that is to be learned. As mentioned, this could be achieved through analyzing the menu, receipt, or commercials of a local Chuck E. Cheese store.

The Schemes and the Participants

The lesson plans that were created to address the culturally relevant or critical pedagogy schemes contained the most evidence for tenets of cultural relevance, as indicated by their over-representation in the substantive and moderate categories, and this was the main idea captured in Table 4 of the previous chapter. This outcome was expected because one of the tenets of cultural relevance is based on building or fostering critical consciousness. Lesson plans developed for cultural relevance versus a critical pedagogy differed most significantly in how they addressed the cultural piece and the social problems (i.e., aspects of cultural competence and sociopolitical

consciousness). The rationale for context in the culturally relevant themed lessons were very intentional about at least trying to include a sense of culture. What was interesting was that though the critical pedagogy lesson plans did not target culture specifically, one might interpret culture to be the whole community. In other words, a culture might be represented by the town or socioeconomic status of the students that they were teaching. However, this culture that the PSTs were emphasizing was not consistently made explicit in the critical pedagogy or situated learning lesson plans.

Conversely, the critical pedagogy plans were very clear about presenting some problem that was seen to be plaguing a community. PSTs were very upfront in regard to identifying this problem and discussing how it might be solved (indicator SC4). They also planned to integrate student opinion concerning whether this problem was something that they were familiar with or had ever thought about solving. We see evidence of this in Patti's lesson plan when she develops questions about the role that they can plan in helping to reduce or eliminate poverty within their communities. This was a piece that often went overlooked in the culturally relevant plans.

The cultural piece was more circumstantial in the lower scoring culturally relevant lessons. By this I mean that in some of these lesson plans, it appeared that culture was the afterthought. This can be seen in Beyonce's lesson where she highlighted the use of crayons. The PST was convinced that referencing crayons would make the lesson more relevant for students. This shallow connection to culture is one that could and seems to have been developed after the PST had developed the mathematics problem, as if the cultural connection was lying dormant and simply needed discovering. I see this connected to the work of Thomas and Williams (2008) in which the teachers they were studying felt that what they were already doing in their lessons were culturally relevant. The underlying premise here is that the teachers were somewhat

convinced that the lesson was culturally relevant. Thus, the apparent afterthought is consistent in that it appears that the PSTs in the current study, and in the case of Thomas and Williams, were trying to force their lessons and/or pedagogy into an already established framework.

I am also very curious about the implications for how the PSTs viewed their students. In terms of culture, it seems that one idea that was consistent, particularly among the critical pedagogy lesson plans, was the idea of class or socioeconomic status. Though the current study does not explore this in further detail, it would be noteworthy to see why this was the prevailing idea for making the lesson relevant and exploring societal problems. I believe other, more celebratory ideas of culture can and do exist, such as those that honor the rich and overwhelming influence of African Americans, People of Color, women, and the LGBT community. I contend, much like Thomas and Williams (2008) and Gutstein (2006), that Black culture alone has roots in politics, education, art, economics, and a plethora of other enterprises, and these all reveal mathematically robust entry into the investigation of social problems. Gutstein and Peterson (2005) offer a wide range of ideas that deal with sociopolitical consciousness involving such topics as Iraq war economics to the usefulness of the Pythagorean Theorem in constructing accessible ramps into buildings. Yet, there was a tendency within these lessons to focus on SES (free lunch and food drives) to connect to students' realities.

Also very interesting to the study is the ethnicity of the PSTs who scored within these categories. Only one of the PSTs who scored in the two highest CR categories (substantive and moderate) was Hispanic; Faith's final CR score was a 23 and thus included in the moderate category. Her lesson plan was one that followed the critical pedagogy scheme. The other three Hispanic PSTs, Diana, Deborah, and Kelly, all selected cultural relevance as their guiding scheme but Diana was the only one of the PSTs in the sample whose lesson plan was identified

as an absent level of cultural relevance. Indeed, the PST to score the lowest on the M-RICR was a Person of Color. Although People of Color, particularly those living in the United States, are typically more aware of their culture (Yosso, 2005), Diana did not seem to incorporate her own into the lesson she designed. Additionally, she represented an outlier in this sense, as she was the only individual to be grouped into this category. Contrastingly, the only PST to have a substantive lesson plan was Gladys, one of the White PSTs. Although one would expect for there to be multiple White teachers in the substantive and moderate group simply based on the fact that the class consisted primarily of White females, I expected a few more of the Hispanic PSTs to be included in these groups as well. This may suggest that one cannot assume Teachers of Color to naturally be culturally relevant pedagogues in their instructional planning.

Themes in Cultural Relevance

The themes presented in the last chapter warrant further discussion. Here, I review each of the themes and interpret them alongside the results from the M-RICR.

Familiarity.

Herein lies the major correlation between Lemons-Smith's (2013) and my own work. As described in the Chapter 4, one of the themes that was overwhelmingly apparent in the lesson plans was that PSTs felt that their lesson plans were culturally relevant because students would be familiar with something involved in the context. Lemons-Smith (2013) described her cursory category as one where engagement as a result of student interest might be typical in how the PSTs used familiar or generic scenarios. One example she provides occurs when she calls the scenario generic because PSTs used ice cream in the story problem, because all kids love ice cream (as their rationale suggested). Similar descriptions were provided within my study by Aretha who said that all students had a mother and thus the problem would be relevant to them,

or in the case of Mariah who said that most students love animals and thus the problem would be particularly interesting and relevant to them.

While I do agree with Lemons-Smith that these represent very cursory and surface level approaches to engaging the students, I do not contend that these contexts alone help to engage student interest. Even traditional mathematics curricula have used pictures of animals to help students learn addition and subtraction concepts, and others have used "mom" references in the body of a problem. Nevertheless, I appreciate the terms established by Lemons-Smith and acknowledge that there does exist some overlap within our analysis of PSTs' lesson plans. I believe our work differs here because PSTs in my study were asked to respond directly to why their lessons were culturally relevant, and articulate their understanding, as opposed to only the researcher analyzing the application in how CRP occurs within the lesson plan. In a sense, I believe this study goes one step further to substantiate the work of Lemons-Smith.

Stephanie was one PST mentioned in Chapter 4 who discussed that her lesson plan was culturally relevant because all students were familiar with an apple and orange. Two ideas stick out in this generalization. The first is that though students may have seen some of these items, and in this case an apple, they may not have constant access to these items or resources. So while students can envision an apple, it may not be most relevant to them because they are limited in their consumption of this food product. What research has shown is that often in urban communities and households, there are food deserts and inflated prices that prevent some families from maintaining healthy diets (Beaulac, Kristjannson, & Cummins, 2009). I would argue that this has some critical impact on just how familiar students will be with a variety of fruit.

My contention here is not that I disagree that students know what an apple is, but that even to assume their overall familiarity with something may warrant further investigation. Secondly, perhaps it would be worthwhile to consider if there are obstacles in place that would prevent access to healthy food. Perhaps this problem could be more culturally relevant if the PST was operating under the assumption that students may have the image in their heads of this fruit, but do not have it as a part of their regular diet. I believe these points are relevant even in thinking about Faith's lesson as well. Though she felt that all students would have participated in a Food-Drive, that may be an assumption that is worth more investigation, and that perhaps should not be an assumption at all. Further, it may stand to be a good idea to discover exactly how much these students understand about how a Food-Drive works and consider this knowledge before it is assumed that it will be relevant to them. My bigger point here is that we must seek to stay away from any assumptions and to do the work it takes to get to know the students as a prerequisite, not look for ways to make blanket statements about what all of them should know or be familiar with at this age or stage in their mathematics career.

Age Group.

Theme two for cultural relevance suggested that the PSTs felt that their lessons were relevant because of connections to middle school student experiences. One question that began to plague me while analyzing these lessons was "who would this lesson be culturally relevant for"? While I do believe that the PSTs were off to a good start, I believe that these contexts could use a further development. One notion regarding age group as a means to address culture is that this is very general in the lesson plans. While it is true that, as Dionne suggested, middle grades students have eaten in the cafeteria, it is also true that most students have eaten in a cafeteria. To design a lesson plan with middle grades students in mind would require that there was a bit more

specificity to the experiences that are in middle school. The very cursory way of thinking about students in middle school does not seem to have the ability to draw in or directly highlight the needs of middle grades students as a goal. Thus, it is easy to disregard more thorough understandings of culture, as well as the sociopolitical consciousness that might occur among middle grades students who frequent their school cafeteria. However, here I am not suggesting that the context involving middle grades students is not relevant, but that this connection to their age group is necessary but not sufficient. There is more work to be done than to group all middle grade students with the same level of experiences and realities than what is communicated in many of the current lesson plans.

For All.

One critique that Ladson-Billings and Tate (1995) had about multiculturalism was that essentially it encompassed too many conceptions of "difference"- racial, ethnic, cultural, gender, ability, and sexual orientation to name a few. This paradigm tried to be everything for everyone, but ended up being not much to anyone. This is interesting because it relates to how the PSTs interpreted these various frameworks, specifically culturally relevant pedagogy and critical pedagogy. This is seen in how Katelyn or Aretha suggested that all of their students are going to be interested in some topic. Aretha stated that after checking profiles for her students, that all of them had mothers and thus the problem was relevant to them. I am reminded of the students that I taught in the inner-city and that though many of them had parent contacts, many of these students were being raised by a grandparent. In communities where young parents are a reality and where grandparents inherit additional roles in children's lives, teachers must be cognizant of any potential oversights. Further, I would argue that in communities where two-parents or the presence of a mother is normative, the lesson still lacks particular interest to students. It may be

relevant in the sense that it has become normalized, but merely adding a mother in a problem does not account for the entire context being culturally relevant. To accomplish this goal, and to align more closely with one of the conceptions of difference proffered by Ladson-Billings and Tate, perhaps Aretha could address marriage rates or celebrate notions of Black love or reimagined depictions of a typical family. Yet, in the current context, the lesson lacks any true depth or uniqueness; it tries to be too much to too many.

This idea of "for all" was a contention Martin (2009) elaborated on when he said that often times what is problematic with the language of "all" is that marginalized groups are typically overlooked. Indeed, it is a desire that all student learn and that all students be able to connect to the curriculum and the lesson, but more thoughtful analyses of historical attempts to accommodate "all", often results in the negligence of minoritized groups. Tate (1995) argued that this type of language ran rampant in the civil rights legislation and Martin established similar arguments in discussing the *Mathematics for All* curriculum popular at the beginning of the No Child Left Behind era. In short, this language almost seems like a cop-out in an effort to avoid any true and noteworthy attention to interrogating what Ladson-Billings (1997) used to define culture, namely, the ideas, traditions, ways of thinking, or activities that are representative of diverse cultures. Further, the question I pose concerns the teacher's willingness to survey the students for these ideas or interests. Given the context of KATE and that these are virtual students, the PSTs were somewhat limited in their ability to do this. Nevertheless, teachers would be remiss to base all of their ideas about classroom instruction on mere assumptions and expectations about their students. Although I believe that all students need to learn, I caution all educators to be critical of exactly whose interests are well-represented when we consider all students. Leonard, Moore, and Brookes (2014) begin to address this in their article by stating that

this framework does not call for essentializing, or a one-size-fits-all type of approach, it values difference.

Nevertheless, the assumption should not be that all students will take interest to what is presented in the lesson, especially without knowing the students personally. This is the assumption that teachers should move away from. As humans are unpredictable and not bound by any unequivocal result or response, we cannot predict behavior and interest with certainty in ways identical to scientific experiments. As Gutierrez (2013) posited, culture and identify are both fluid, multivocal, and contradictory. A lesson may be appealing to members within a cultural group and others within that same group may be indifferent. The contention, then, is that culturally relevant lessons, that are truly relevant for the students, are expected to garner more attention and engagement from the students. Toni Morrison contended that knowing race or culture does not tell us anything for sure about an individual. There is more work, I argue, to be done but culture provides some starting point to anchor the inquiry. Some teachers did try to account for this later in the plan, such as in the questions that they posed to students. It was not unusual for PSTs to include a question asking students about what information, item, or reference should instead be included into the mathematics problem and lesson. This is seen in the case of Aaliyah who questioned which apps the students would prefer to buy or in Tamia's lesson plan when she asked which sports equipment would they rather have. Though they mentioned that all students would be interested in the current context, what these lessons had in common is that the PST made time to survey the interests of the students.

It was very interesting that the PSTs felt that their lessons were culturally relevant if it was a context that all students could be familiar with. I believe this to be the exact opposite of what Ladson-Billings outlined in culturally relevant pedagogy. It appears that the PSTs were on

a mission to make their lessons universal and to standardize the lesson and/or curriculum. This, however, runs counter to the goal of culturally relevant pedagogy. Ladson-Billings (1998) suggested that a "race-neutral perspective purports to see deficiency as an individual phenomenon. This instruction is conceived as a generic set of teaching skills that should work for all students" (p. 19). The impetus behind using culturally relevant pedagogy is not to dilute it to the point that it is general beyond any personal identification that students can have with the content, the idea is that students can see themselves, their questions, their interests, and their realities within the curriculum. Eglash and colleagues (2013) address this idea when they suggest that heritage culture allows students to see that complex mathematical ideas were present even prior to the occurrence of European colonialism. I believe that the PSTs in this sample, although commendable for at least attempting to cater to the needs of all students, created, for the most part, lessons that were not particularly relevant for any distinct student group and that the notions of culture were too vague.

Real Life.

Additionally, I began to question for some of the lessons plans submitted by the PSTs exactly how the problems they presented were any different from what is considered to be traditional mathematic instruction. The claim was often that what they presented in the mathematics problem was something that can occur in real life. For example, one can pick up just about any mathematics textbook and find a problem that mentions crayons or school food. These contexts or references do not, alone, make the lesson culturally relevant. To quote Keyshia or Dionne, students do complete chores or go to the movies in real life, but there is not anything particularly revolutionary about them including that in their lesson plans. Their mere mentioning of something that students have heard is nothing new in the curriculum and it certainly does not

warrant the distinction of being culturally relevant. It is the thoughtful investigation into the familiar contexts that makes content culturally relevant, and it is for this reason, I believe, that all three tenets are needed to achieve the theoretical framework. Further, I began to question how often mathematics problems use scenarios that do *not* occur in real life. If the justification for a lesson being relevant is occurrence in real life, then one could argue that all mathematics is relevant to real life. I turn to pre-calculus for an heuristic example. To say that a problem is culturally relevant because it involves students attending a carnival and students go to carnivals in real life, is to reduce this pedagogy to something rather futile and standard. This is the logic by which Stephanie operated when she said that the problem was relevant because students do enjoy getting pizza when they are hungry. In all honestly, this problem may have been more engaging if the students were not going to a pizza store, and rather one located intergalactically; however, this does not happen in real life.

My point here is that by much of the rationales that were provided in this study, the greater portion of mathematics curricula in this nation would be perceived as culturally relevant. I argue that this the framework is much more complicated than merely being familiar to the students or occurring in real life. Eglash and colleagues (2013) found that mirroring the communication patterns of African American students from real-life conversations and Black vernacular allowed the students entry into the mathematical space. The researchers in that study found that culturally relevant lessons were better suited for helping to attract youth engagement, and engagement that is not by any means conspicuous in many of these lesson plans.

Given the PSTs' rationale for cultural relevance, the concept of critical consciousness was not necessary. In many of the ways that the PSTs explained their lesson as culturally relevant (e.g., familiar, for all), there was no need to critique the social environments in which

students may be coming from. What I mean by this is that for the majority of the PSTs in this study, for cultural relevance to exist, it was not incumbent upon them as teachers to foster a notion of deep thought about community resources and social issues, ideas that Ladson-Billings (1995) argued permeate culturally relevant pedagogy. If it were, I argue, then this would have been salient in more of the PSTs' responses about why their lessons were culturally relevant.

Synthesizing the Themes.

Gay's (2010) words seem ever relevant here in which she asserted that many PSTs "do not think deeply about their attitudes and beliefs towards ethnic, cultural, and racial diversity" (p. 145). I would argue that much of what is proffered in the rationales provided by the PSTs is an ideology that was prominent in the post-civil rights era. I am reminded of one episode of *GoodTime*s, a popular Black sitcom in the early 70s. In one very memorable episode, the parents go to their son's school to confront the teacher about the test that he was required to take. As one of the brightest kids in their family, they had high expectations for their son's post-secondary capabilities. However, the test suggested that he should have career goals that were not contingent on a college graduation. The underlying argument in this episode was that Michael did not perform well because he was tested on content about which he had no background knowledge. The test used scenarios that were only relevant to children who came from middle or high-class ways of life. My argument here is that during this period, there was a consensus that assessment and curriculum needed to be accessible to all students, and that only resources accessible to students from all backgrounds should be used to make conclusions about student knowledge. Yet, I see the framework proposed by Ladson-Billings (1995) to extend this mandate. Ladson-Billings is not arguing for a curriculum that is just familiar to all, (e.g., one that uses familiar fruit), she is arguing for a curriculum that represents that ideas and traditions of a

specific people. This curriculum is one that should represent the brilliance and accomplishments of diverse groups, while simultaneously challenging systems of oppression that assume deficits in non-dominant groups within society in general, and in education specifically. This, I argue, is particularly more advanced than what was deemed necessary in the 70s.

I began this study by posing the problem that ideas of diversity and equity tend to be much more neutral conceptualizations, and that those who are seeking to become more culturally relevant in their pedagogy are less often approaching it through a racialzized lens. I also argued that though not necessary to address culture or to make the lesson culturally relevant, that if the PSTs in the current study were making no ties to culture from a racialized lens, I was interested in understanding which lens or conception of culture they were targeting in their lesson plan. The findings discussed in the previous chapter are interesting given the context in which these lesson plans were written. In a spirit of currere, a journey into the regressive moment is mandatory in understanding the context in which these lesson plans were created. Fall 2013 represented a very crucial time in America particularly for African Americans, as this marked the same year that Trayvon Martin was assassinated. Briefly, Trayvon Martin was a Black teenager who was killed by a neighborhood watch volunteer in Florida. Trayvon's death sparked a rekindled rage in America about social justice, particularly among African Americans, and police brutality. His death led to a movement that has since become well known on a national level, that which is known as Black Lives Matter. What is relevant about Trayvon's death is that cultural relevance must account for its two progressive tenets, cultural competence and sociopolitical consciousness. It would seem to me that some of these lesson plans developed around this time would integrate the needs of some of the students who were very concerned about whether their Black Lives Matter, especially within the mathematics classroom. I do not believe that education

can exist in a vacuum that ignores these realities or seeks to avoid them for the sake of avoiding difficult dialogue.

The aforementioned discussion is consistent with the admonitions proposed by Ladson-Billings (1998) and Martin (2009). The reality is that this pedagogy, like others following the multicultural or critical race traditions, are susceptible to a more distilled and ineffective version that does not accomplish the original goals. As a result, there is a reality of transmuting theory in a way that only allows multicultural theories to be shadows of their conceptual selves (Ladson-Billings, 1998), but that result in manifestations that are superficial and trivial celebrations of diversity" (p. 22). For the critic that may argue that the lens through which I see cultural relevance is narrowly focused on race and that these PSTs need not mention cultural relevance along racial or ethnic lines, I counter this notion by suggesting that the original framework of culturally relevant pedagogy arrived out of Ladson-Billings' work with low-income, African American students. To see color allows one to begin to see culture, to value cultural relevance, and to utilize it within one's pedagogy.

I believe that Pinar (2004) provided a way to avoid the triviality that researchers like Martin and Ladson-Billings have warned against. To understand the moments that are transpiring in a student's life is to understand what is culturally relevant to them in that space and time. I do believe that cultural relevance can and is generational, and that these ideas are fluid. What is culturally relevant, particularly for students in this time from a political standpoint, are the propositions that permeate social media and that call for greater attention to Black Lives Matter, the current presidential administration, the NFL and its commitment (or violation) of freedom of speech, and the ability to mathematize all of these aspects. This has the potential to make the lessons culturally relevant and that avoid the potentially superficial levels of cultural relevance

described in previous research. Further, I contend that these are ideas that can be planned for in a lesson plan and that have the ability to connect to students' experiences. This builds on the understanding of the PSTs in this study because these are issues that I would argue are familiar to the students and that may be important to them and that promote more rigorous mathematics learning. In future research, the ideas presented here that merge the ideologies of currere and CRP will be interrogated further to suggest how culturally relevant mathematics tasks are contingent upon the current political factors, especially as one analyzes connections to cultural competence and sociopolitical consciousness. While one must acknowledge the ongoing debates between critical other curriculum theorists (e.g., the "purposes and methods of explanation, justification, and empirical validation in radical scholarship", (Pinar & Bowers, 1992, p. 174)), curriculum and pedagogy would benefit from renewed attention to past, present, and future events that impact mathematics learning for diverse learners.

Though part of this discussion may be speculation, what would have been interesting is that if more of the students felt that the presentation from Chance Lewis on culturally relevant pedagogy or the reading of Ladson-Billings affected their diversity awareness or knowledge about teaching for equity *a lot*, would their lesson plans have been a bit more culturally relevant. In other words, would more lesson plans have ranked higher on the M-RICR. What this information does suggest is that perhaps the PSTs' understanding of cultural relevance was not necessarily grounded in the theoretical implications as proposed by the developer of this pedagogy.

Lastly, there is potential in these lessons to accomplish what NCTM outlined in the *Principles to Actions* (Leinwand et al., 2014) publication and have designated as the higher cognitive demands. In describing cognitively guided instruction, Lienwand and colleagues

suggest that higher order mathematics skills are captured in tasks that require students to perform mathematical procedures that are connected to the conceptual understandings, and that "doing mathematics" involved students finding solutions that were not necessarily laid out for them by the instructor. What is interesting is that the ideas which promoted more rigorous mathematical thinking were typically articulated in the latter half of the PSTs' lesson plans (i.e., extensions and questions to probe understanding) and were more consistent with inclusion and exclusion criterion that placed this evidence in the critical consciousness and academic excellence categories. I believe the PSTs demonstrated this at different points in their lesson plans, such as when Candi planned to ask students to compare the different methods that were used. Rigorous mathematics thinking helps students to build notions of why they complete certain procedures. However, I do believe that the rigorous mathematics learning can be conducted alongside the full scope of culturally relevant pedagogy and include all three tenets, and Matthews, Jones, and Parker (2012) offer practical means by which this can be done.

Research Question 2

In this section I highlight certain ideas from the previous chapter that were of particular interest to this study, and provide a bit more commentary on the significance of these findings. I begin by addressing the PSTs who scored in the moderate and substantive categories, and then discuss ideas regarding some of the other course activities.

The High-Scoring PSTs

As mentioned in Chapter 4, most of the high scoring PSTs indicated that Kathryn McKenzie's lecture was the course activity that was able to change their awareness about diversity issues. In describing equitable and excellent teaching (McKenzie & Locke, 2009), McKenzie asserted that all children are capable of high levels of academic achievement and that

the use of the word all was irrespective of the child's race, culture, language, religious affiliation, or any other component of their identity. She then proceeded to address the idea that traditional school practices were not working for all school children, and that a change in practices was thus necessary.

It is intuitive that the theme of "for all" was consistent across many of the lesson plans submitted by the PSTs. They indicated how much of an impact that the incredible scholarship of McKenzie had on their diversity awareness, and this became evident in their rationales and in the mathematics problem contexts that they provided. However, it is important to note here that a key element to what McKenzie and Locke suggested is that traditional school practices may not work for all students. I argued earlier that by much of the rationale provided by the PSTs, traditional curriculum could be seen as culturally relevant. The charge that McKenzie and Locke described was not salient in the PSTs' lesson plans. Although they began to acknowledge that equity was lacking in the curriculum as a whole and that it was not reflecting all students' needs and interests, I argue that they interpreted the language of McKenzie and Locke so generally that it does not take into account the needs or the representations of any particular student groups. It seems that, in an effort to address the concern about school practices that were not working for all students, that they attempted to design lesson plans that were generic enough in their instructional practices (in this case, lesson plans) that they could be effective and consistent with any diverse group that saturates American classrooms. These PSTs are making steps towards thinking about all students and thus towards notion of equity, but I believe that this work warrants further grappling with ideas that are particularly culturally relevant.

McKenzie and Locke (2009) further established that schools are rich with diversity, and that this diversity should be embraced and viewed as an asset. I argue that the PSTs' infatuation

with "for all" neglected to make use of diversity and/or difference that accompanies ideas of cultural relevance. It is antithetical to erase any means of diversity in an attempt to account for all students, and it dilutes the potential of a mathematics curriculum that can be genuinely culturally relevant; I posit that these two endeavors cannot exist simultaneously and that diversity exists as one prerequisite of culturally relevant pedagogy.

Martin (2012) insisted that learning mathematics while Black should be a consideration of educators. Further, he asserted that "This is not a narrow call meant to suggest that Black children are idiosyncratic in their mathematics development. This is a call with much richer aims focused on learning and identity, two centrally important considerations in children's mathematical development" (p. 49). It would stand to reason, then, that there are individualistic nuances that accompany what Martin has termed mathematics identities. These identities are not constructed productively, I argue, when the curriculum and the lessons do not reflect aspects of students' culture. Assimilationist curricula such as *Mathematics for All* (Martin, 2009), overlook the tenets of culturally relevant pedagogy with claims of neutrality and benefits for all students. Cultural relevance, in its push towards establishing equity in mathematics education, does not, as these PSTs implied, omit specificity towards culture and difference, it utilizes it in the instructional process. Further, I assert that this was an aspect of McKenzie and Locke's (2009) scholarship that the PSTs did not fully employ.

One finding that arose out of this study was that the PSTs did not indicate much impact of the Ladson-Billings (2006) article on their awareness or knowledge. Among the PSTs who had a substantive or moderate lesson plan, only one PST out of this subgroup indicated that the reading changed their awareness or knowledge *a lot*. An interesting phenomenon here is that in describing culturally relevant teachers, Ladson-Billings states that "these teachers use many real-

life and familiar examples that help the classroom come alive" (p. 33). This language found its way into the lesson plans submitted by the PSTs, so much so that they became themes within my findings. Yet, Ladson-Billings constructs the idea of *real-life* and *familiar* in ways that incorporate metaphors that are consistent with the students' view of the world and builds on their affinities and interests. I believe this to be starkly contrasted with the way the PSTs operationalized notions of familiarity and real-life. For them, it was sufficient if the described context could actually occur in real life. This meant that because seasons did change, or because kids did eat in cafeterias, their problems were culturally relevant. In comparison to the teacher that Ladson-Billings described as structuring her entire class around different sectors of the economy, the examples provided by the PSTs are beginning steps towards more real-life and familiar connections. I argue here that a more thorough reading or internalization of what was presented in this particular scholarship from Ladson-Billings would have impacted the PSTs' awareness of diversity and knowledge about teaching for equity, and helped to design more substantive and moderate lesson plans according to the M-RICR.

It seems that there are some important points that counter the ideas and themes that arose in many of these lesson plans. For one, Ladson-Billings (2006) suggests that cultural relevance helps teachers to understand that neither curriculum nor instruction are neutral documents, and that they are in fact cultural artifacts. She goes on to say that it is this understanding of instruction and curriculum that helps teachers in their efforts to "engage, cajole, convict, and perhaps fool students into participation" (p. 33). Further, I argue that these actions (e.g., engaging and convicting) require connections to students' culture that are anchored on more specific aspects of students' individual interests, not something that promises to be relevant for all students.

The other course activities referenced in the findings included one of the Algebra Problem-Solving Equity Challenge (APSEC) problems and the language moves assignment. The APSEC problem reference on the DPRI was entitled the Soda Problem, and like all of the APSEC categories, followed one of the equity strategies that the PSTs designed their lessons around. Because students of color are more likely to be in classrooms where teachers are less prepared to teach mathematics (Kulm et al., 2016), the APSEC activities include two to four misconceptions for the PST to address. Also included in these activities are equity questions that may reflect student backgrounds and everyday experiences, as well as "off-topic" issues that may be important to diverse students whom the PSTs may later encounter. The language moves assignment, as it implies, was geared towards the PSTs becoming more cognizant of the language that they were using during tutoring sessions in the virtual environment and the implications that were communicated with this language. Part of this language looked at how the PSTs moved from what the students were doing in a mathematics problem to what he or she was thinking about the concept (Oner, Davis, & Kulm, 2014a). Another move that was analyzed in this activity was whether the PSTs asked the students to articulate meaning behind a procedure that was being performed. These two activities, although referenced by two of the 10 teachers in the high-level CR categories, were not indicated by the PSTs to be as prominent in changing their awareness or knowledge.

Lastly, the findings indicated that the only PST to have a substantive lesson plan, Gladys, did not indicate that any of the activities changed her awareness or knowledge about diversity *a lot.* However, she did indicate, similar to the other PSTs in this sample, that the one course activity that impacted her awareness and knowledge *somewhat* was the presentation by Kathryn McKenzie. While her lesson had many elements of culturally relevant teaching, she did not

attribute this ability to incorporate these elements into her lesson plan as a result of the activities from the problem-solving course. The evidence within her lesson plan accounted for many facets of academic excellence, cultural competence, and sociopolitical consciousness in ways similar to how Ladson-Billings (2006), Tate (1995), and Leonard and colleagues (2014) have described. This may suggest that Gladys came into the course with a natural propensity towards these and prior reflection on how they become ingrained in lesson planning and pedagogy. Contrastingly, Phyllis, the second highest scoring PST in the group, indicated that most of the activities changed her awareness and knowledge *a lot*. It would seem that for Phyllis, the entire collective of course activities helped her to construct more practical notions of equity, diversity, and cultural relevance that could then be incorporated within her lesson plan for the virtual environment.

All the PSTs

One of the culminating activities in the problem-solving course was the Second Life lessons where the PSTs presented the lesson in a virtual middle grades classroom simulation. Much work was done to introduce the PSTs to ideas of equity and culturally relevant pedagogy and this work was structured to prepare the PSTs to design more effective and equity conscious lesson plans. A tangible manifestation of these efforts was incorporated within the PSTs' problem-solving lessons in Second Life. Though not explored further in the current study, it is palpable that the PSTs found the Second Life problem-solving lessons to be the other activity that helped to change their awareness about diversity issues and knowledge about teaching algebra for equity.

What is unique about the KATE project was that the virtual classroom simulations allowed the PSTs to have more focused practice with diverse students than the sporadic instances

that may arise in field experiences (Davis et al., 2012). The teacher preparation activities were designed to help PSTs teach three early algebra concepts (e.g., change, variables, and operations) effectively to diverse learners, and their lesson plans were designed particularly for this context. It is reasonable, then, as to why the lesson presentations were seen by the PSTs to be so crucial in helping them understand issues of equity. Ma and colleagues (2016) further described the Second Life environment in which these PSTs taught as one that resembled a classroom of ethnically diverse students. The construction of avatars and role-playing by KATE research members alongside the PSTs in Second Life helped to integrate various types of ethnic and cultural perspectives that could be transferable in the PSTs' lesson plans.

I say all of this to suggest that the Second Life lessons, as a huge component of the problem-solving course, has evidence in how the PSTs came to experience and learn about diversity and equity. In referencing the results from the M-RICR, it would seem that perhaps more than one opportunity to teach within Second Life would allow the PSTs to design more culturally relevant lessons. However, the time constraint within one semester and on semi-large class sizes may not allow for this to occur. Nevertheless, this activity shines light on how thoughtful the KATE team was in designing the classroom and simulations in Second Life, and how much work is needed to help prepare teachers to design mathematics problem-solving lessons that reflect the tenets of culturally relevant pedagogy.

In addressing the scholarship of Ladson-Billings as one of the assigned readings, the PSTs in this study suggested that it really had little change on their awareness or knowledge about diversity. Of all the items in the DPRI, the indication of *no change* was highest on this particular activity. Most of the PSTs indicated that the reading caused them to, at best, rethink their awareness and knowledge. While there is a need for further analysis on this finding, it could

be a product of PSTs finding assigned readings to be less apt, exciting, or practical to their experience as undergraduate students.

Implications for Practice

I believe that a thorough and conscious look into philosophy will benefit the field of mathematics education. One implication that I provided in this study is that a more concrete look into the idea of hermeneutics would allow for a better understanding of cultural relevance. What is often the case is that terminology that is used within the academic or scholarly realms is not always synonymous with that which is deemed colloquial. I believe that one step that teachers and teacher educators must take is to become more familiar with the concept of hermeneutics, a concept that post-modernism has described as the art of interpretation (Krasny & Slattery, in-press). Though not fully explored in this study, future research would benefit from a reflective approach to hermeneutics (Slattery, 2003) as a goal of implementing culturally relevant pedagogy. Like Gallagher (1992), I argue that creativity and aesthetics is central to interpretation, and these components are inherent in developing and understanding culturally relevant mathematics curriculum. Curriculum and the approaches to implement it must undergo a hermeneutical enterprise. In this sense, I suggest revisiting Ladson-Billings' (1994) original conception of culturally relevant pedagogy. An important prerequisite in developing PSTs who fully embody a culturally relevant pedagogy is to understand that cultural relevance does not exist outside of these three tenets. To suggest that a lesson plan is culturally relevant with no attention to the tenets of culturally relevant pedagogy taints the authenticity of this framework. This is why hermeneutics is important to CRP because, in its reflective form, hermeneutics is concerned with understanding, interpretation, and critical assessment (Slattery, 2003). We must help PSTs understand that the work of culturally relevant pedagogy is not reduced to idiomatic

understandings of the colloquial connotations of *relevant* or *culture*, but that collectively, culturally relevant pedagogy is interpreted and operationalized through the tenets of academic success, cultural competence, and critical consciousness.

To this point, I believe there is more work needed to assist PSTs account for cultural competence. The results in this study showed the indicators of cultural competence were some of the lowest in regard to being fully implemented. While the entire framework is important to the overall implementation of culturally relevant pedagogy, it would be worthwhile in perhaps devoting increased attention to developing this concept for PSTs. In a recent article, I have articulated how this could be approached for Black students (Ortiz et al., in-press). Briefly, as metaphors are so common in Black vernacular and in hip-hop music, mathematics discourse (Ball, 1991) could be promoted by privileging communication patterns that permeate music and reframing them as new forms of praxis within our mathematics classrooms. The opportunities abound.

Secondly, I believe it is the job of the teacher educators to help PSTs develop more thorough understandings of culturally relevant pedagogy. In the same way that teacher preparation programs allocate considerable amounts of time to designing lesson plans, these educators must plan to incorporate cultural relevance as a requirement for these lesson plans. I believe a more thorough way to approach this is to ask students, instead of how or why their lessons are culturally relevant, how they have addressed each tenet within their lesson plans. The M-RICR is a promising and useful tool to accomplish this goal within mathematics methods courses.

Conclusion

In closing this study, it is important to revisit the objectives and the significance of the scholarship. I have shown how at least one PST designed a substantive lesson plan and thus provided a good representation of cultural relevance. I have analyzed all lesson plans to determine how they aligned with culturally relevant pedagogy, and have shown why I believe that the PSTs did, and in some cases did not, demonstrate alignment with the tenets of culturally relevant pedagogy. I have articulated how the PSTs have changed in both their awareness of diversity issues and their knowledge about teaching algebra for equity. Lastly, I have addressed tenets of culturally relevant pedagogy as they are operationalized within the 11 indicators and shown that though cultural relevance can and does occur during face-to-face instruction, it is also an aspect that occurs within the lesson plan. In attending to each of these objectives, I have answered my research questions and indicated how well the PSTs did with designing culturally relevant mathematics lesson plans for a virtual classroom environment, as well as discussed the change in their awareness of diversity and knowledge about teaching for equity.

In addressing the research problem, it is clear that ideas of race and racism are not prevalent in PSTs' lesson plans, and as such, lacked one intuitive way to make the lessons culturally relevant. Although there are beginning ideas of equity in many of the lesson plans, there is still potential to expand upon these ideas in ways that make it more applicable to a wide range of students. As a unique aspect of this study, I found it helpful for the PSTs to articulate why they felt their lesson plans were culturally relevant. This provided more insight into how they perceived this framework and allowed me to better understand the realities and positionalities that they were bringing into their teaching. If this aspect of the study was not here, many of the lessons would not have had readily apparent conceptions of culture. In this regard, I

believe I bring new ideas to the field concerning exactly why the PSTs may be designing mathematics problem-solving lessons that are not yet exemplars of this framework. Their articulation regarding their lesson plans is crucial.

Limitations

As the researcher, my own biases necessarily impact the story that is told in this study, yet this construction is meant to be authentic and to represent the PSTs' accomplishments and shortcomings most effectively. Qualitative work takes into account that certain lenses influence all constructivist scholarship. While I operated within a conception of culture along the lines of racial and ethnic identity, I was open to the many other interpretations of culture that could have, and often times did, emerge throughout this study. Also another element of qualitative research, this data is situated within one location and thus cannot be generalized to all populations of PSTs. It provides a depiction about possibilities that may undergird the attempts of other PSTs to implement cultural relevance into mathematics lesson plans, but it does not definitively account for all PSTs. Additionally, I fully acknowledge that some critics may argue that the lesson presentation within the Second Life virtual classroom would have allowed me to further triangulate the findings discussed here. While this may be true, I see this as a means for future research. As was articulated by my conceptual framework, I am much more interested, as a preliminary step, in understanding how PSTs *plan* to use cultural relevance to teach mathematics. I see the planning and delivery process as two processes that overlap but warrant their own attention. With this principle in mind, the current study intentionally addresses the first of these two manifestations.

Although culturally relevant pedagogy may surface in the actual lesson presentation and interaction with students, evidence of CRP should be consistent even in the planning process, or

in other words the first of the two manifestations described. In her book, Ladson-Billings (1994) described the pedagogy of teachers that she identified as culturally relevant. In this sense, the teachers were using cultural relevance even without knowing the formalized conceptual framework coined by Ladson-Billings. For this reason, it was worthwhile to use the M-RICR on the lesson plans, and more specifically, to use it on all the lesson plans from each scheme, as there was some evidence of cultural relevance even in the critical pedagogy and situated learning conceptual schemes.

REFERENCES

Adefope, O. (2014). Geometry: A medium to facilitate geometric reasoning among sixth grade African American males. *Georgia Educational Researcher, 11*(1), 86-121.

Anderson, J. R., Reder, L. M., & Simon, H. A. (2000). Applications and misapplications of cognitive psychology in mathematics education. *Texas Educational Review,* 29-49.

Arreguin-Anderson, M. G., & Ruiz, E. C. (2013). Looking for science and mathematics in all the right places: Using mobile technologies as culturally-sensitive pedagogical tools to capture generative images. *Association of Mexican-American Educators Journal, 7*(1), 17-26.

Ares, N. (2008). Cultural practices in networked classroom learning environments. *Computer-Supported Collaborative Learning, 3,* 301-326.

Ball, D. L. (1991). What's All This Talk about" Discourse"?. *The Arithmetic Teacher*, *39*(3), 44-48.

Ball, D. L. (1996). Teaching learning and the mathematics reforms: What we think we know and what we need to learn. *Phi Delta Kappan, 77*(7), 500-508.

Baker, T. L. (1994). *Doing social research* (2nd ed.). New York: McGraw-Hill Inc.

Banks, J. A. (1979). Shaping the future of multicultural education. *Journal of Negro Education, 47*(3), 237-252.

Bell, D. (1992). Race, racism, and the law. *Boston: Little*.

Berry III, R. Q., Thunder, K., & McClain, O. L. (2011). Counter narratives: Examining the mathematics and racial identities of Black boys who are successful with school mathematics. *Journal of African American Males in Education,* 2(1), 10-23.

Berry, R., III, & Walkowiak, T. A. (2012). Using culturally relevant pedagogy and social justice to understand mathematics instructional quality in an urban context. In J. L. Moore, III, & C. W. Lewis, (Eds.), *African American students in urban schools: Critical issues and solutions for achievement,* (pp. 161-184). New York, NY: Peter Lang.

Blaisdell, B. (2016). Schools as racial spaces: Understanding and resisting structural racism. *International Journal of Qualitative Studies in Education, 29*(2), 248-272.

Bonner, E. P., & Adams, T. L. (2012). Culturally responsive teaching in the context of mathematics: A grounded theory case study. *Journal of Mathematics Teacher Education, 15*(1), 25-38.

Boykin, A. W. (1983). The academic performance of Afro-American children. In J. T. Spence (Ed.), *Achievement and achievement motives* (pp. 322-371). San Francisco: Freeman.

Bracey, J. M. (2013). The culture of learning environments: Black student engagement and cognition in math. In J. Leonard & D. B. Martin (Eds.), *The brilliance of Black children in mathematics: Beyond the numbers and toward new discourse* (pp. 171–195). Charlotte, NC: Information Age.

Boaler, J., & Staples, M. (2008). Creating mathematical futures through an equitable teaching approach: The case of railside school. *Teachers College Record, 100,* 608-645.

Bourdieu, P., & Passeron, J. (1977). *Reproduction in education, society, and culture*. London: Sage.

Burns, R. B., & Lash, A. A. (1988). Nine seventh-grade teachers' knowledge and planning of problem-solving instruction. *Elementary School Journal, 88,* 369-386.

Cahnmann, M. S., & Remillard, J. T. (2002). What counts and how: Mathematics teaching in culturally, linguistically, and socioeconomically diverse urban settings. *Urban Review, 34*(3), 179-204.

Capraro, R. M. (2001*). Exploring the influences of geometric spatial visualization, gender, and ethnicity on the acquisition of geometry content knowledge*. Paper presented at the annual meeting of the Southwest Educational Research Association, New Orleans, LA. ERIC Document Reproduction Service No. ED451057.

Carter, P. (2003). "Black" cultural capital, status positioning, and schooling conflicts for low-income African American youth. *Social Problems, 50*(1), 136-155.

D'Ambrosio, U. (1985). Ethnomathematics and its place in the history and pedagogy of mathematics. *For the Learning of Mathematics, 5*(1), 44-48.

Darling-Hammond, L. (2006). Constructing 21st-century teacher education. *Journal of Teacher Education*, *57*(3), 300-314.

Darling-Hammond, L., & Baratz-Snowden, J. (2007). A good teacher in every classroom: Preparing the highly qualified teachers our children deserve. *Educational Horizons*, *85*(2), 111-132.

Davis, T. J. (2017). *Technology-mediated practice-based teacher education: Designing, using, and researching digital environments for teacher learning*. Paper presented at the annual meeting of the Association of Mathematics Teacher Educators, Orlando, FL.

Davis, T., Brown, I., Kulm, G., Chien, C.F. & Phillips, G. (2012). Knowledge for Teaching Algebra For Equity: Preservice Teachers' Perceptions of Classroom Simulations and Experiences in Second Life. In P. Resta (Ed.), *Proceedings of Society for Information*

Technology & Teacher Education International Conference 2012 (pp. 2498-2509). Chesapeake, VA: Association for the Advancement of Computing in Education (AACE).

Davis, T. J., Kulm, G., Oner, A. T., Indiogine, S. E. P., Goldsby, D., & Ma, T. (2015). Preservice teachers' problem solving lesson engagement and knowledge and beliefs about teaching for equity. In J. Hammer & Y. Li (Eds.), *Teaching at Work* (pp. 51-80). Rotterdam, Netherlands: Sense.

Davis, T. J., & Ortiz, N. A. (2017). Technology and African American girls: We can be techies too. In P. J. Larke, G. Webb-Hasan, & J. Young (Eds.), Cultivating achievement, respect, and empowerment (CARE) for African American girls in preK-12 settings: Implications for access, equity and achievement (pp. 133-152). Charlotte, NC: Information Age.

Davis, T. J., Phillips, G. A., & Kulm, G. (2018). Creativity and the design of music-mathematics activities in a virtual simulation learning environment. In V. Freiman & J. Tassell (Eds.), *Creativity and Technology in Mathematics Education*. New York: Springer.

Delpit, L. (1995). *Other People's Children.* New York, NY: The New Press.

Delpit, L. D. (2012). *" Multiplication is for White People": Raising Expectations for Other People's Children*. The New Press.

Dewey, J. (1933). *How we think: A restatement of the relation of reflective thinking to the educative process.* Boston: D. C. Heath.

Doak, R. K., & King, S. L. (1999). *U.S. Patent No. 5,864,869*. Washington, DC: U.S. Patent and Trademark Office.

Du Bois, W. E. B. (1935). Does the Negro need separate schools? *The Journal of Negro Education, 4*(3), 328-335.

Eglash, R., Gilbert, J. E., Taylor, V., & Geier, S. R. (2013). Culturally responsive computing in urban, after-school contexts: Two approaches. *Urban Education, 48*(5), 629-656.

Enyedy, N., & Mukhopadhyay, S. (2007). They don't show nothing I didn't know: Emergent tensions between culturally relevant pedagogy and mathematics pedagogy. *Journal of Learning Sciences, 16*(2), 139-174.

Erickson, F. (1986). Culture difference and science education. *The Urban Review*, *18*(2), 117-124.

Esmonde, I. (2009). Ideas and identities: Supporting equity in cooperative mathematics learning. *Review of Educational Research, 79*(2), 1008-1043.

Esposito, J., Davis, C. L., & Swain, A. N. (2012). Urban educators' perceptions of culturally relevant pedagogy and school reform mandates. *Journal of Educational Change*, *13*(2), 235-258.

Ezeife, A. N. (2002). Mathematics and culture nexus: The interactions of culture and mathematics in an Aboriginal classroom. *International Education Journal, 3*(3), 176-187.

Farrell, T. S. (2002). Lesson planning. *Methodology in language teaching: An anthology of current practice*, 30-39.

Ferrell, B. G. (1992). Lesson plan analysis as a program evaluation tool. *Gifted Child Quarterly, 36*(1), 23-26.

Foley, D. E. (1997). Deficit thinking models based on culture: The anthropological protest. In R. Valencia (Ed.) *The evolution of deficit thinking: Educational thought and practice* (pp. 113-131). Washington, DC: Falmer Press.

Fruden, S. J. (1984). Lesson plans can make a difference in evaluating teachers. *Education, 104*(4), 351-353.

Gallagher, S. (1992). *Hermeneutics and education.* Albany: State University of New York Press.

Gay, G. (2002). Preparing for culturally responsive teaching. *Journal of Teacher Education, 53*(2), 106-116.

Gay, G. (2007). The rhetoric and reality of NCLB. *Race, Ethnicity, and Education, 10*(3), 279-293.

Gay, G. (2010). Culturally responsive teaching (2nd ed.). New York, NY: Teachers College Press.

Gay, G., & Howard, T. C. (2000). Multicultural teacher education for the 21st century. *The Teacher Educator*, *36*(1), 1-16.

Gee, J. P. (2008). A sociocultural perspective on opportunity to learn. *Assessment, Equity, and Opportunity to Learn,* 76-108.

Gerdes, P. (1988). On culture, geometrical thinking, and mathematics education. *Educational Studies in Mathematics,* 137-162.

Glaser, R., & Silver, E. (1994). Assessment, testing, and instruction: Retrospect and prospect. *Review of Research in Education, 20*, 393-419.

Gonzalez, N., Moll, L. C., Tenery, M. F., Rivera, A., Rendon, P., Gonzales, R., & Amanti, C. (1995). Funds of knowledge for teaching in Latino households. *Urban Education*, *29*(4), 443-470.

Greene, D. M., & Walker, F. R. (2004). Recommendations to public speaking instructors for the negotiation of code-switching practices among Black English-speaking African American students. *Journal of Negro Education*, 435-442.

Gutierrez, K. D. (2002). Studying cultural practices in urban learning communities. *Human Development, 45*(4), 312-321.

Gutiérrez, R. (2008). A "gap-gazing" fetish in mathematics education? Problematizing research on the achievement gap. *Journal for Research in Mathematics Education, 39*(4), 357-364.

Gutiérrez, R. (2013). The sociopolitical turn in mathematics education. *Journal for Research in Mathematics Education, 44*(1), 37-68.

Gutstein, E. (2003). Teaching and learning mathematics for social justice in an urban, Latino school. *Journal for Research in Mathematics education*, 37-73.

Gutstein, E. (2006). *Reading and writing the world in mathematics.* New York: Teachers College Press.

Gutstein, E., Lipman, P., Hernandez, P., & de los Reyes, R. (1997). Culturally relevant mathematics teaching in a Mexican American context. *Journal for Research in Mathematics Education*, 709-737.

Gutstein, E., & Peterson, B. (Eds.). (2005). *Rethinking mathematics: Teaching social justice by numbers.* Milwaukee, WI: Rethinking Schools.

Haberman, M. (1991). The pedagogy of poverty versus good teaching. *Phi Delta Kappan, 73,* 290-294.

Harper, S. R., & Davis III, C. H. (2011). They (don't) care about education: A counternarrative on Black male students' responses to inequitable schooling. *The Journal of Educational Foundations, 26*, 103-120.

Hmelo-Silver, C. E., Ducan, R. G., & Chinn, C. A. (2007). Scaffolding and achievement in problem-based and inquiry learning: A response to Kirschner, Sweller, and Clark (2006). *Educational Psychologist, 42*(2), 99-107.

Hollis, E. R. (1996). *Culture in school learning: Revealing the deep meaning.* Boston: Allyn and Bacon.

Howard, T. C. (2003). Culturally relevant pedagogy: Ingredients for critical teacher reflection. *Theory into Practice, 42*(3), 195-202.

Howard, T. C. (2008). Who really cares? The disenfranchisement of African American males in prek-12 schools" A critical race theory perspective. *Teachers College Record, 110*(5), 954-985.

Howard, T. C. (2010). *Why race and culture matters in schools: Closing the achievement gap in America's classrooms*. New York, NY: Teachers College Press.

Johnson, W., Nyamekye, F., Chazan, D., & Rosenthal, B. (2013). Teaching with speeches: A black teacher who uses the mathematics classroom to prepare students for life. *Teachers College Record, 115*(2), 1-26.

Krasny, K. A., & Slattery, P. (in-press). Hermeneutics: The art of interpretation.

Krenshaw, K. (1989). Demarginalizing the intersection of race and sex: A Black feminist critique of antidiscrimination doctrine, feminist theory and antiracist politics. *University of Chicago Legal Forum,* 139-167.

Kulm, G., Brown, I. A., Lewis, C. W., Davis, T. J., An, S., & Anderson, L. (2011). Knowledge foundations for teaching algebra for equity. *Proceedings of the 33rd Annual Conference of the North American Chapter of the International Group for the Psychology of Mathematics Education* (pp. 182-189).

Kulm, G., Merchant, Z., Ma, T., Oner, A. t., Davis, T., & Phillips, G. (2016). Algebra problem-solving equity challenges: Building middle school preservice teachers' awareness. *Teacher Education and Practice, 29*(4), 642-659.

Ladson-Billings, G. (1994). *The dreamkeepers: Successful teachers of African American children.* San Francisco, CA: Jossey-Bass.

Ladson-Billings, G. (1995a). But that's just good teaching! The case for culturally relevant pedagogy. *Theory in Practice, 34*(3), 159-165.

Ladson-Billings, G. (1995b). Toward a theory of culturally relevant pedagogy. *American Educational Research Journal, 32*(3), 465-91.

Ladson-Billings, G. (1997). It doesn't add up: African American students' mathematics achievement. *Journal for Research in Mathematics Education, 28*(6), 697-708.

Ladson-Billings, G. (2006). Yes, but how do we do it? Practicing culturally relevant pedagogy. In J. Landsman & C. W. Lewis (Eds.), *White teachers/Diverse classrooms: A guide to building inclusive schools, promoting high expectations, and eliminating racism* (pp. 29-42). Sterling, VA: Stylus Publishing.

Lamont, M., & Lareau, A. (1988). Cultural capital: Allusions, gaps, and glissandos in recent theoretical developments. *Sociology Theory, 6*(2), 153-168.

Leinwand, S., Brahier, D. J., Huinker, D., Berry, R. Q., Dillon, F. L., Larson, M. R., . . . Smith, M. S. (2014*). Principles to actions: Ensuring mathematical success for all*. Reston, VA: NCTM.

Lemons-Smith, S. (2013). Tapping into intellectual capital of black children in mathematics: Examining the practices of pre-service elementary teachers. In J. Leonard & D. B. Martin (Eds.), *The brilliance of Black children in mathematics: Beyond the numbers and toward new discourse* (pp. 323-339). Charlotte, NC: Information Age.

Leonard, J., Brooks, W., Barnes-Johnson, J., & Berry, III, R. Q. (2010). The nuances and complexities of teaching mathematics for cultural relevance and social justice. *Journal of Teacher Education, 61*(3), 261-270.

Leonard, J., Moore, C. M., & Brookes, W. (2014). Multicultural children's literature as a context for teaching mathematics for cultural relevance in urban schools. *Urban Review, 46*, 325-348. doi: 10.007/s11256-013-0264-3

Leonard, J., & Moore, C. M. (2014). Learning to enact social justice pedagogy in mathematics classrooms. *Action in Teacher Education, 36,* 76-95.

Leonard, J., Napp, C., & Adeleke, S. (2009). The complexities of culturally relevant pedagogy: A case study of two secondary mathematics teachers and their ESOL students. *The High School Journal*, *93*(1), 3-22.

Lincoln, Y. (2007). The collection and generation of data. Unpublished manuscript, Department of Educational Administration and Human Development, Texas A&M, College Station, TX.

Lincoln, Y. S., & Guba, E. G. (1985). *Naturalistic inquiry*. Sage.

Lipka, J., Hogan, M. P., Webster, J. P., Yanez, E., Adams, B., Clark, S., & Lacy, D. (2005). Math in a cultural context: Two case studies of a successful culturally based math project. *Anthropology & Education Quarterly*, *36*(4), 367-385.

Ma, T., Brown, I. A., Kulm, G., Davis, T. J., Lewis, C. W., & Allen, G. D. (2016). Constructing and role-playing student avatars in a simulation of teaching algebra for diverse learners. *Urban Education, 51*(5), 534-555.

Martin, D. B. (2009). Researching race in mathematics education. *Teachers College Record, 111*(2), 295-338.

Martin, D. B. (2012). Learning mathematics while Black. *Educational Foundation, 26,* 47-66.

Mason, A. M. (2016). Disciplining Dalmar: A demand to uncover racism and racialization in pursuit of culturally relevant pedagogy. *International Journal of Qualitative Studies, 29*(2), 205-223.

Matthews, L. (2008). Illuminating urban excellence: A movement of change within mathematics education. *Journal of Urban Mathematics Education, 1*(1), 1–4.

Matthews, L. E., Jones, S. M., & Parkers, Y. A. (2012). Advancing a framework for culturally relevant, cognitively demanding mathematics tasks. In J. Leonard & D. B. Martin (Eds.), *The brilliance of Black children in mathematics: Beyond the numbers and toward new discourse* (pp. 123-150). Charlotte, NC: Information Age.

McKenzie, K. (2014). Auditing for excellent and equitable teaching. Presentation presented at Texas A&M University.

McKenzie, K. & Locke, L. (2009). Becoming a leader for equity and excellence: It starts with instruction. In S. Douglass Horsford (Ed.), New Perspectives in educational leadership: Exploring social, political, and community contexts and meaning (pp.27-58). New York: Peter Lang.

Moses, R. P., & Cobb Jr, C. (2001). Organizing algebra: The need to voice a demand. *Social Policy*, *31*(4), 4-12.

Moses-Snipes, P. R. (2005). The effect of African culture on African American students' achievement on selected geometry topics in the elementary mathematics classroom. *The Negro Educational Review, 56*(2&3), 147-166.

Nasir, N. I. S., & Hand, V. M. (2006). Exploring sociocultural perspectives on race, culture, and learning. *Review of Educational Research*, *76*(4), 449-475.

Nasir, N., Hand, V., & Taylor, E. V. (2008). Culture and mathematic in school: Boundaries between "cultural" and "domain" knowledge in the mathematics classroom and beyond. *Review of Research in Education, 32*, 187-240.

National Council of Teachers of Mathematics. (2000). *Principles and standards for school mathematics.* Reston, VA: NCTM.

Oner, A. T., Kulm, G., & Davis, T. (2014a, February). *A review of pre-service teachers' teaching analysis gained in a virtual environment.* Paper presented at the annual meeting of Southwest Educational Research Association (SERA), New Orleans, LA.

Oner, A. T., Indiogine, S. E. P., Kulm, G., Hao, H., & Allen, G. D. (2014b). Preservice mathematics teachers' effectiveness in addressing misconceptions in algebra. In M. J. Mohr-Schroeder & S. S. Harkness (Eds.). *Proceedings of the 113th annual convention of the School Science and Mathematics Association,* pp. 139-146. Jacksonville, FL: SSMA.

Ortiz, N. A. (2015, February). *Geometric resilience of African American learners.* Paper presented at the annual meeting of the Southwest Educational Research Association, San Antonio, TX.

Ortiz, N. A., Capraro, R., & Capraro, M. M. (in-press). Does it really matter?: Exploring cultural relevance within a majority White classroom. *Journal of Negro Education.*

Ortiz, N. A., Davis, T. J., & Kulm, G. (2015). A culturally relevant approach to equity inside a virtual simulation mathematics classroom. In M. J. Mohr-Schroeder & J. Thomas (Eds.), *Proceedings of the 114th annual convention of the School Science and Mathematics Association Conference*, Oklahoma City, OK: SSMA.

Ozogul, G., Olina, Z., & Sullivan, H. (2008). Teacher, Self and Peer Evaluation of Lesson Plans Written by Preservice Teachers. *Educational Technology Research and Development*, *56*(2), 181-201.

Pinar, W. F. (2004). *What is curriculum theory? (2nd ed).* Mowah, NJ: Lawrence Erbaulm Associates.

Pinar, W. F., & Bowers C. A. (1992). Politics of curriculum: Origins, controversies, and significance of critical perspectives. *Review of Research in Education, 18,* 163-190.

Polit, D. F., Beck, C. T., & Williamson, P. (2004). Design and analysis of pilot studies: Recommendations for good practice. *Journal of Evaluation in clinical Practice, 10*(2), 307-312.

Saldana, J. (2009). *The coding manual for qualitative researchers.* London (UK): Sage.

Simon, M. K. (2011). *Dissertation and scholarly research: Recipes for success* (2011 ed.). Seattle, WA: Dissertation Success, LLC. http://dissertaionrecipes.com/

Smith, L. N. (2014). Culturally relevant teaching: A case study on teaching statistics in the high school setting. (Doctoral dissertation). Retrieved from http://scholarcommons.sc.edu/etd/2944

Spielhagen, F. (2013). Disrupting inequity: How policy change can foster STEM access for underserved students. In M. M. Capraro, R. M. Capraro, & C. W. Lewis (Eds.), *Improving urban schools: Equity and access in K-12 STEM education for all students* (67-84). Charlotte, NC: Information Age.

Shulman, L. S. (1986). Those who understand: Knowledge growth in teaching. *Educational Researcher*, *15*(2), 4-14.

Skrla, L., Scheurich, J. J., Garcia, J., & Nolly, G. (2004). Equity audits: A practical leadership tool for developing equitable and excellent schools. *Educational Administration Quarterly*, *40*(1), 133-161.

Slattery, P. (2003) Hermeneutics, subjectivity, and aesthetics: Internationalizing the interpretive process in U.S. curriculum research. In W. F. Pinar, (Ed.), *International handbooks of curriculum research* (pp. 651-658). Mahwah, NJ: L. Erlbaum Associates.

Slattery, P. (2013). *Curriculum development in the postmodern era: Teaching and learning in an age of accountability, 3rd ed.* New York: Routledge.

Spooner, F., Baker, J. N., Harris, A. A., Ahlgrim-Delzell, L., & Browder, D. M. (2007). Effects of training in universal design for learning on lesson plan development. *Remedial and Special Education, 28*(2), 108-116.

Stigler, J. W., & Baranes, R. (1989). Culture and mathematics learning. *Review of Research in Education, 15*, 253-306.

Stinson, D. (2006). African American male adolescents, schooling (and mathematics): Deficiency, rejection, and achievement. *Review of Educational Research, 76*(4), 477-506.

Stinson, D. W. (2016). Dewey, Freire, and Foucault and an ever-evolving philosophy of (mathematics) education. *Journal of Research in Curriculum & Instruction, 20*(2), 70–78.

Strutchens (2012). M., Bay-Williams, J., Civil, M., Chval, K., Malloy, C. E., White, D. Y., ... & Berry, R. Q. (2012). Foregrounding equity in mathematics teacher education. *Journal of Mathematics Teacher Education*, *15*(1), 1-7.

Tate, W. F. (1995). Returning to the root: A culturally relevant approach to mathematics pedagogy. *Theory into Practice, 34*(3), 166-173.

Tate, W. F. (1997). Critical race theory and education: History, theory, and implications. *Review of Research in Education, 22*, 195-247.

Tate, W. F. (2005). *Access and opportunities to learn are not accidents: Engineering mathematical progress in your school.* Greensboro, NC: SERVE Center.

Thomas, C. D., & Williams, D. L. (2008). An analysis of teacher defined mathematical tasks: Engaging urban learners in performance-based instruction. *Journal of Urban Learning, Teaching, and Research, 4,* 109- 121.

Wager, A. A. (2014). Noticing children's participation: Insights into teacher positionality toward equitable mathematics pedagogy. *Journal for Research in Mathematics Education, 45*(3), 312-350.

Wallin, J., & Graham, T. (2002). Generativity: Lived experience as curricular content. *The Alberta Journal of Educational Research, 48*(4), 341-349.

Ye, L., Varelas, M., & Guajardo, R. (2011). Subject-matter experts in urban schools: Journeys of enacted identities in science and mathematics classrooms. *Urban Education, 46*(4), 845-879.

Yosso, T. J. (2005). Whose culture has capital? A critical race theory discussion of community cultural wealth. *Race Ethnicity and Education, 8*(1), 69-91.

Young, E. (2010). Challenges to conceptualizing and actualizing culturally relevant pedagogy: How viable is the theory in classroom practice?. *Journal of Teacher Education*, *61*(3), 248-260.